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## Development of Spatial Planning Scenarios for Eco-Tourism Planning of Dikgatlong Dam, Botswana

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### Abstract

*Spatial and environmental planning of the fragile water ecosystems in semi-arid climatic conditions of Botswana and the Dikgatlong Dam Land Lease Area (DDLA), as one of the country's largest water reservoirs, present a complex task that requires the application of different methods and techniques. These techniques emanate from diverse fields and sub-fields of geography, hydrology, climatology, environmental science, engineering, spatial planning, cartography, tourism studies, etc. For that reason, an interdisciplinary project team has been assembled to embark on the application of GIS-based multi-criteria decision analysis (GIS MCDA) to develop future planning scenarios applicable to different eco-tourism planning zones depicted in the Dikgatlong Dam Tourism Master Plan (DDTMP). The results achieved through this systematic approach have helped clear the demarcation of individual land use planning zones of DDLA that need to be preserved, developed, maintained, and/or repaired in case of potential ecosystem damage. It is highly expected that a similar approach can be applied in other parts of the African continent where expectations to support the quality of abiotic and biotic life are high for the benefit of today's and future generations.*

**Keywords:** *Environmental planning and design, GIS multi-criteria decision analysis (GMCDA), planning scenario developments, eco-systems, eco-tourism*



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## Introduction

Botswana is one of the best tourism destinations not only on the African continent but globally as well. Tourism has been identified as a key sector in diversifying the country's economy away from being excessively dependent on diamond mining and cattle farming. As one of emerging economic activities, the tourism sector has become the second major driver of Botswana's growth and has over the years contributed significantly to the country's output. As recent studies have shown, tourism contributed 13.1% of Botswana's GDP in 2019, increasing from 6.3% in 2000. In 2019, travel and tourism together accounted for 8.9% of total employment in Botswana (Chinya, 2021), and efforts are continually being made at progressively developing virtually all tourism attractions and assets in the country.

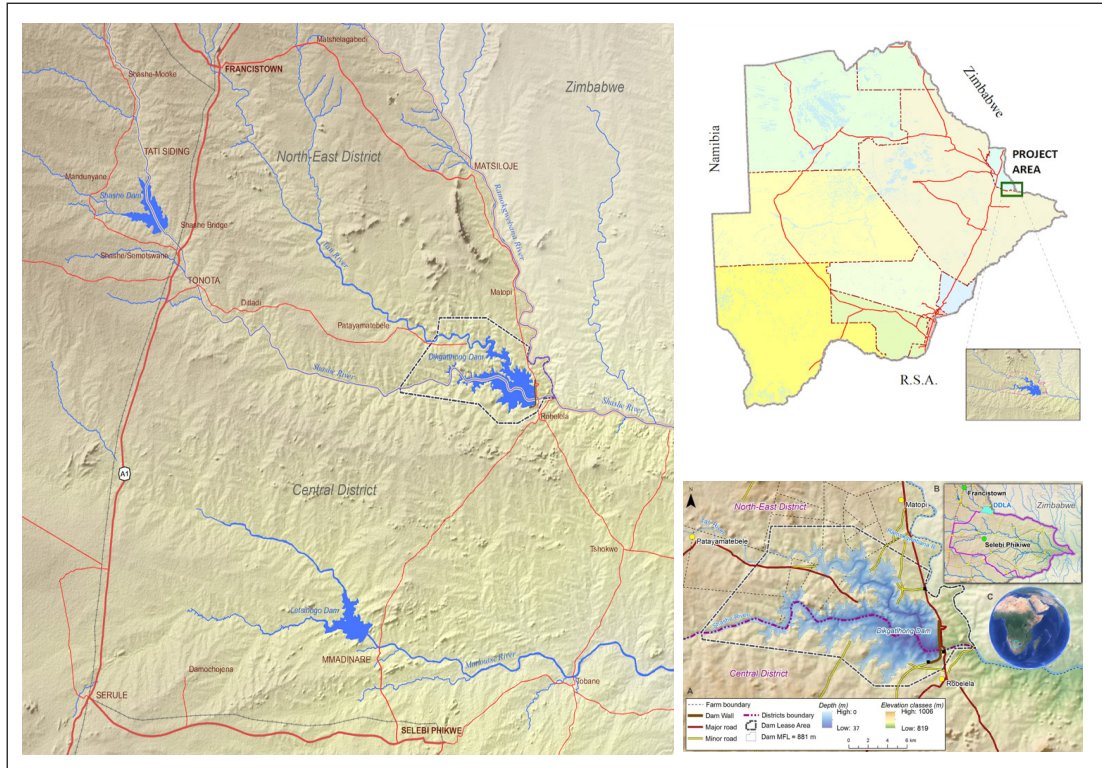
The current situation is that Botswana's tourism is largely wildlife and wilderness-based. It is mostly found in the northern part of the country where the well-known Okavango Delta and Chobe River are situated. This area is endowed with a rich variety of fauna and flora, diverse and dynamic ecosystems, as well as pristine and wilderness character. Consequently, northern Botswana has been the main draw card of Botswana's tourism industry for now. However, apart from wildlife and wilderness-based tourism assets, Botswana has a wide range of other tourism resources in the form of rich cultural heritage sites, archaeological values, areas of unspoiled beauty, and unique and varied landscapes and landforms (Eckardt, 2022).

The challenge, however, is that even though Botswana is endowed with a wide range of tourism assets, which could provide the basis for developing a much more diversified tourism product for the country, they have not all yet been developed to their fullest potentials. To enhance tourism experience in general, and eco-tourism in particular, several Botswana parastatal and government organizations are at the junction where it is now opportune to increase the country's tourism offerings, by packaging these diverse attractions and assets into an adequate tourism product mix that can broaden the traditional tourism destinations. In this way, niche tourism products and markets were created in Botswana, such as Dam Tourism, Agro Tourism, Gastronomy Tourism, Photographic Tourism, Digital Tourism, Heritage and Cultural Tourism, Health Tourism and Sports Tourism.

A special type of tourism linked to water bodies such as lakes, rivers and seas is developing its prospect in Botswana in the form of artificial lakes impounded by man-made dams. These water bodies and their hinterlands referred to as the Dikgatlhong Dam Lease Area (DDLA) represent a good opportunity for tourism diversification especially in the North-East and Central Districts where several larger rivers (eg., Shashe, Tati, Motloutse, Ramokwebana) and their tributaries in combination with shallower aquifers formed ideal opportunities for construction of Shashe, Dikgatlhong, Letsibogo, and Tune dams (Figure 1). One of the most prominent and largest amongst them is Dikgatlhong Dam, where Botswana Tourism Organisation (BTO) in cooperation with Water Utilities Corporation (WUC) and Selebi-Phikwe Economic Diversification Unit SPEDU (eg., SPEDU Region) has embarked on a process of tourism products diversification through the preparation of tourism master plans as the first step in that process. Such initiative is an attempt to unlock the leisure and tourism potential around these water bodies constructed in Botswana Central and North East District in general and SPEDU

Region in particular, which represents a special economic zone with a population of 172,150 people according to the last census (Statistics Botswana & UNFPA, 2022).

