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Balanced Scorecard Model for Hazards Risk Management at Limpopo River Basin

"A Country Participatory Approach for MCDA with Scenario Planning"

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Abstract

This paper focuses on the application of both Balanced Scorecard (BSC) conceptual framework and Multi-criteria Decision Analysis (MCDA) a tool for Scenario Planning as a tool for Strategic Decision Thinking, on hazard risk management within Limpopo River Basin. We discuss best practices in four main domains areas, namely Politic (as pool for country raking worldwide), Economic, Social Development and Technology and how they can contribute to build a viable scenario for the management of the basin.

Keywords: Limpopo River Basin BSC, MCDA, strategic thinking, hazard risk management scenario planning.

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Introduction

The Limpopo River Basin, fig. 1 below, is shared by four countries namely, Botswana, Mozambique, South Africa and Zimbabwe. Availability of data about this basin is relatively limited due to different factors that are specific to each country. Three of the benefiting countries, Botswana, South Africa and Zimbabwe have common historical background as former British colonies and are English speaking, while Mozambique is the only country culturally oriented to Portuguese [6]. The above stated reasons as well as political issue have contributed how the four countries share and benefit from the Limpopo River Basin.

According the profile given in [8], the Basin is over 400000 Km² in size and covers between 11-16% of each of four countries and benefits about 14 million people. Socially and economically those countries benefit differently and how much effort is put into common efforts for risk sharing. Mozambique, located downstream, has suffered mostly from Limpopo floods in the past decades. Vaz [9], discusses the floods that occurred in the last 25 years namely in 1975, 1977, 1981, 1996 and 2000, being those of 1977 and 2000 of severe impact. Although the four countries where affected by those floods, Mozambique was most affected, and also given less contributions by the other countries.

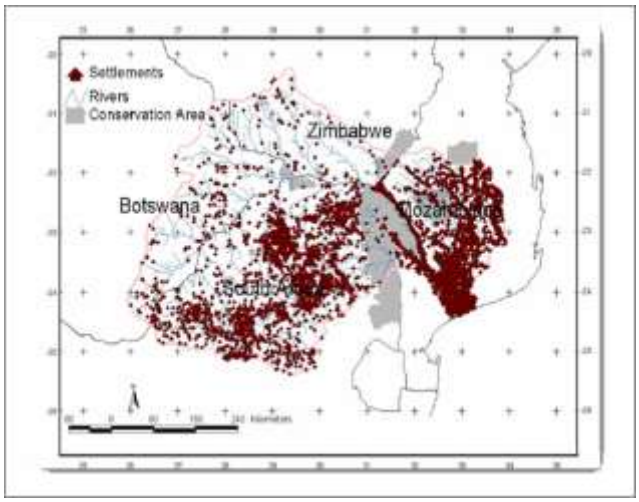


Fig. 1 Geographical distribution of social and settlements in the Limpopo River Basin *Source: [5]*

Limpopo Basin Strategic Plan for reducing vulnerability to floods and droughts [5] highlights the main sources of weaken effective management process of natural disasters over Limpopo River Basin; three layers are diagnosed namely, at country level, at basin level and overall.

At country level the strategic plan indicates the absence of clear guidelines on workflows and responsibilities, at national level regarding disaster management coupled with inappropriateness of centralize decision making to local community situations. Different landscape over the countries and settlements, characterized by inappropriate flood resistant material and lack of communication capacity, between disaster management agencies and the communities are part of the problems that reinforce the countries' imbalances and differences.

At basin level the strategic plan identifies the absence of clear guidelines rooted in a harmonized policy framework for establishing effective inter-country cooperation flood and drought disaster management and mitigation. The above situation is seemed to be a lead of shortage of information about the basin among the countries. Overall, the strategy reinforce that the critical aspects at country and sub-regional levels create weak organizational framework and low levels of preparedness at local level to flood and droughts.

Our understanding is that people when provided with the right information in prior are able to create their own preventive and managerial skills; therefore the usage of Balanced Scorecards along the Basin Strategy can contribute to minimize the suffering of those who live in the basin and develop an appropriate decision strategic thinking scenarios. Isolable, governments have shown their limited capabilities to cope with natural disaster; hence there is a need of mobilizing additional resources internally and in the region to deal with the Basin Management.

