D06: Evidence Base

Name of Project: Climate Resilient Development Pathways

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Quality Assurance Checklist

In preparing this document CRIDF can confirm that it has followed CRIDF's internal general procedures, including appropriate CRIDF generic scope of work and that it has undergone appropriate quality assurance (QA) and quality control (QC) procedures as detailed in CRIDF's QA manual. Furthermore, CRIDF can confirm the applicable specific internal process and procedures have been followed including:

- CRIDF's Cost Benefit Assessments (CBAs) guideline have been applied as appropriate;
- CRIDF's Gender Equality and Social Inclusion (GESI) guidelines have been applied as appropriate;
- CRIDF's Climate vulnerability mapping methodology has been applied as appropriate;
- CRIDF's Climate Change Risk Assessment (CCRA) protocol have been applied as appropriate;
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- CRIDF's Screens as appropriate.

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Disclaimer

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List of acronyms

Acronym	Long-Form
CIVAT	Climate Impact and Vulnerability Assessment Tool
CRDP	Climate Resilient Development Pathways
CRIDF	Climate Resilient Infrastructure Development Facility
DFID	Department for International Development
GTAP	Global Trade Analysis Project
ITCZ	Inter-tropical Convergence Zone
MSIOA	Multi Sector Investment Opportunity Analysis
RCP	Representative Concentration Pathway
SOMs	Self-organizing maps

Climate Resilience Integrated Development Pathways and their Application to the Okavango Transboundary River Basin – Methodological Note on Evidence Base.

The purpose of this document is to provide guidance for the development and combined use of the evidence base produced through different lines of inquiry related to the vulnerability assessment of selected water infrastructure development scenarios under the Multi-Sector Investment Options Analysis (MSIOA) program for the Okavango Basin. The guidance directly builds on details in CRIDF's Foundations and Approach report on Climate Resilient Development Pathways[1]. The evidence base was constructed through a multi-stage process shown on Figure 1.

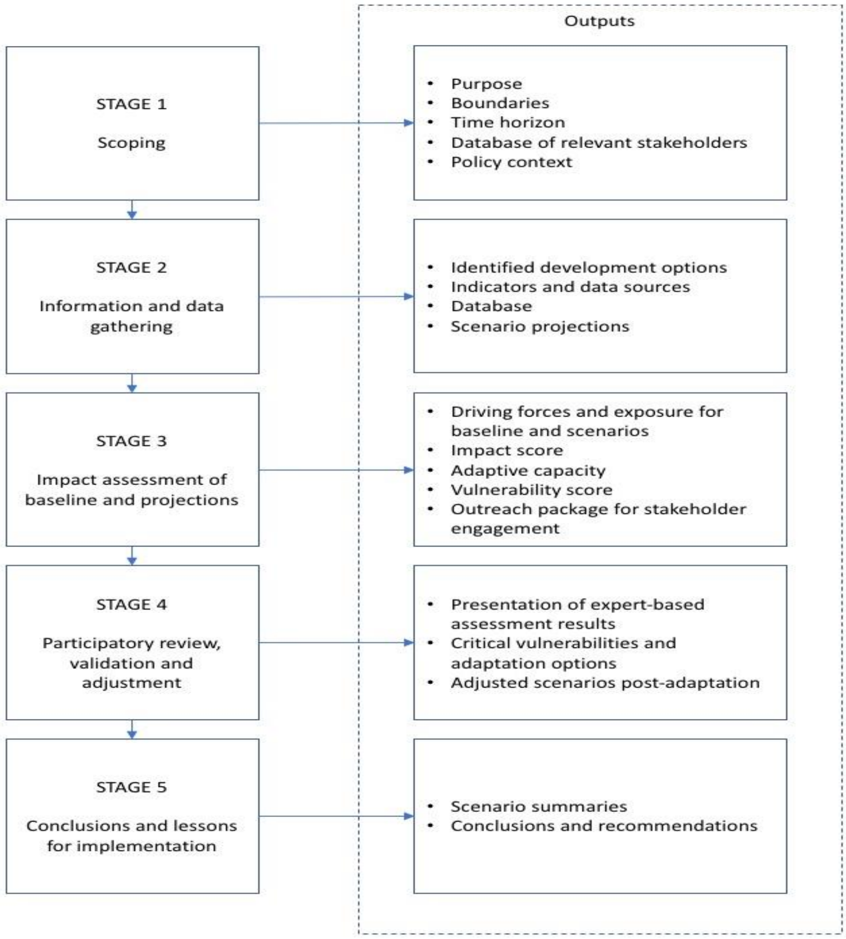

Figure 1: Outline of CRDP approach

As for **Stage 1**, given the nature of the task, the CRDP approach has a complex frame of reference and analytics that have to be aligned with the need to present results to a non-expert stakeholder audience in a simple,

[1] CRIDF (2016) Climate Resilient Integrated Development Pathways and their Application to the Okavango Transboundary River Basin – Foundations and General Approach. Pretoria: CRIDF.

understandable form, suitable for participatory work and informed decision-making. Key elements of the frame of reference are shown in Table 1.