**Figure 1. National and regional settings of Dikgatlong Dam**



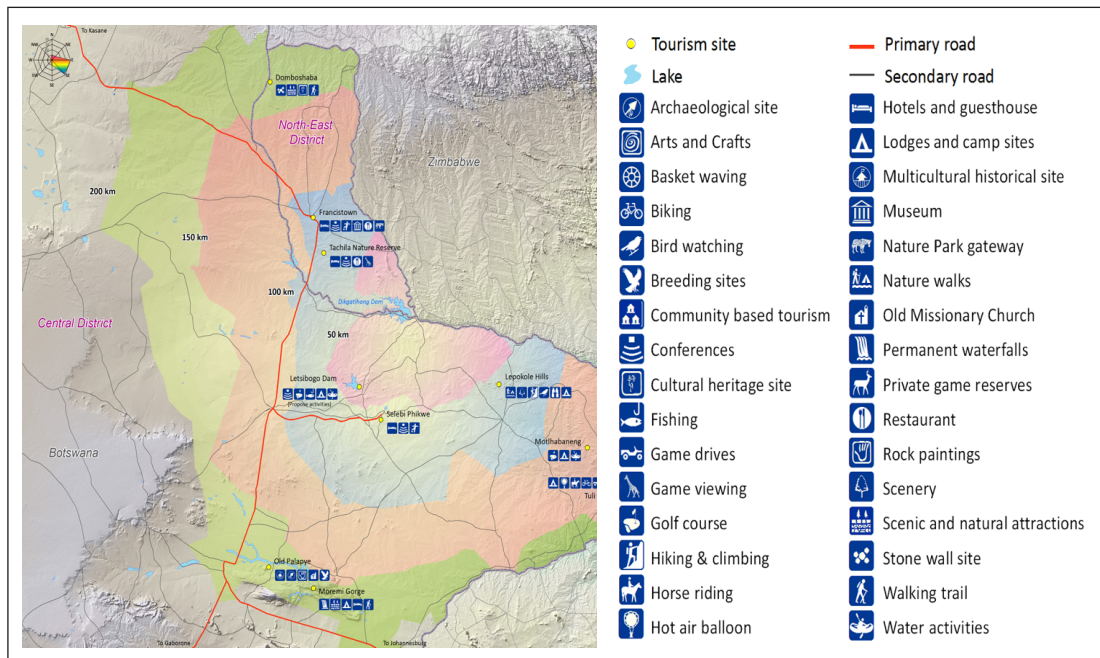
As a sub-region located in Central District, the SPEDU comprises five geographical areas including Bobonong (76,922), Lerala-Maunatlala (33,743), Sefophe (5,913), Mmadinare (13,087) and Selebi Phikwe (42,488). If the population size is factored in for the entire Central and neighbouring North-East District, there is a gravitational triangle of over half a million people (Statistics Botswana, UNFPA, 2022a), whose habitation depends on sufficient quantity of stored water in surrounding reservoirs for which a series of master plans have either been prepared or are on their way.

The Dikgatlong Dam straddles the Central and North-East Districts, with about 80% of the DLA falling within the North-East District. The DLA covers an area of 13,125 hectares, while the Dam itself is a zoned earth fill structure, 41 metres high and 4.5 kilometres in length. Dikgatlong Dam, which is the largest Dam in the country, with a reservoir capacity of 400 million  $m^3$  and a spillway capacity of 11,000  $m^3/s$ . The maximum length of the artificial lake reservoir is about 20 kilometres. The Dam is meant to increase the secure supply of water for Botswana's capital Gaborone, as well as towns and villages along the North-South route, for the near future (GISPlan, BTO, 2016).

In case of its Tourism Master Plan preparation, the major goal, among other things,

was to provide a land use zoning for the DDLA, where tourism activities or products taken into consideration should secure optimal use of land, with a great focus on environmental sensitivity, provision of guidelines and mechanisms that enhance biodiversity and conservation. It is envisioned that with a Dikgatlong Dam Tourism Master Plan (DDTMP) in place and with tourism activities in its DDLA, there will be increased economic benefits to the local communities (villages) of Robelela, Matopi and Matsiloje, and gravitational zones of Mmadinare and Francistown, in the form of income improvements, diversified job opportunities and more compatibility of tourist destinations within a radius of 200 km. of Central and North-East Districts and SPEDU Region (Figure 2).

**Figure 2. Tourism facilities in radius zone of 200km from Dikgatlong Dam**



It is therefore pertinent that all the tourism products, attractions and assets in the DDLA are developed to the fullest with identification, guidelines and regulation of all tourism activity types (commercial, leisure, recreational), their locations and operational methods within DDLA. The DDTMP will thus be both a management and regulatory tool meant to provide the relevant authorities and the future prospective tourism operators/concessionaires, with a guide on how to manage and operate tourism activities in the DDLA, as well as what should be done to maximize the DDLA tourism and recreational potentials, in line with the principles of economic and environmental sustainability.

This article gives an overview of GIS multi-criteria decision analysis (GMCDCA) for the development of different planning scenarios, based on numerous bio-physical, environmental, and socio-economic indicators. It also summarises different theoretical planning concepts which are important in the preparation of eco-tourism plans, and they are not relevant and limited only to the DDLA presented here. These issues lie at the core of the new planning and tourism paradigms developed and utilized around the world, but this time with special focus

on an African case study.

## Literature Review

In assembling planning and research literature for this multidisciplinary task the major approach of the project team was to consult different sources of information to establish a sound theoretical and methodological foundation, and to translate tourism planning principles into an operational management document with all elements necessary to guide the future of DDTMP area. This framework and results the DDTMP proposal describes our approach which can be applied in other parts of the African continent where tourism and its impacts are envisioned as important development strategies especially in environmentally sensitive settings. The reason for this is that many spatial and environmental changes in Botswana, where the systems of settlements, rural and ecological areas (e.g. national and natural parks and reserves) have undergone unprecedented urban, socio-economic and environmental changes. The country has experienced the fastest urbanization which greatly affected the type of town and country planning in general, and the development of urban and eco-tourism sectoral planning in particular, where the partnership between tourism and nature becomes essential from a spatial perspective view.

Contemporary eco-tourism planning and design ideas, and subsequent integrated eco-tourism development, have become the most significant socio-economic and environmental phenomena of today, more so in situation where the world is seriously re-thinking sustainability, resilience and designing its future by the rules of nature. In that context, there are numerous physical and environmental planning and design tools which can contribute to the preparation of ecologically more sound plans, management documents, guidelines and strategies, with the major aim of saving natural and man-made resources for current and future generations. With this in mind our project team in preparing the tourism master plan for Dikgatlhong Dam which was meant to inspire and address numerous aspects of better quality of life and experience (of dwellers, tourists and visitors alike), by balancing components of natural, social, economic and political realities of Botswana, with infusion of international practices and levels of their applicability in the case of DDTMP preparation, included the following seven considerations (Table 1).

**Table 1. Planning concepts for preparation of the Dikgatlhong Dam Master Plan**

No.	Planning Concept/Movement	Applicability for Dikgatlhong Dam		
		Low	Medium	High
1	The Landscape Tradition			
2	Regionalism			
3	Bioregionalism			
4	Environmentalism			
5	Sustainability			
6	Green movement			
7	Marine/Coastal Spatial Planning (MCSP)			

### *The Landscape Tradition*

This concept integrates planning and design for green areas, parks and open spaces and perfectly aligns with trends such as green buildings and infrastructure, green and blue ways, renewable resource independency, and few others. It stresses on provisions of ecosystem services including the regulation of infiltration and storm water runoff, mitigation of the microclimate, reduction of the heat impacts air and water pollution. They also contribute to improve well-being perception by local people and tourists in the restoration of cognitive resources. For these reasons, the amount of forest land per inhabitant is a pivotal efficiency indicator to be considered in the sustainable governance, land management, planning and design of urban areas (Tomao et. al., 2017).

The following factors stand out as the key elements of this concept: (i) the design elements conformation to the natural landscape, (ii) the creation of mixed rural/urban spirit, (iii) the facilitation of escape to nature from stress release of urban dwellers and tourists, (iv) interconnecting green sub-systems into integrated green network, (v) keeping and maintaining green areas in the process of DDTMP area development.

### *Regionalism*

This concept represents the reaction to uncontrolled urbanization, sprawl, overpopulation and discrepancy between different land uses. It calls for the construction of integrated infrastructure, aimed at wider spatial connectivity, relocation of industrial and business activities, work redistribution and “the need for rooting social life in the natural patterns of the landscape and preached the need to plan holistically for ecological region” (APA, 2006). The concept favours the idea of balanced regional development, which is of great importance for Botswana and the SPEDU region, due to the economic gap between the South East and other parts of the country. It follows principles of sustainable development, where human activities should be coordinated with natural and built-up areas carrying capacity. Any deviation from it provokes disproportionate and unforeseeable economic and ecological consequences.

### *Bioregionalism*

This concept is based on the rules of nature and application of environmental appraisal techniques which bring rationality in environmental planning, management and decision-making. These approaches range from threshold analysis, carrying capacity and suitability ratings such as eco-zoning, to more radical ideas (McManus & Haughton, 2006) on environmental matrix found in “eco-footprint” methodology, which consider the impact of humans and cities on natural resources and ecosystems (Huiqin & Linchun, 2011).