Kaplan and Norton [7] argue that "Machines are designed to run automatically. The people's job is to think, to solve problems, to ensure quality, not to watch the parts go by. Here, people are provided as problems-solvers, not variable costs", based on the above statement we believe that by sharing a balanced strategy along the Basin the four governments can add values to the process of disaster management, preventive measures and or coping with natural hazards, by combining technical efforts with local knowledge.

At regional level, the Southern African Development Community (SADC) was launched in 2001 a Sub-Regional Disaster Management Strategy covering food security, climate and environment and water management. Floods and droughts are covered by the SADC Water Sector Coordinating Unit that has a strategic approach to the management of floods and droughts. The SADC Regional Early Warning Unit develops information on weather threats, drought conditions and food security [10].

1.1. Motivations, Purpose and Methodology

We have selected those variables as part of the strategic KPI that if the countries excel in their management, they contribute to boost the economy and lower the impact of natural disatsters. The paper is composed by six sections, staring with the present one, the Introduction, which covers the basic information on the study object, the purpose and motivation of the research and describe the applied methodology.

Section two consists on a set of steps where we focus our attention to analyse of existing situation within the riparin countres. We carry out an assessment through a SWOT analysis followed by a comparative analysis of sellected key performance indicators and some keys success factors withing the countries. Section tree looks at practical application of Balanced Scorecards framework, using the KPI from section two.

The core of this research is discussed within section four where a combinantion of BSC output with MCDA is put on place for generation of scenario planning and analysis by using performance measures value tree and grapfic illustration using data from section three and KPI from section two. Here we generate scenarios using a model that we built on excel worksheet. This model enables us to manipulate simultaneously multi-variable under uncertatinty. The following section, number five, consistis on discussion of achieved results, while on section six we close our work with conclusions and recommendations for futher work.

The concept of Balanced Scorecards was developed by Kaplan and Norton [7] by 1990 as part of Nolan Norton Institute, the research arm of KPMG, sponsorship to support a study on Measurement of Organizations of the Future. The geographical distribution of social and settlements over Limpopo River Basin, fig.1, illustrates to what extent if good resource management is in place can contribute to add value to the riparian countries and the region.

The purpose of this paper is to apply Multi-criteria Decision Analysis in strategic scenario planning for Decision making, using Balanced Scorecard principle as the conceptual managerial framework for the Limpopo river basin management, as part of common regional strategy in general and especially for the four riparian governments, toward strategic decision thinking.

It is our perception that the impact of natural hazards over the Limpopo River Basin has significant implication on both social and economic assets; It is our belief that each country has its own strategy to manage the river and whenever a disaster occur each country, singularly, forwards its own recovery efforts and means;

We assume that different countries have different capabilities to deal with river disaster management in different manner, what, to some extent, undermine the possibilities for sharing results from a certain event. Therefore, we suggest the concept of balanced scorecard, based on the managerial framework by Kaplan and Norton [7] and an MCDA, to model decision approaches for strategic scenario planning and management for natural disaster over the Limpopo River Basin, using a set of Key Performance Indicators (KPI) from the riparian countries.

With this approach, we aim to create more awareness among the leadership of those countries benefiting from Limpopo on generating positive and best practice in the process of hazard risk management of natural disaster, by sharing common effort for planning, preventing, managing and coping with natural disasters.

The methodology applied in this research is based on the concept of “sensitive analysis”, by bridging two strategic planning tools for a decision making. We combine both Balanced Scorecards fig. 2, and Analytic Hierarchy Process (AHP) a tool for MCDA, fig.3, to build decision approaches, using scenarios, for strategic planning and management, carried out in section four, using four domains as alternatives, figs 4-6. We also develop a graphical analysis of scenarios using an additional set of selected alternatives based on country’s Key Performance Indicators, namely: Energy production to energy use (ENPRCOS), Percent of HIV infected population (%HIV), Literacy rate (LR), Political stability and absence of violence (PSAV), Disaster Risk Index (DRI) and Accessto water supply (AWS).

So the framework that we propose as a base to build Scorecards models for hazards risk management at Limpopo River Basin aims to verify and validate the concept toward a optimum benefit trough combination of cost to avert risk with expected loss due to risk.