Table 1

Geographic area[2]	Wet ITCZ region of Okavango basin (Climate Zone 1) Semiarid/arid region of Okavango basin (Climate Zone 3)
Political context	Angola, Botswana, Namibia
Time scale	2016-2035, 2046-2065, 2081-2100 (equivalent to IPCC time scales)
Development scenarios	Selected from MSIOA set (2-3)
Climate scenarios	Three climate variants: RCPs 2.6, 4.5, 6.0, 8.5 scenarios rolled up into low and high probability climate outcomes and compared with present day climate as a third variant; qualitative comments on the implications of higher-end climate scenarios will be added as relevant in the workshop
Hydrological projections	Pitman model outputs around four MSIOA development options LS3, 6, 9 and LS1 as baseline) and 12 hydrological indicators

For the purposes of this work we adopt a terminology where we refer to MSIOA development ***scenarios***, climate ***projections*** and the different combination of the two as ***scenario assemblies***. Social, environmental and economic impacts are referred to as ***themes***. A set of model predictions/projections, all for the same future period, produced either by variations of a single model, or by a group of different models, or by a combination of both methods is referred to as an ***ensemble***.

Stage 2 involves the development of the scenario architecture and the generation of model-based quantitative projections. Considering the focus of the project, the MSIOA development scenarios serve as the primary organizing level for the evidence base and impact assessment. Combined with the three climate variants, the MSIOA scenarios produced the scenario assemblies shown in Table 2.

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[2] Longitude and latitude of the project area:

Geographic unit	**North**	**West**	**East**	**South**
Entire basin	12.25	16.25	24.0	20.5
Northern part	12.25	16.25	20.0	18.0
Southern part	18.0	18.25	24.0	20.5

Table 2: Overview of 12 scenario assemblies resulting from three climate projections (columns) and four MSIOA scenarios (rows).

	Present day (PD) climate	Higher probability (HP) CC	Lower probability (LP) CC
LS1	LS1/PD	LS1/HP	LS1/LP
LS3	LS3/PD	LS3/HP	LS3/LP
LS6	LS6/PD	LS6/HP	LS6/LP
LS9	LS9/PD	LS9/HP	LS9/LP

Generating the evidence base for the Okavango CRDP assessment in **Stage 3** involved a combination of model and indicator based quantitative methods and quantitative information-based expert judgment. The information was complement by qualitative information provided by stakeholders in a workshop.

As for climate change, projections for the Cubango/Okavango basin were calculated based on atmosphere/ocean models used in the IPCC's 5th Assessment Report. The results were compiled as ensembles means diagrams and ensemble standard deviations diagrams. The projections were analyzed using self-organizing maps (SOMs), based on rainfall and temperature projections and rainfall less evaporation and temperature projections. Individual projections are created for each time slot and climate representative concentration pathway (RCP) and based on individual SOMs, with indications of likelihood occurring for each, summarized as a more likely and less likely climate future. Technical details of the methodology and detailed results are available in a separate report[3].

Based on the results of climate models hydrological impact projections were calculated using the Pitman model. Hydrological information is available separately for the upper and lower parts of the Okavango basin for the baseline and selected future time scales but rolled up into a basin-wide single projection to limit the complexity of scenario assemblies. Hydrological model runs produced results for mean monthly flows and deviations of mean flows from the base case at a number of monitoring sites in the basin. Based on these results impacts on a series of hydrological indicators shown in Table 3 and related ecological integrity dimensions were assessed.

Table 3: Hydrological indicators assessed based on Pitman model runs.

Mean annual runoff
Dry Min 5d Q
Dry duration
Dry ave daily vol
DryOnset (HydroWeeks)
Wet Max 5d Q
Wet duration
Wet ave daily vol
WetOnset (HydroWeeks)
Flood volume
FloodType

[3] Climate change scenarios for the Cubango/Okavango Basin – Detailed Text. Prepared by CCRM.