The implications of bioregionalism are clearly for political control by local communities, where people are considered as part of a life-place cycle, as dependent on natural systems as are native plants or animals. However, these techniques have not been applied during preparation of spatial plans in Botswana (Cavric and Chephethe, 2019). A large number of physical plans are approved without following out necessary environmental studies based

on “What If Analysis” (WIA)”, Tourism Environmental Carrying Capacity (TECC), Tourism Ecological Footprint (TEF), Tourism Ecological Capacity (TEC) and GIS-based Multicriteria Analysis (MCA) applied as the principal analysis method in preparation of DDTMP, just to name a few (Cavrić, 2009).

### *Environmentalism*

The concept represents the reaction to super urbanization, uncontrolled urban sprawl and endangering of natural assets by manmade and natural impacts and an increased carbon footprint (Cevik, 2022). For example, wide areas of prime agricultural land and natural vegetation that represent unique habitats disappear under pressure of urbanization. The pressure of uncontrolled urbanization and ambition to be closer to the city or to the sea resulted in forced change in land use worldwide. A similar pattern is approaching Africa and its attractive natural frontiers. Furthermore, the frequency of recent incidents including natural disasters such as drought, floods, bush fires, earthquakes, tsunamis, and difficulties caused by wars and the economic downturn has highlighted the vulnerability of human settlements and makes the appropriate consideration of resilience in the planning for future of natural areas of vital importance. The visionary words of Ian MacHarg (1992), are a clear message to today’s planners and developers, as they suggest “the unabashed reversal of the customary relationship between developers and environment, for to design with nature means to privilege the natural environment and to fit development where it does the least harm, not where it is most economical or efficient”.

### *Sustainability*

This concept evolved as a response to the declining quality of regional and urban environments all over the world. Planning of cities and territories, as an ongoing attempt to guide their future development and redevelopment, should rest on sustainability premises, and application of an approach, where cities and towns should be treated together with their hinterlands and regarded as the entire ecosystem (Garde, 2004; Glasby, 2003).

In many countries, the implementation of sustainable development and smart growth was based on the following six key principles: (i) future-oriented long-term planning; (ii) planning with carrying capacity and growth limits in mind; (iii) natural and geographic delineation of planning areas; (iv) looking at “means” rather than “end” in the planning process; (v) holistic, interconnected and integrated approach to planning; and (vi) participatory and people-oriented planning.

Sustainable planning and design of the future images of the eco-tourism destinations require unprecedented and simultaneous emphasis on the efficient use of its spaces, based on minimizing the consumption of essential natural capital. Critical links between these specifics sector and ecosystems occur at two levels. First, environmental protection has its *raison d’être* in the necessity of maintaining, each year, the environmental capital intact, which represents one of the main sources of profit for local tour operators. Second, the impairment of this natural capital may result in the loss of any tourist attraction, which turns negatively on the

development of the sector (Battaglia, 2012).

### *Green movement*

The green movement stands for the “four pillars” of: ecology, social responsibility, grassroots democracy, and non-violence, which are then translated into principles of (i) community self-reliance, (ii) improvement of the quality of life, (iii) harmony with nature, (iv) decentralization, (v) diversity, and (vi) freedom, equality and democracy (Tokar, 1987). Most recently, the green idea encompassed additional aspects, such as green urban and building design, green infrastructure and green economy, but all of them have been taken holistically. Unfortunately, a larger amount of “greenery”, its visibility in tourism landscapes and the built-up areas, effectiveness of the green development control, common knowledge about greening by ordinary people, and large financial consequences of planning decisions, are not so popular with decision makers.

The strong links between property issues and taxes are still not considered as important part of the green agenda, requiring planning agencies to protect open spaces and natural resources. Politics and its developers’ flagman ships are usually seen as a seamy and often corrupt, and the more that green planning could be kept out of it, the better (Levy, 2003).

### Marine/Coastal Spatial Planning (MCSP)

This is a new concept evolved with main aim to tackle developmental and management issues related to the oceans and seas, coastal areas but it has been adopted by our project team in the case of DDTMP to tackle the issues related to the reservoir, coastal and terrestrial parts. It is therefore considered to be an effective tool in regulating user-to-user conflicts and user-to-environment conflicts taking place at the fragile coastal/shore/marine zones, for some of which the tourism industry is also responsible (Papageorgiou, 2016). It is the fact that these areas are expanding into deeper offshore environments in response to growing consumer demand for fishing, water consumption, tourism, and recreational activities, and many more activities linked to the use of water. Therefore, sustainable development of aquaculture requires quantification and minimization of its impacts through scientifically informed spatial planning which was applied in the case of the DDTMP.

As aquaculture moves into new frontiers, both geographically and technologically, there is an important opportunity to determine where to pursue offshore development in the context of the seas and other water complexes ecological dynamics and the diversity of existing water activities and benefits that could interact with or be impacted by aquaculture (Gentry, 2017).

Ensuring sustainable management of these relationships requires a full understanding of the coastal zone inclusive of water and terrestrial parts, because a lot of activities are taking place in the water, while facilities which support them are mostly located on land and in urbanized areas, interacting with other tertiary sector services which are researched by some authors (Siljeg et. al., 2019). To resolve, plan and manage all these complex interplays, the MWSP concept has the ultimate goal to achieve so-called “blue growth” (Papageorgiou,



2016), which is also expected to take place in the Dikgathlong area. These twin interests are regarded as closely interrelated, because human demands threaten the environmental integrity of the water resources and capacities. In that regard, an application of the MWSP concept in the case of our project were supposed to bring the following benefits:

- providing a strategic planning framework to guide investment decisions;
- facilitating the sustainable exploitation of natural resources;
- optimizing the use of the water and water shore areas and allocating space in a rational manner;
- promoting a mix of uses that are compatible with each other and the environment;
- coordinating the needs of different sectors and managing potential conflicts;
- ensuring that all water related activities are fairly allocated land (space) to develop;
- improving the consideration of the cumulative effects of different uses;
- identifying, conserving and restoring water and land ecosystems;
- ensuring consistency between land and water systems;
- providing a mechanism for stakeholder interests to be represented and reconciled;
- improving information provision and reducing duplication of effort;
- reducing regulatory (administrative) and compliance costs (Jay, 2009).

## Methodology

### *Background*

Anticipated development of several planning scenarios for DDTMP has a strong connection with eco-tourism modelling. Sustainability in the case of the DDLA depends on the relationship between tourism and environment with remarkable evidence in northern, central and southern parts of DDLA. For example, a sustainable planning and management of DDLA geared towards eco-tourism development could be spelled out as one of potential options for conservation and maintenance of the biological richness of the area. It also supports economic improvement of the local people's quality of life. In addition, DDLA eco-tourism can be seen as an opportunity to promote the values in the protected areas and to attract finances from interested investors and developers. In this respect, numerous spatial analyses and evaluation of individual and group parameters applied in DDLA project are all regarded to planning concepts and discussed earlier in literature review. These are basically concepts which could support sustainable eco-tourism based on a carefully selected set of criteria and indicators.

### *Geospatial Approach*

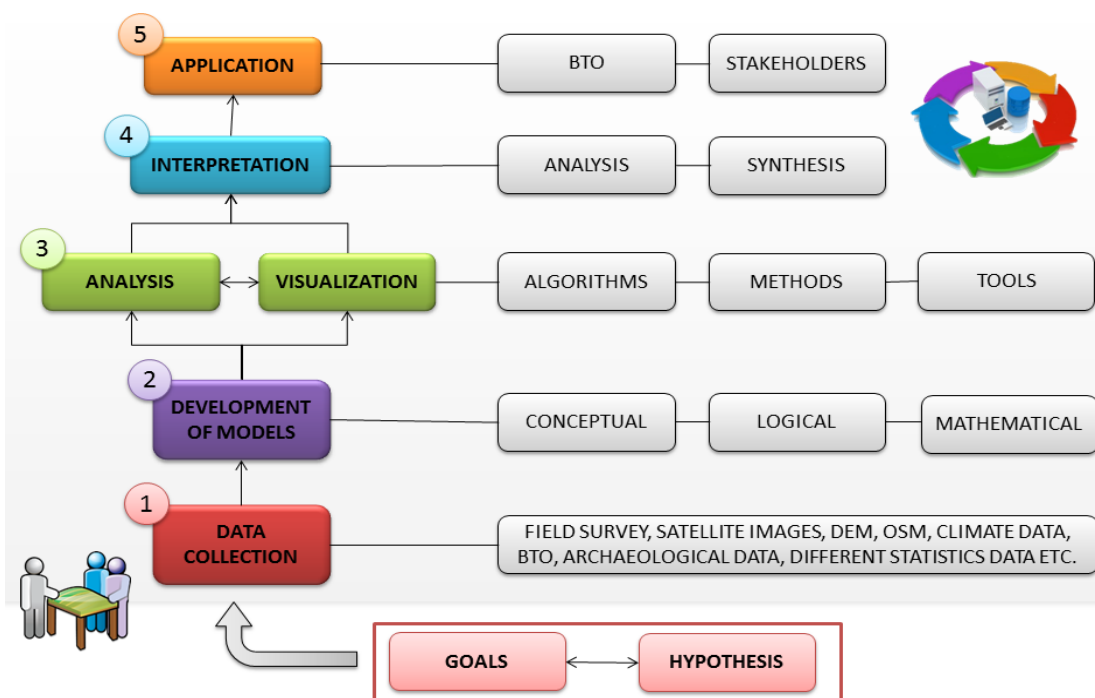
Ideally, the proposed DDLA eco-tourism zones should take care of conservation of biological and hydrological regimes and cultural diversities through (i) conservation development, or alternatively stand on pillars of (ii) sustainable development which takes care of biodiversity with minimal land use/built environment impacts. In addition, the room has also been left for application of business as usual, which is geared more towards (iii) intensive development.