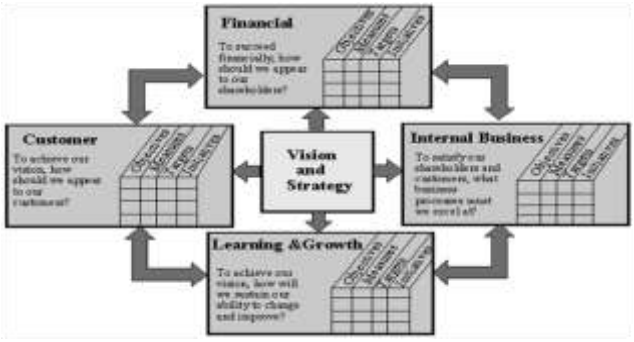


Fig. 2 Illustrative model of Balanced Scorecards, Source [7]

Traditionally, the Balanced Scorecard Model aims to translate strategy into action, and according to Kaplan and Norton [7] it should translate a business unit’s mission and strategy into tangible objectives and measures, fig. 2; It consists on

four domain that balance the business life of an organization, namely the Internal perspective, customer perspective, financial perspective and education and growth perspective.

On another hand, AHP, a mathematical method for building complex decision analysis (Saaty 1995) in [17], constitutes a powefull tool within MCDA. A breakoutstruture of AHP, based on the BSC framework, is represented in fig. 3.

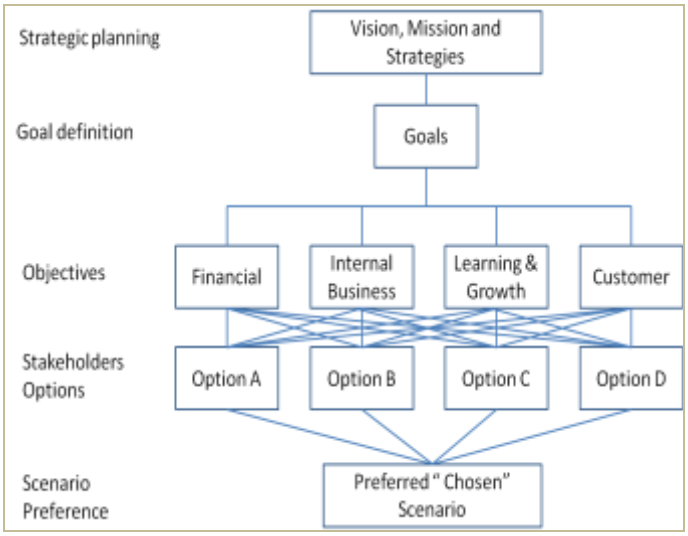


Fig.3 AHP Breakdowstructure of Balanced Scorecards

AHP comprises basically 6 main steps namelly [13]

- The clear definition of the probblem, goal setting, and composition of possible alternatives,
- Breackdowstructure of the problem in an hierarchical way with criteria and subcriterias
- Pairwise comparison of elements composing the hierarchical level, bearing in mind the parents and children of a certain branch, at that specific level
- Determination of wieght and or coeficient in regard to the whole problem
- Evaluation of their consistency throghy a sensitive analysis; and
- Definition or sythesis of a preffered choice for the decision making process.

Within our framework the preffered “chosen” scenario constitues the synthesis of the AHP.

2. Comparative analysis of Key Indicators

In this section we ilustrate a comparison of the key indicators of the four riparian countries, aiming to build the measurements and other variable that will sustain the Balancing Scorecard and Multi-criteria Decision analysis Model.

Our approach is to migrate from this conceptual model to apply our four domains for each country: Politic and governance, Economic, Social development and Technology; by using identified indicators within those domains we will generate values, measures and weights that support our analysis. According to Cobbold and Lawrie (2002) [11], the Balanced Scorecard is an approach to performance measurement that combines traditional financial measures with non-financial measures to provide managers with richer and more relevant information about the activities they are managing.

From two main sources Global Edge [4] and Bakhtina, M. Zgurovsky [3] together with the Limpopo Basin Strategic Plan for reducing vulnerability to floods and droughts [5] and the CIGAR [8] we combined different indicators, which are most important for the Limpopo Riparian Governments to stabilize in their own countries; therefore they can concentrate on a more sub-regional issues. An analysis of different country’s strategies and policies was made and the capabilities of the sub-region ensure that combined efforts and holistic policies to manage this basin can reduce the risks of floods.

In order to complement the process developed in graphics 1, 2, 3, 4 and table 1, a SWOT Analysis of the Limpopo Riparian countries provided in order to list the potentiality that can be exploited toward a better and objective strategy; Sub-section 2.1 summarizes our analysis. The aim of this Analysis is to list the Strength and Weakness that exist within the countries and the Opportunities and Threats that can be brought in from the surrounding in order to contribute in the process of Limpopo River Basin risk management. These opportunities and threats can be both regional and worldwide issues as well as inter countries themselves among those who share the river.