All the three planning scenario directions were derived and enhanced by geospatial approach. Combination of GIS capabilities with MCDM techniques has helped to phase the entire process and apply the planning intelligence support system (PISS), in modelling all sequences of DDTMP project work which is shown in Figure 3. With such integrated approach to eco-tourism development, the *first step* was to identify potential eco-tourism sites. Then *secondly*, to assess the suitability of these sites by matching their characteristics with attributes that are the most appropriate for eco-tourism development and different land use activities. This method has been proven beneficial for supporting decision-making when planning and allocating tourism facilities in different eco-tourism land use zones of DDLA area.

### Data Collection

After clarification and acceptance of the above framework, a five-step process was established focusing on (i) primary and secondary data collection; (ii) development of GIS mapping models based on concepts, spatial/environmental logic and mathematical calculus; (iii) GIS visualization analysis of 51 indicators within more than 100 different GIS layers; (iv) interpretation of analytical data and integration into GIS data base and reporting materials; (v) preparation of Scoping Report for client and stakeholders.

**Figure 3. Dikgathong Dam Modelling and Planning framework**



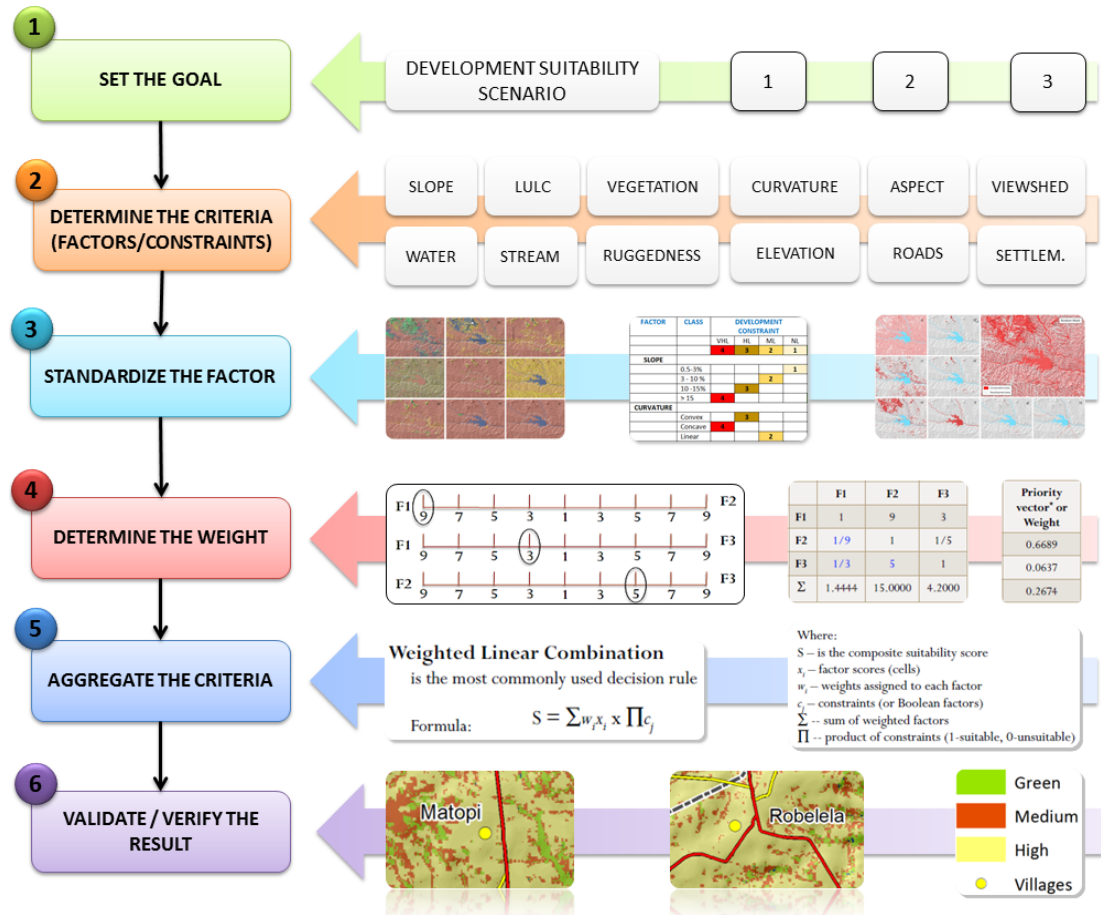
Data used in this report were assembled from a variety of sources. *Firstly*, the primary data from the field survey were collected through interviews and questionnaires answered by experts in the related fields of study to identify important factors in the North-East and Central Districts. *Secondly*, data were collected along with Statistic Botswana, Global Positioning System (GPS) and drone field surveys, and from GIS data sources available locally (DSM), regionally (SADC) and internationally (FAO, UN Habitat, UNEP). Then *thirdly*, the GIS-based land suitability analysis has been applied in a wide variety of situations including sites and administrative boundaries expanding at international, national, regional, district and local levels. However, the large-scale (1: 25,000) suitability scenarios maps have been derived for DDLA and its countryside, including the three closest villages of Robelela, Matopi, and Patayamatebele. The further downscaling of maps has continued once the preferred planning scenario is selected. Then the series of detailed land use maps, landscape model and urban design site solutions were prepared outlining proposal for individual tourism development zones.

### ***Application of Multi-Criteria Evaluation (MCE) and Analytical Hierarchy Process (AHP)***

As proven in several studies (Jankowski & Richard, 1994; Malczewski, 2006, Charabi & Gastli, 2011; Gigović et al., 2016), GIS and remote sensing tools were used for identifying location suitability and resource inventories according to environmental, socio-economic and spatial planning concerns. A well-known weight evaluation method of the Analytical Hierarchy Process (AHP) and Multi Criteria Evaluation (MCE) were similarly applied in flood prevention (Fernández & Lutz, 2010), wildfire risk estimation (Kant Sharma et al., 2012), agricultural management (Mendas & Delali, 2012) and energy generation (Abudeif et al., 2015). A few efforts were done to analyse ecotourism potentials as well (Bunruamkaew & Murayam, 2011; Koschke et al., 2012; Gigović et al., 2016; Jeong et al., 2016; Fang, 2017; Çetinkaya et al., 2018; Siljeg et al., 2019).

The AHP weights were calculated using Microsoft Excel and ArcGIS 10.3 and other software to produce GIS maps showing various levels of land use suitability in accepting diverse tourism activities on particular sites and zones. In general terms, there were four crucial objectives emanating from the major goal of producing the DDLA suitability maps: (i) finding suitable factors to be used in the analysis (ii) assigning factor priority, weight and class weight (rating) to the parameters involved (iii) generating land suitability map for tourism, and (iv) determining potential tourism areas. As can be seen from Figure 4, after goal and objectives settings, the applied method was executed in six major steps specifying the hierarchical structure, determining the relative important weights of the criteria and sub-criteria, assigning preferred weights of each alternative and determining the final score, and at the end validating achieved results.

Figure 4. Dikgathong Dam Methods of Multi-Criteria Evaluation (MCE)



Our planning/GIS team has identified a set of 12 criteria and 51 indicators, which have been employed and scrutinized by application of MCE and AHP techniques and then kept as GIS layers. The following factors as indicators of suitability within the land ecosystems of the DDLA context were determined and identified: slope, aspect, ruggedness, basin network density, landform, planar curvature, vegetation, land cover, land use, settlement size, and road accessibility. For example, land cover/land use factor was classified and reclassified from 2015 data obtained from Regional Centre for Mapping of Resources for Development (RCMRD), while the values for landform and ruggedness were aggregated by using geo-morphometric algorithms. Slope factor was classified by degree measurement unit. Distance from roads factor depends on the transport condition by access types and distance from the road types. The settlement size factor was classified by settlement population size and its rank in the National Settlement hierarchy.

Typically, the priority of each factor involved in the AHP analysis was determined by knowledge of experts who were part of our interdisciplinary team and information available from various primary and secondary sources, literature review, historical records, and many more (Siljeg et al., Cavric 2009 and 2011; GISplan, BTO 2016). In this process, experts’

opinions have helped to calculate the relative importance of the factors and criteria involved. To ensure the credibility of the relative significance used, AHP also provided measures to determine inconsistency of judgements mathematically. Consistency ratio index (CR) was also calculated and found to be 0.143 (out of 1.00), which is acceptable to be used in the suitability analysis for eco-tourism master planning.

As an ultimate outcome of the entire evaluation process, the three land suitability scenario maps for eco-tourism were created, based on the linear combination of each used factor's suitability score. The AHP method was applied here to determine the relative importance of all selected factors. The total suitability score "Si" for each land unit (i.e. each raster cell on the map) was calculated from the linear combination of suitability score obtained for each factor and criteria involved.

In Multi-Criteria Evaluation (MCE) using a weighted linear combination, the assigned weights were summed up to 1 for each category/subcategory defined. However, each factor in the last layer was classified into 4-5 suitability classes and their suitability scores were presented in the standardized format ranging from 0 (least suitable) to 1 (most suitable).

## Discussion

Based on the outcomes of the spatial and suitability analysis which included, amongst others, site characteristics (slopes, aspects, ruggedness etc.), site resources (vegetation, wildlife, birds) and site location, vis-a-vis the whole Lease Area, as well as related tourism and recreational attractions/opportunities identified, the DDTMP project team has produced three alternatives/scenarios which were evaluated and a preferred alternative (The Master Plan) was chosen. The zones have been established to serve as management units, within which prospective tour operators/concessionaires shall (through open tenders) be granted rights to carry on prescribed or recommended land use/tourism activities for each zone. The management zones thus aimed at classifying uses within zones according to the levels of sensitivity and suitability of each zone. Specific land uses/tourism activities and land use development forms were assigned to each zone, based on the zone type. The areas/zones are ranked from 1 to 4 and described as:

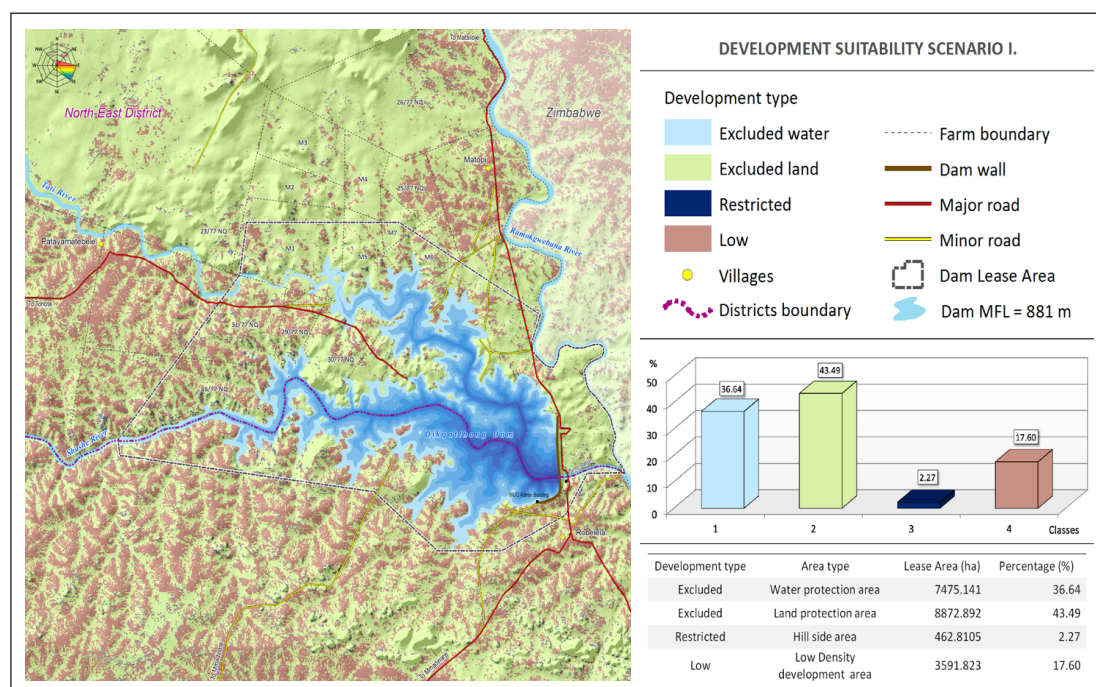
- A suitability ranking S1 indicates minor or no suitability limitations to development.
- A ranking of S2 indicates that such areas/zones present moderate limitation to development.
- A ranking of S3 represents high limitation and suitability for development is low.
- A ranking of S4 indicates extremely high limitations and suitability for development is very low and/or prohibited.

The description of each suitability scenario and the final land use zoning and design is presented as follows:

## Conservation Development – Suitability Scenario I

This model was developed with the intention of identifying/establishing those parts or sections of the DDLA with ecological and resource significance and thus important for protection and conservation. Using this model, the functional aim was to conserve valuable natural vegetation areas and protect ecologically sensitive areas within the Dam Lease Area's. Ecologically sensitive areas have included areas with riparian vegetation and areas prone to flooding. The output of applying this model is presented in Figure 5 and Table 2.

**Figure 5. Dikgatlong Dam Conservation Development - Suitability Scenario I.**



As can be gleaned from the Figure 5 and the Table 2, there are four suitability classes assigned by the model. The largest is land protection area measuring 8,872.89 ha or 43.49% of the total land area. It is followed by water protection area (the Dam) with the same regime of excluded development accounting for 7,474.14 ha or 36.64 %. The low-density type of development is allowed on 3,591.82 ha or 17.60%, thus placing the focus on conservation and green urbanism solutions. The smallest land chunk belongs to restricted area on hilly sides with 462.82 ha or 2.27% respectively.

**Table 2. Land Use Statistics for Conservation Development - Suitability Scenario I**

Development type	Area type	Suitability Class	ha	%
Excluded	Water protection area	S4	7,475.14	36.64
Excluded	Land protection area	S4	8,872.89	43.49
Restricted	Hill side area	S3	462.82	2.27
Low development	Low density area	S1	3,591.82	17.60
			<b>20,402.67</b>	<b>100.00</b>