The idea behind this analysis is to create awareness among the decision makers in order to by inn different approaches and methodologies applied by other communities for better management of natural hazards in a common principle and maximize the management of the Limpopo River Basin and also convert threats into opportunities. Our approach is

based on Pandey's (2005) [12] statement saying: "organizations survive when they create values for their stakeholders. Stakeholders have their own choices to make and choose from multiple options. There is fierce competition among organizations to win over these stakeholders", this is a combined win-win strategy is recommended.

2.1. Risk Assessment SWOT ANALYSIS

In order to create a strong link between the process of flood/hazards modeling based on the BSC and MCD using key driving factors we diagnose the dynamic of the four riparian countries using SWOT analysis process. This focuses on the cross check of the Strengths, Weakness, Opportunities and Weakness of four countries toward Hazards Risk Management.

Strength

- Rich on diversified mineral resources and Qualified Skills;
- Common indigenous ground roots;
- Young and growing Population;
- Abundance of water over Limpopo and other basins across countries;
- Favorable geographical situation;
- Hydroelectric potential;
- Political stability and good governance;
- Diversified industry and agricultural potentiality;
- Economic growth and common mega projects

Weakness

- Dependency on external aid;
- Diversified strategies among the countries;
- Lack of common risk sharing policies;
- Lack of common sectorial development plans;
- Regional disparities among the countries;
- Significant social risk, migration and xenophobia;
- HIV/AIDS prevalence and social vulnerability;
- Inflation and External debits.

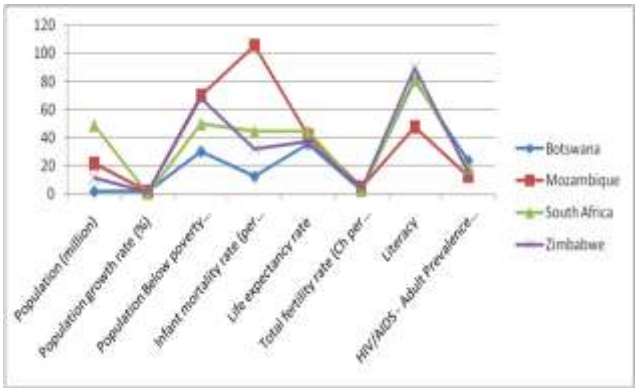
Opportunities

- Design of common development strategies;
- Common and regional policies for trade and economic development;
- Shared policies for risk prevention and management;
- Water policies and risk management strategies based on shared principle;
- Mobility of people and goods among countries;
- Use of technology and ICT for disaster risk management;
- Expansion of Communication facilities among the countries.

Threats

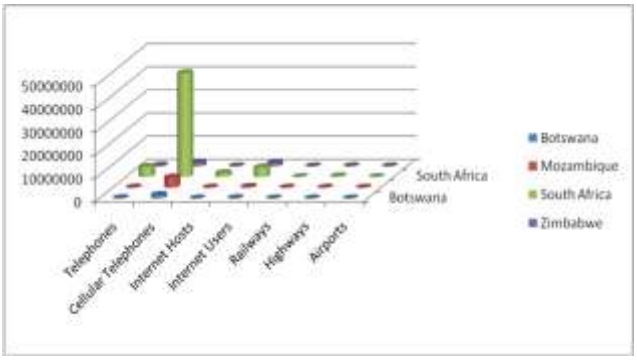
- High rate of infant mortality at birth;
- Low rate of Millennium Development Goals achievement;
- Social instability and economic volatility and Xenophobia;
- Impact of international financial crises;
- Climate change and natural disasters (floods and droughts);
- War for water over Limpopo;
- Exposure to cyclones and depressions over the Indian ocean;
- Low rate of life expectancy and HIV/Aids over developing corridors.

Graphic 1, summarizes a set of trends, which illustrate that a side from vulnerability to natural disaster, floods and droughts along the basin, Mozambique with most population below poverty line, infant martality rate and life expectance rate. Botswana, South Africa and Zimbabwe are highly ranked in literacy which to some extent is a positive indicator for risk awareness and management.

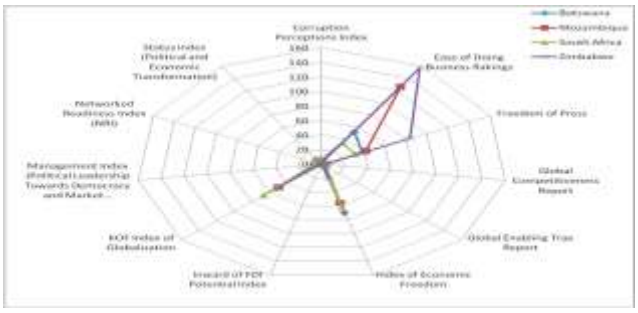


Graphic 1: Comparative Analysis Social development indicators. Data Source: [4] – Global Edge

Technologically, the four Limpopo Riparian Basin are led by South Africa and alternatively, the other three countries occupy different levels of development that can contribute to Disaster risk Management in terms of communication, GIS applications, remote sensing and earlier warning.



Graphic 2: Comparative Analysis of Technology Indicators. Data Source: [4] – Global Edge



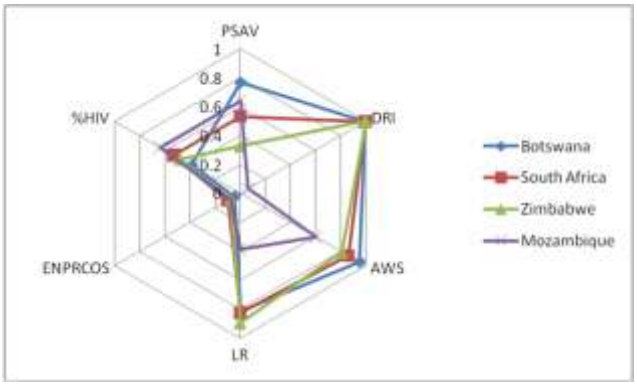
Graphic 3: Comparative Analysis of Countries Rankings. Data Source: [4] – Global Edge

An additional analysis we made from Bakhtina, Zgurovsky [3] data, where on their qualification of key developmental risk in Africa, the four riparian countries rank as shown in, table 1, and our comparative analysis of these indicator is illustrated on grapfic 4. As we can see Mozambique ranks on the worst scenarios despite the HIV Index and energy production to energy use (ENPRCOS). The index of disaster risk is the worst given the vulnerability of the country and exposure to different type of natural hazards.

COUNTRY	PSAV	DRI	AWS	LR	ENPRCOS	%HIV
Botswana	0.769	0.996	0.95	0.812	0.045	0.388
South Africa	0.533	0.995	0.86	0.824	0.099	0.531
Zimbabwe	0.331	0.999	0.81	0.894	0.077	0.477
Mozambique	0.64	0.064	0.6	0.387	0.08	0.636

Table 1: Key developmental Risk indicators. Source: [3]

Bakhtina, Zgurovsky [3], in their work deeply discuss and simulate the results of six main variables such as Energy production to energy use (ENPRCOS), Percent of HIV infected population (%HIV), Literacy rate (LR), Political stability and absence of violence (PSAV), Disaster Risk Index (DRI) and Accessto water supply (AWS). Extracted data for the Limpopo Riparian countries ilustrate that Mozambique exhibits very low rates almost in all indicatores, especiall in disaster risk index, and only supresses Zimbambwe and Botswana on energy production to energy use.



Graphic 4: Comparative analysis of Key developmental Risk indicators. Data Source: Adapted from [3] comparative analysis key indicators

The above weakness for Mozambique combined to geographically exposure to natural hazards namely; floods, cyclones, tropical depressions and droughts make it highly vulnerable therefore the need of more combined strategy to deal with natural disaster with special focuses on floods over the Limpopo River Basin.

3. The Application Balanced Scorecard Model

In this section we illustrate mostly the outcomes from the analysis of a sample of four alternatives from each domain illustrated on graphics 1. 2, 3, and 4 and we will simulate those combined with the one given in table 1 so that we cover general indicators cross checked with those of the Limpopo River Basin. Cobbold I. and Lawrie G (2002) argue that Balanced Scorecards developed for the purpose of Management Control tend to favor the use of 'benchmark' or comparative data – both in terms of the measures selected and in terms of the targets set. Our modeling process focuses on both planned (baseline) and targeted data as source of simulation.