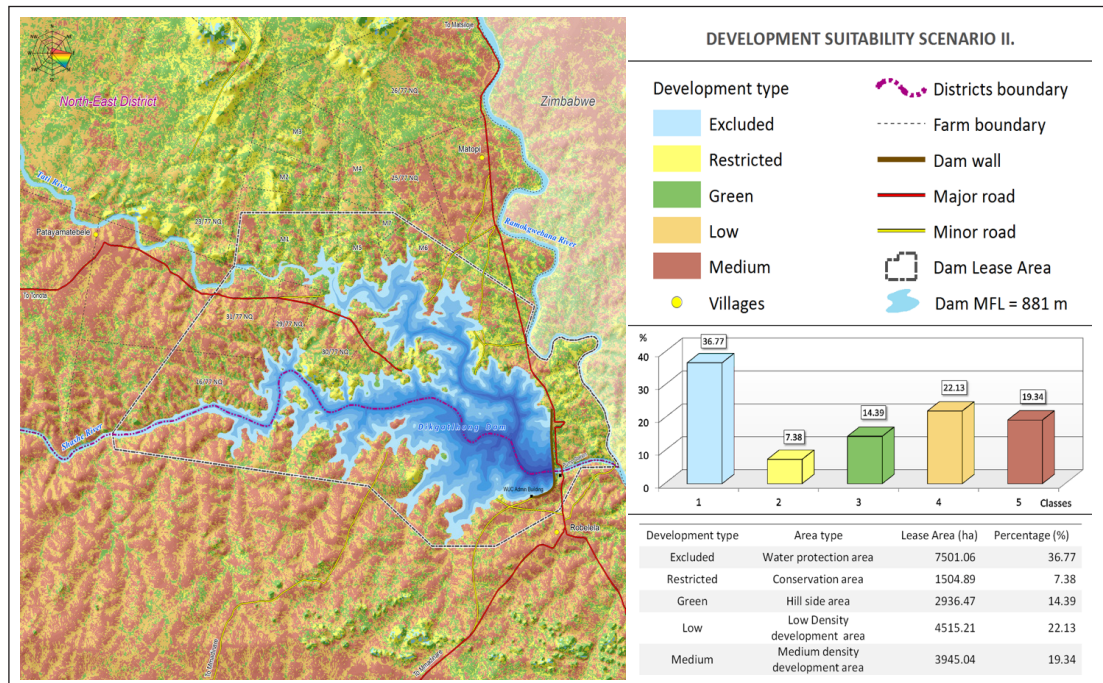
Source: GIS Plan computation, 2015

Zones of valuable natural vegetation and ecological sensitivity, which should be protected and conserved, while not being suitable for intensive development are more suited for recreational uses and wildlife conservation. Conservation efforts should therefore be focused on preservation/regeneration of natural vegetation cover and water points, streams and aquifers, because of their role in sustaining wildlife and recreational values.

*Sustainable Development – Suitability Scenario II*

This development suitability model considers a set of biophysical (natural conditions) factors as determinants of a site’s suitability for development. The following factors were considered in the application of this model for land suitability analysis: Site slope; slope aspect (exposition), height elevation, ruggedness, and planar curvature. The suitability analysis in this regard, sought to establish the suitability of the Dam Lease Area, using the above factors as parameters. The output of the analysis is shown in Figure 6 and Table 3.

**Figure 6. Dikgathong Dam Sustainable Development - Suitability Scenario II.**



The analysis shows that this model has a higher level of flexibility in terms of allowing more forms of land development. Like model one, the largest area is still under protection including 7,501.06 ha or 36.64% of the Dam water surface. Conservation area occupies 1,504.89 or 7.38% and is restricted for development. Forms of green urbanism development are permitted to take place below hilly sides on 3,936.47 ha or 14.39% of land, and under condition of application of adequate engineering and environmental protection techniques. Low density development is approved in an area of 4,515.21 or 22.13%, while the medium density development can be implemented on 3,945.04 ha or 19.34% of total land mass.

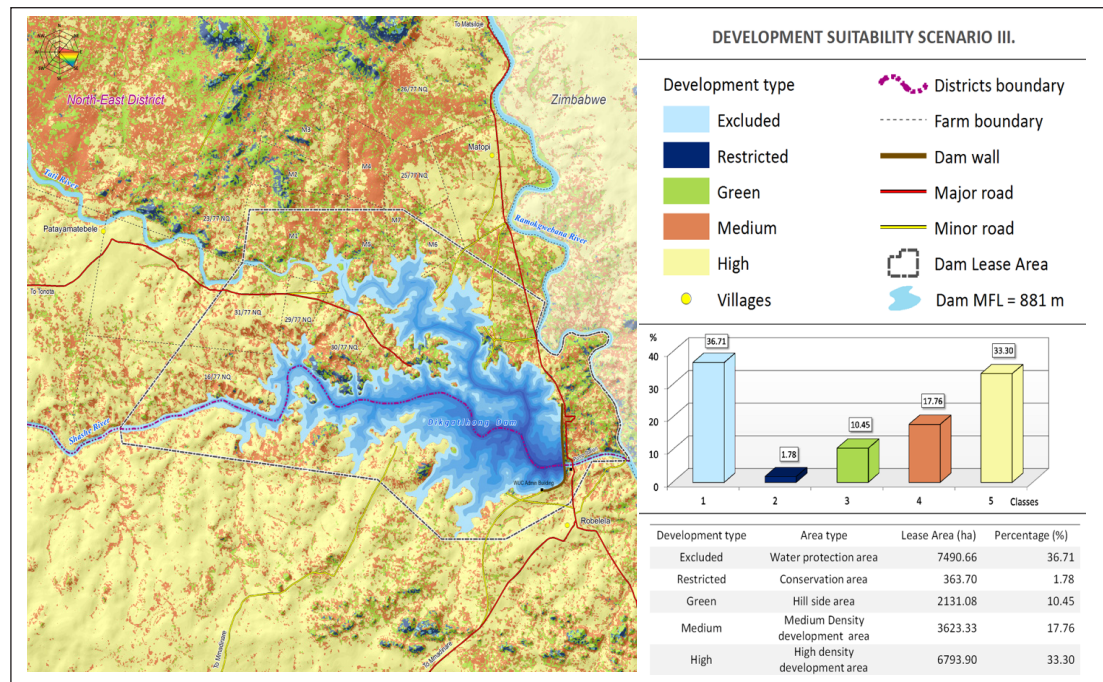
**Table 3. Land Use Statistics for Sustainable Development - Suitability Scenario II**

Development type	Area type	Suitability Class	ha	%
Excluded	Water protection area	S4	7,501.06	36.64
Restricted	Conservation area	S4	1,504.89	7.38
Green	Hill side area (bottom part)	S3	2,936.47	14.39
Low	Low density area	S1	4,515,21	22.13
Medium	Medium density area	S2	3,945.04	19.34
			<b>20,402.67</b>	<b>100.00</b>

Source: GISPlan computation, 2015

### Intensive Development – Suitability Scenario III

The third model is more favourable for mass tourism and limits the extent of environmental protection and conservation. It allows the introduction of more intensive forms of development spreading over larger portions of land. If not controlled this type of suitability could compromise the basic function of the dam as a water resource of national importance. Also, other valuable ecological elements (e.g. natural habitats, stream channels, quantity/quality of water, landforms), highlighted in previous two models could be endangered and basic tourism attractions can fade away. This model opens the room for built-environment growth and intensive change of land use and land cover.

**Figure 7. Dikgathong Dam Intensive Development - Suitability Scenario III**



One-third of the area in this model still belongs to the water body of the dam. Conservation area is limited to 363.70 ha or 1.78% only. On the other hand, this model anticipates more than 10,000 ha or 51.06% to be designated for different forms of medium and high-density development. More sustainable forms of green urbanism are seen around hilly sides, mostly at their hill steps taking 2,131.08 ha or 10.45%.

**Table 4. Land Use Statistics for Intensive Development - Suitability Scenario III**

Development type	Area type	Suitability Class	ha	%
Excluded	Water protection area	S4	7,490.66	36.71
Restricted	Conservation area	S4	363.70	1.78
Green	Hill side area	S3	2,131.08	10.45
Medium	Medium density area	S1	3,623.33	17.76
High	High density area	S1	6,793.90	33.30
			20,402.67	100.00

Source: GISPlan computation, 2015

#### *Evaluation of Suitability Scenarios*

With regard to specific evaluations of the three zoning scenarios, a Multi-Criteria Evaluation Matrix was used to show how the scenarios were ranked with regard to the checklist of performance criteria presented above. The relative performance of each scenario was evaluated/assessed against the checklist, with ratings ranging from 0-5, where 0 represents a bad performance, while a rating of 5 represents an excellent performance. Table 5 is the result of the multi-criteria evaluation of each scenario showing how they ranked with regard to the checklist of performance criteria and indicators.

**Table 5. Multi-Criteria Evaluation Matrix for the Broad Zoning Scenarios**

#	Multi-Criteria Evaluation Check List/Performance Criteria	INDICATORS	SCENARIO		
			I	II	III
1	Conservation of biodiversity and natural resources	<ul style="list-style-type: none"> <li>❖ Total spatial area coverage (ha) designed for conservation/nature base uses</li> <li>❖ Total area (ha) designed for low impact tourism activities</li> <li>❖ Number of zones and proposed tourism activities</li> <li>❖ Intensity of development</li> </ul>	5	4	1
2	Alignment with outcomes of suitability and sensitivity analyses	<ul style="list-style-type: none"> <li>❖ Number of deviations from the development suitability maps in the siting of proposed tourism activities and developments</li> </ul>	5	4	3

#	Multi-Criteria Evaluation Check List/Performance Criteria	INDICATORS	SCENARIO		
			I	II	III
3	Provision of good mix of tourism activities that appeal to diverse market segments	<ul style="list-style-type: none"> <li>❖ Number of tourism activities</li> <li>❖ Types of tourism activities and developments</li> <li>❖ Number and types of market segments catered for</li> </ul>	3	4	5
4	Assurance of good economic returns on investment for Investors	<ul style="list-style-type: none"> <li>❖ Anticipated volumes of tourists (Low or High)</li> <li>❖ Number and types of tourism activities</li> <li>❖ Types of tourism activities offered</li> </ul>	3	4	5
5	Promotion of sustainable tourism development	<ul style="list-style-type: none"> <li>❖ Depletion of natural resources</li> <li>❖ Environmental damage and degradation</li> <li>❖ Water pollution</li> <li>❖ Ability to sustain tourism in all respects over time</li> </ul>	5	3	1
6	Benefits to surrounding communities	<ul style="list-style-type: none"> <li>❖ Opportunities to conduct tourism business in the Dam Lease Area</li> <li>❖ Opportunities for commercial fishing</li> </ul>	4	4	4
<b>Totals</b>			<b>25</b>	<b>23</b>	<b>19</b>

**Notes:** 5=Excellent; 4=Very Good; 3=Good; 2=Fair; 1=Poor; 0=Bad

In terms of the degree to which each scenario promotes or achieves the conservation of biodiversity and natural resources, the evaluation process reveals that Scenario I scored the highest with the maximum score of 5 points, followed by Scenario II, with 4 points. Under Scenario I, a total of 10365 ha or 72.14% of the total Dam Lease Area is devoted to conservation-related or nature-based use activities, while 3063 ha or 21.35% of the total area is for adventure tourism activities. The intensity of development and the number of facilities, as well as the number of zones in scenario I are the lowest among the three zones. With predominantly low volume tourism development in scenario I, biodiversity and natural resources will be much more conserved. Scenario III scored badly with 1 point under the conservation of biodiversity and natural resources criteria. It has the highest number of zones and the intensity of development and the number of facilities and activities to be provided are the highest, which means that the scenario will attract high volumes of tourists and diversified market segments. Scenario II scored 4 points with regard to conservation of biodiversity and natural resources. The Scenario has a smaller number of zones and activities than Scenario III, but with more zones and activities than Zone 1. It strikes a balance between the need to conserve biodiversity and promote tourism development sustainably.

With regard to alignment of the scenarios with the outcomes of the land suitability analysis carried out, all three scenarios performed well in this regard. Scenario I scored the maximum 5 points while Scenario II scored 4 points and Scenario III scored 3 points. With regard to the provision of a good mix of tourism activities which appeal to diverse market segments, Scenario I scored the maximum 5 points, since it provides the highest number and

types of tourism activities catering for all market segments, while Scenario I scored 3 points and caters mostly for the up-market segment but nonetheless caters for other market segments. Consequently, Scenario III thus assures good economic returns on investment for investors, while under Scenario I prospects of good economic return on investments are not as high as in scenarios II and III, since there will be fewer tourism activities and lower tourism volumes. Scenario II scored 4 points on this criterion, which is very good. In terms of the promotion of sustainable tourism development, Scenario III scored poorly, with 1 point, while Scenario II scored 4 points which is very good, and scenario I scored 5 points which is excellent. Scenario III has the ability to sustain tourism in all respects over time.

The communities surrounding the Dam Lease Area stand to benefit economically from tourism activities in all the zoning scenarios, particularly Robelela and Matopi, which are closest to the Dam. This is because there will be craft shops and vending stalls from which residents of these communities can engage in tourism-related business. Furthermore, there are proposals for the establishment of Community Development Trusts in the villages to serve as vehicles for the establishment of tourism businesses in their respective villages and in the Dam Lease Area, such as cultural villages, lodges and guest houses.

#### *Selection of Preferred Scenario and Development of Master Plan Land Use Zoning Proposal*

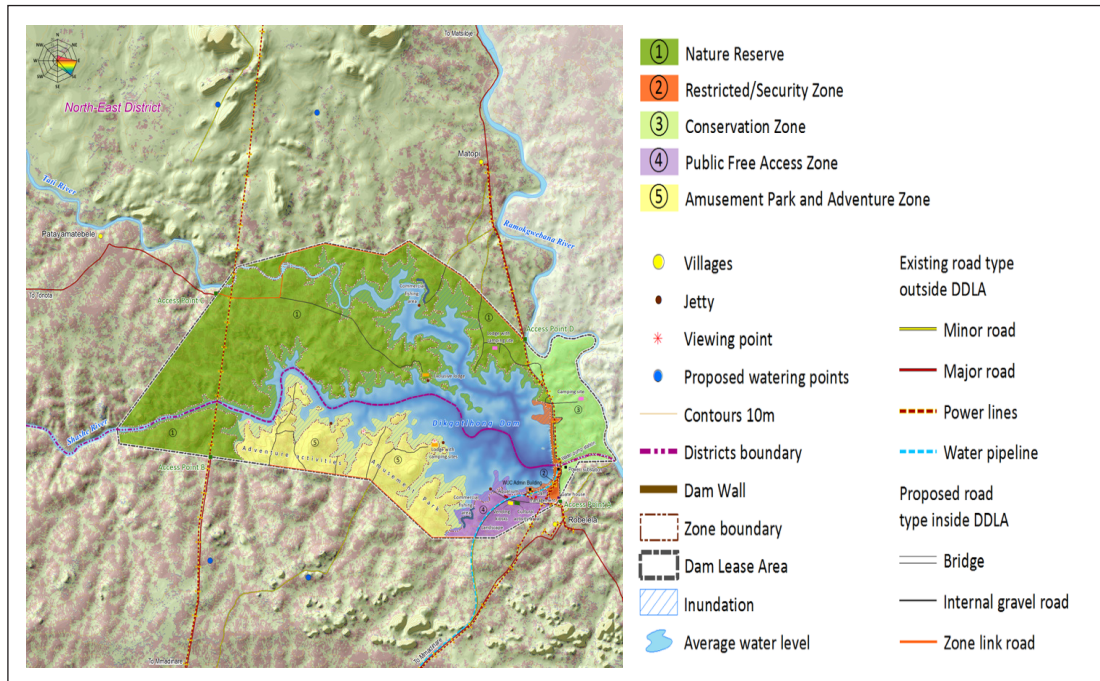
From all the evaluations above, broad zoning scenario I – Conservation Development has scored the highest with a total of 35 points and is recommended as the preferred planning scenario for DDTMP area. This scenario serves as the basis for the development of land use plans for each zone within the scenario, as well as the preparation of detailed development guidelines and management prescriptions dealing with the Tourism Master Plan proposals and recommendations. A composite zoning map of all the five zones in this scenario is shown in Figure 8. The details of each zone's intents and objectives; zone's attractions and characteristics; permitted and non-permitted uses in each zone, are presented under the following sub-headings:

##### *Nature Zone (1)*

This zone encompasses the northern and southwestern portions of the Dam Lease Area and the area is characterized generally by dense vegetation cover, with the following specifics: the presence of relatively dense tree stands of different Acacia species; the presence of riparian forest and savannah mixed woodland, comprising Mophane, Mohudiri and Morula; the presence of African Elephant, Kudu, Impala, Steenbok and spotted Hyena. There have been sightings of Leopard in the area; the presence of birdlife. There is availability of forage which is good for browsers such as Elephant, Kudu and Impala. The area has moderate grazing capacity for grazers such as Zebra and blue Wildebeest. The zone is an unmodified natural environment. With the above characteristics, the zone's attractions thus lie in its potential to offer opportunities for experiencing and appreciating its natural values in pristine and natural settings, while experiencing a closeness to nature and solitude. Consequently, it is intended that the zone be established as a Nature Reserve. The following activities are recommended in Zone 1 (Nature Reserve): Guided Game Drives and Walking Safaris; Bird Watching and Photographic Safaris. It is recommended that a Lodge (36-bed facility) with a camping site,

be developed in the far eastern portion of this zone, which is near the border with Zimbabwe. A lodge facility will be well suited and needed for this zone, given that there will be tourists who will want to spend a couple of days in the Nature Reserve, to appreciate and experience a closeness to nature and fully engage in the activities on offer. While the lodge will appeal to the up-market and mid-market segments, the camping site will appeal to the budget market segment.