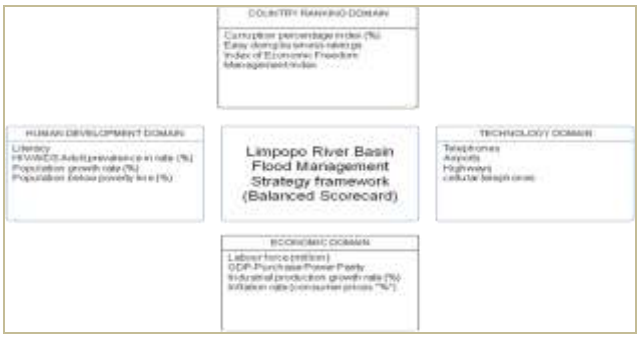


Fig. 4 BSC Framework for Limpopo River Basin Flood Management Strategy. Source: Author

Fig. 4 illustrates to what extent the four targeted domains namely, Politic "country rakings", social development, economic and technology if managed toward the development of each country and common efforts are put in place; this can positively influence a inter country Limpopo River Basin Strategy. We used those indicators as part of many key variables that governments can work them in order to generate positive policies and strategies aiming to protect their countries against hazards' risk.

Common strategy means risk sharing, therefore if the riparian countries maximize the management of their inter countries and sub-regional key indicators, they can focus on common risk and minimize the negative impact of floods/hazards over the Limpopo River Basin. If we have good governance, higher social development and we are technical and economically strong we can easily develop strong and secure Disaster Risk Management policies, and hence, produce a strong and applicable flood/Hazards Risk Strategy for the sub region.

Fig. 5 represents the full picture of BSC outcome with analytical details of Limpopo River Basin Flood Management aiming to use different indicators linked to four main domains of each riparian country, for this specific case of floods.

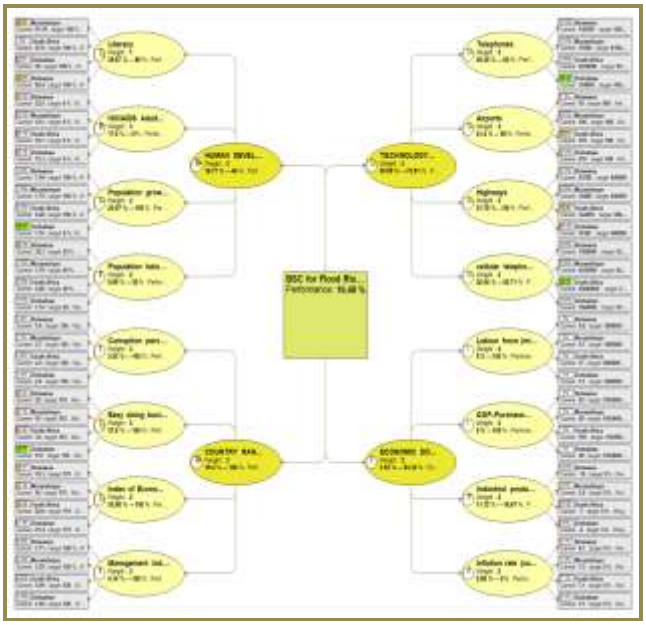


Fig. 5 Limpopo River Basin Flood Management Strategy Map. Source: Author

Our approach is to demonstrate that if each country contributes with specific targeted percentage and or score of resource in benefit of the management of floods/hazards over the Limpopo River Basin, preventive measures can become better than corrective. A comparative analysis that shows a more comprehensive picture of our simulation is given on fig. 10: below.

Fig. 6 BSC for Flood Risk Management at Limpopo River Basin Simulation Output. Source: Author

The Diamond picture given on fig 10 illustrates the behavior of the four main domains simulated within the Balances Scorecards Model, aiming to compare three additional levels to the original domain: a) the targeted, b) the Baseline, and c) the entered values from the original tables. The linkage of the domains under analysis is given by four isosceles triangles on lateral opposition. This represents the basic model of equilibrium as basic of Balances Scorecard model, specifically for floods.

At the second level we have the targeted level as an outcome from data that are a kind of optimum contribution of each country toward the achievement of its contribution within the four domains to share the risk on Limpopo River Basin Flood Management, those data are also inserted in model as the best scenarios that the risk sharing can receive. The next level is the baseline as an outcome of planned indicators that each riparian country can offer in the planning process if a common strategy were to come as inter country common view, where average indicators were to be applied and finally the basic values with which each country and isolate enters at the present moment to share its resources over the Limpopo River Basin.

The model, apart from the above results also generates different outputs by country, domains, category and indicators as dynamic process, according to the objectives of the simulation. Here, we demonstrate to what extent the Balanced Scorecards Models can generate framework applicable for common risk sharing in the Limpopo River Basin Flood Strategy.

4. Scenario Planning with BSC and MCDA

Additional analysis for an MCDA can be illustrated by using Key Performance indicator from fig. 4 in a Performance measures value tree, which in our case has just a qualitative illustration due to lack of data, hence the raking priority has least importance.

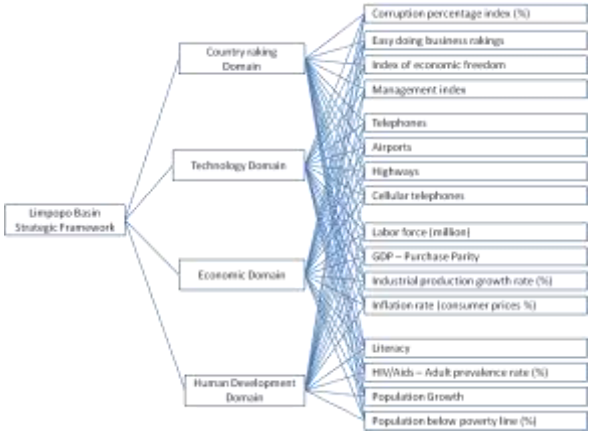


Fig. 7 Performance measures value tree

A deeper analysis of the above tree can generate a set of scenarios using AHP weighted value tree or tradeoffs, which within the concept of MCD might be a result of open workshop with stakeholder during the planning process

Scenario planning is part of the strategic decision thinking that enable a participatory approach of all involved stakeholders. Table 2 illustrates the outcome or the brainstorming process for criteria definition toward an MCDA application

CRITERIA	Unit s	Countries				Bes t	Wors t	Swing Weight	% Weight
		Botswana	South Africa	Zimbabwe	Mozambique				
PSAV	%	0.769	0.533	0.333	0.64	0	100	89	18.62%
DRI	%	0.998	0.995	0.999	0.064	0	100	50	10.46%
AWS	%	0.95	0.86	0.81	0.6	0	100	96	20.08%
LR	%	0.812	0.824	0.894	0.267	0	100	54	11.30%
ENPRICOS	%	0.045	0.099	0.077	0.08	0	100	89	18.62%
%HIV	%	0.388	0.531	0.477	0.636	0	100	100	20.92%

Table 2: Criteria definition based on table 1.

On table 2, we have ranked the figures from the original data in table 1, section 2, from worst to best by with zero and hundred points respectively. This table enables us to generate the single attribute values for each country. Table 3 and consequently to build the tool for the sensitive analysis using the sliders illustrated in table4

	Countries' Single attribute Value			
CRITERIA	Botswana	South Africa	Zimbabwe	Mozambique
PSAV	99.04	99.33	99.59	99.20
DRI	99.00	99.01	99.00	99.94
AWS	99.05	99.14	99.19	99.40
LR	99.10	99.08	99.01	99.57
ENPRICOS	99.96	99.90	99.92	99.92
%HIV	44.57	24.14	31.86	9.14

Table 3: Countries' single attribute value

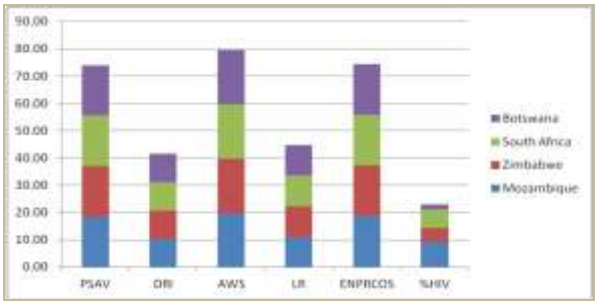
By using the sliders we can manipulate the data in table 2 and create different scenarios illustrated by graphics 5, 6 and 7.

It is of extreme importance to highlight that scenario planning consists on a specific management tool for foreseeing the future that an organization/society have challenged. It differs from other planning tools such as simple Sensitive analysis, computer simulations, contingency planning, and "what ifs" methods. Scenario planning is about managing different uncertainties at the same time, "side by side equals", argues Schoemaker [14]

CRITERIA	Units	Countries				Best	Sensitivity Analysis	Worst	Swing Weight
		Botswana	South Africa	Zimbabwe	Mozambique				
PSAV	%	18.44	18.50	18.54	18.47	0		100	80
DRI	%	10.36	10.36	10.36	10.45	0		100	100
AWS	%	19.89	19.91	19.92	19.96	0		100	100
LR	%	11.20	11.19	11.18	11.25	0		100	90
ENPRCOS	%	18.61	18.69	18.69	18.60	0		100	100
%HIV	%	9.32	5.85	6.66	1.91	0		100	70