**Figure 8. Dikgathong Dam - Proposed Land Use for Sustainable Conservation Development**



### *Restricted/ Security Zone (2)*

This zone stretches from the eastern side of zone 4 which is the free public access zone, up to the Dam Wall area and lies immediately east of Matsiloje-Matopi-Robelesa road. The zone covers a total area of 194 hectares, which represents 1.35% of the total Dam Lease Area. Zone 2 houses the water pump station; BPC substation; Dam spillway and other Dam installations; and WUC administration offices. The general intents of this zone are to: Protect and safeguard the valuable and technical equipment that are required for the smooth operation and functioning of the Dam itself, from damage and vandalization or even sabotage. Ensure that these assets are always in good working conditions. Given the security and sensitive nature of zone 2, its entry shall always be restricted and shall only be accessible to staff of WUC and BPC permission for entry may be granted to special groups, such as students on educational tours. There shall be 24-hour security presence in the zone.

### *Conservation Zone (3)*

Zone 3 is located at the eastern end of the Dam Lease Area, with Ramokgwebana River and

Zimbabwe bordering it to the east, Matsiloje-Robelega road to the west. The zone covers a total area of 1319 hectares, which represent 9.19% of the total Dam lease Area. Zone 3 has similarities to zone 1, in terms of biodiversity richness. The zone is characterized by riparian forest and savannah mixed woodland comprising Mophane, Mohudiri, Morula and riparian tree species, including *Acacia Eriloba* and *Ziziphus Mucrowata*; and the presence of Elephant, Kudu, Impala, Steenbok and Hyena. Whenever the spillway in the security zone is opened, some parts of the southern portion of zone 3 are flooded, and water is channelled through a diversion channel into Shashe River. As a result, this portion of the zone is most of the time marshy and characterized by a wide area of depression, interspersed with mounds of rock. It is therefore recommended that this southern portion of zone 3 be free of any developments, since it serves in receiving water from the spillway and thus have a unique landscape. With its richness in biodiversity and unique landscape in the southern portion, the intention is for the area to be designated as a conservation zone. It is recommended that a camping site be established in the central part of zone. This recommendation is inspired by the need to have a human presence in the zone, given that it is bordered by Zimbabwe and the possibility of poaching activities cannot be dismissed. The camping site will be targeted at the budget market segment.

#### *Public Free Access Zone (4)*

Zone 4 which serves as “the gateway” and main entry point into the Dam Lease Area, is in the southeastern corner of the Dam Lease Area, near Robelela village. The zone covers an area of 726 hectares, which represents 5.06% of the total Dam Lease Area. The area for zone 4 is characterized by the following: relatively open and flat terrain which lies on a generally high ground and thus presents opportunities for leisure and social interactions; sparse vegetation of shrub savannah and fringed by riparian vegetation along the shorelines; low ecological sensitivity, which makes the zone suited for high volumes of visitors envisaged; easy access to the shorelines, with panoramic views of the hills to the northern parts of the Dam and the Dam waters. The Public Free Access Zone will be open to all visitors to the Dam. Given that the zone is easily accessible to all visitors to the Dam and is the first major open area on arrival to the Dam, from Selebi Phikwe/Mmadinare/Robelega and Francistown /Matsiloje/Matopi, it is recommended that the following should be developed in this zone: (i) dam entrance canopy and gate house, (ii) dam management and tourism information centre, housing interpretation centre, arts gallery (iii) exhibition hall, (iv) curio/craft shop, snack/coffee shop, vending kiosks, (v) landscaped lawns, (vi) aquarium, and (vii) viewing platforms. With the above developments, it is recommended that the following activities should take place in zone 4: (i) cultural activities in the form of annual dance and cultural festivals, and (ii) showcasing local dance, art and cuisine of communities surrounding the dam, picnics and wedding events.

#### *Amusement Park and Adventure Zone (5)*

Zone 5 lies in the southern part of the Dam Lease Area and is bordered by zone 1 to the west and the Dam waters to the north, and to the east by zone 4. The zone has a spatial area coverage of 3063 hectares or 21.35% of the total Dam Lease Area, and is defined by the

following biophysical characteristics and attractions: relatively open and flat grounds which present opportunities for leisure and active recreation; sparsely vegetated shrub savannah and moderately bare soils; easy access to the shorelines with open views of the Dam waters and hills to the north of the Dam Lease Area, with good locations for the placement of elevated viewing points; low ecological sensitivity, thus suited for high tourist volumes. Given that the zone has large expanse of relatively flat land and with low ecological sensitivities the following activities are recommended for this zone: (i) passive and active recreation, (ii) mountain biking and quad biking, (iii) sport/recreational fishing, (iv) equestrian sport, (v) wedding events. With the above activities, the following developments are recommended in zone 5: (i) amusement park, with roller coaster, joy rides, and slides, (ii) lodge (24 beds) with camping site, (iii) landscaped lawns, (iv) mountain biking trails, (v) quad biking tracks, (vi) vending kiosks, (vi) snack/coffee shop, etc. It is proposed that the preferred market segments for zone 5 will be the budget, mid-market and up-market segments.

## Conclusion

With this innovative approach, the DDTMP team has opened the door for a new era in Botswana planning practice, focusing this time on **(i)** the action area planning, and **(ii)** special area planning, which are the major planning fields of BTO interest. The same principles applied in this project are applicable to other planning types currently existing in the country (e.g. settlement, regional, district, environmental, site, and integrated land use and national planning). In summary, it was a combination of GIS capabilities with MVE/APH techniques, and involved the phases of planning intelligence system and choices by project team, BTO and stakeholders.

There are number of ways in which future planning practice and research could strengthen the validity of DDLA land suitability findings that could also be applied in other BTO projects. The findings give concrete information at which DDLA sites, the location of different types of tourism activities and land uses can take place. Furthermore, the applied method reduces subjectivity which is common in Botswana planning arena as a result of weak application of modern tools and technologies, and in many cases influenced by political powers.

The vision for tourism development at Dikgathong Dam is the product of shared aspirations and wishes of stakeholders, including community residents, as captured during stakeholders and community consultations, as well as community surveys. Importantly also, the remits of the Terms of Reference as issued by the client (BTO), have informed the long-term vision for tourism development at Dikgathong Dam. Vision in this context, is taken to represent a desired future state. Tourism development vision, involves the elaboration of the style of tourism; stakeholders would like to see a particular tourism destination offer, and who the target markets for the destination should be.

The aspirations and wishes expressed by stakeholders and community residents point to the vision of tourism in Dikgathong Dam as being leisure, recreational and adventure-based, while at the same time offering opportunities for tourists to experience natural settings in the form of outdoor camping, bird watching, walking safaris/trails and game viewing drives,

all set against the backdrop of spectacular views of the reservoir lake and sunsets. Tourism in the area will therefore offer “multi product” in terms of product mix, which will appeal to high-end, mid-market and low-end (budget) market segments (to be determined by the tourism activity zones). It is envisioned that Dikgatlhong tourism will embrace and embody sustainable tourism in all its ramifications, with conservation of biodiversity and natural resources as a major focus. The Dikgatlhong future tourism activities will also continuously benefit the surrounding communities economically, while yielding good returns on investment for tour operators and other investors.

The DDTMP project and its interdisciplinary nature of researching into sustainable eco-tourism through application of GIS MCDA and AHP is a pioneering work in Botswana. It aims at introducing principles of contemporary planning paradigms in combination with the latest technological advancements rooted around geo-spatial technologies and expert planning support systems, which help to avoid subjectivity and wrong decision-making related to environmental land use planning and developments. The DDTMP offers a new model, the one on tourism as the niche of “production of space and construction of place” (Dujmovic and Vitasovic, 2013), where cooperation between scientists, community, parastatals, government and private stakeholders can yield the best possible eco-tourism solutions without compromising the quality of life and quantity of natural resources.

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