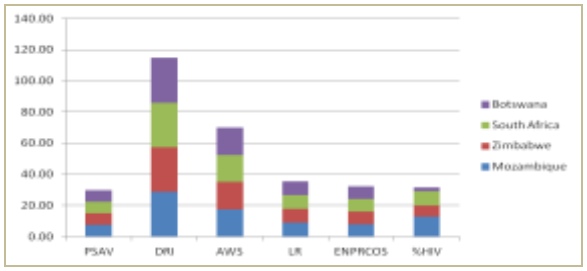
Table 4: Sensitivity analysis process with swing weight

The Scenarios generated by different variables management are illustrated on graphics below.



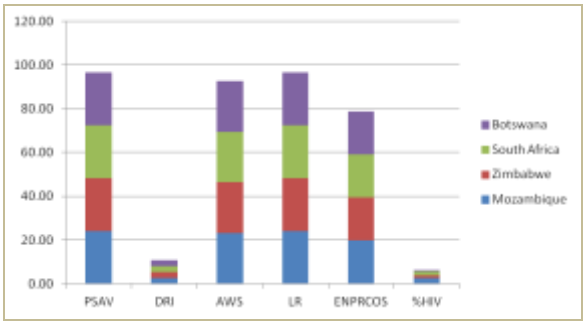
Graphic 5: Scenario I.

In Scenario I we analyze the impact of maximizing PSAV, AWS, LR and ENPRCOS, but keeping DRI and HIV normal, this can balance positively to some extent the economies, but it will be affected negatively by the rise of DRI and HIV due to their genitive impact to human development index.



Graphic 6: Scenario II.

In Scenario II we minimizing PSAV, AWS, LR and ENPRCOS, maximizing DRI, but keeping HIV normal what might create a worst case scenario by weakening the economy and reinforcing the hazardous variables.



Graphic 7: Scenario III.

This might be the best Scenario where we maximize the PSAV, AWS, LR and ENPRCOS, but minimizing the impact of hazardous variables, namely, DRI and HIV.

5. Results and discussions

Our domain analysis indicates that at the performance of 16,48% of the balanced efforts the model generates additional outcomes for the four key areas, led by the Social development domain with 18.77%, Technology domain with 20.98%, the governance and politic domain represented by the country rakings with 14.4% and finally the Economic domain with 3.52%. Our perception is that the Social Development and Technology domains Social development play a pooling role,

given the size of population of the four riparian countries and the relative advanced Technology in South Africa, while the contribution of Zimbabwe and Mozambique in the Economic Domain is least.

Within the Social development domain Literacy is the category that contributes negatively with 35.67% followed by HIV/Aids adult prevalence in rate with 17.6%, then population growth and population below poverty line with 20.87% and 9.99% respectively. Technology domain is led by highways with 21.75% followed by airports with 21.4% then landline phones and cellular phones with 20.35% and 20.04% respectively. The entered data show that both country raking and economic domains little contribute for the development of the four Limpopo River Basin Riparian countries, namely ranked at 3.93% on corruption percentage index, 37.6% easy doing business, 4.34% management index (political leadership towards democracy and a market economy) and 30.58% economic index of freedom on one hand and the economic contributes with 5.86% of inflation rate (consumer prices) and 11.72% of GP-Purchase power parity. Labor force and industrial growth rate have null contribution toward both targeted and baseline planned indicators toward a good and shared for Limpopo River Basin Flood Management Strategy based on the Balances Scorecard Model.

6. Conclusions and Recommendations

From this research we can conclude that over the Limpopo River Basin exists relative limited data therefore our study faced considerable limitations. The aim was to create awareness to the decision makers that a combined strategy over the management of floods over Limpopo River Basin can create synergies and bring added value when compared to isolated mechanisms so far in place.

Our analysis show that applied (real) data least contribute when compared with those projected, see fig. 10, for the base line (planned) and targeted (optimum) scenarios, therefore our recommendation is embrace a more risk shared common strategy for the management of the Limpopo River Basin Floods and reduce vulnerability. Also we can conclude that different domains contribute differently to each partner country in order to sustain a Disaster Risk Strategy. Finally, our challenge is to continue this research, taking into account that the SADC disaster management strategy and its other programs support the strengthen policies and territorial strategies on disaster management and risk reduction.

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