Sediment supply

Projections of baseline and climate scenario adjusted flows from the Pitman model served as a quantitative basis for impact assessments under social, ecological and economic themes. Due to the lack of an integrated impact assessment model calibrated to the Okavango Basin and due to different conceptual and data challenges, impact assessment under the three themes followed different methods. *Economic impact* assessment was based on the Global Trade Analysis Project (GTAP) model to generate country-scale projections of economy-wide effects as a results of adjusted trade flows and other economy-wide connections influenced by climatic and water availability parameters derived from the climate and hydrological models. Given the relative scarcity of social data, *social impacts* were derived from an understanding of impacts of similar projects globally and tailored as much possible to the local circumstances. *Environmental impacts* for selected water and biodiversity-related indicators were estimated on a relative scale in response to hydrological impact projections using present conditions as a baseline. As general guidance, indicator selection can follow selection criteria such as those proposed by UNDG[4].

In order to express indicator values in terms of desirability / undesirability and to bring them to a common scale, each indicator was turned into a 5-level performance score ranging from -2 to +2 and color coding using a red-green-yellow traffic light system (Table 4). The color coding proposed is in sync with the scheme used by the climate index developed for the Okavango by Knight (2016)[5]. While the establishment of scores under the three themes followed the approaches as described above, a more elaborate approach could be based on the following considerations: (1) difference between projected value and baseline; (2) direction and slope of trend; (3) distance to target or critical threshold where known; (4) reversibility / irreversibility; (5) critical interlinkages with other indicators; and (6) scale of impact. In the case of qualitative indicators or when no numerical projection is possible due e.g., to data limitations, the rationale for color coding would need detailed explanation in the text.

Table 4: Color coding of indicator scores

Score	Impact	Color scheme
2	positive	
1	weak positive	
0	neutral	
-1	weak negative	
-2	negative	

In order to record indicator scores and to roll up results at different levels of aggregation, an Excel-based Climate Impact and Vulnerability Assessment Tool (CIVAT) was created. CIVAT is composed of a series of five interlinked modules as follows.

Modules 1-3 are designed to capture individual indicators and indicator scores under social, economic and environmental themes for all scenario assemblies, a baseline value and two future time periods (Table 5). In the

[4] https://undg.org/wp-content/uploads/2015/02/Selecting-indicators-criteria-UNICEF.doc
[5] Knight, J. (2016) Climate index: Update and discussion. Presented at the 33rd OBC meeting of OKACOM, November 28 – December 2, 2016, Gaborone, Botswana.

default version five indicators are assumed. Indicator scores are entered both numerically and with the matching traffic light color. The tool calculates average scores for each theme, time period and scenario assembly. Unless credible information is available regarding differential weights, the indicator scores are weighted equally and the resulting thematic impact average applies the same color coding system as the individual indicators.

Table 5: Illustration of the thematic indicator scoring modules 1-3 in CIVAT.

MSIOA scenario: LS3				
Climate: High probability				
Economic impacts				
Indicator name & unit of measure	**Type of number**	**Baseline indicator values and scores**	**Projected indicator values**	
			2016-2035	**2046-2065**
Indicator 1	Indicator value	155,693	1,111	
	Indicator score	0	1	
Indicator 2	Indicator value	0	1,130	
	Indicator score	0	1	
Indicator 3	Indicator value	34,216	-40	
	Indicator score	0	-1	
Indicator 4	Indicator value	30,630	334	
	Indicator score	0	1	
Indicator 5	Indicator value	17,280	84	
	Indicator score	0	0	
Average impact scores / time period		0	0.4	0

Module 4 is designed to roll up aggregate impact scores by theme separately for each development scenario and climate projection assembly and then calculate an equally weighted higher-level aggregate where the three thematic impact scores are also rolled up into a single impact score by each scenario assembly, as shown by Table 6. Aggregated impact scores are color-coded according to the same traffic light scoring system.

Table 6: Structure of the thematic indicator scoring module 4 in CIVAT.

LS1	No climate change	*Environmental*	0	0	0
LS1	High probability	*Environmental*	0	0	0
LS1	Low probability	*Environmental*	0	0	0
LS3	No climate change	*Environmental*	0	0	0
LS3	High probability	*Environmental*	0	0	0
LS3	Low probability	*Environmental*	0	0	0
LS6	No climate change	*Environmental*	0	0	0
LS6	High probability	*Environmental*	0	0	0
LS6	Low probability	*Environmental*	0	0	0
LS9	No climate change	*Environmental*	0	0	0
LS9	High probability	*Environmental*	0	0	0
LS9	Low probability	*Environmental*	0	0	0
LS1	**No climate change**	***Combined***	**0**	**0.13333333**	**0**
LS1	**High probability**	***Combined***	**0**	**0.13333333**	**0**
LS1	**Low probability**	***Combined***	**0**	**-0.1333333**	**0**
LS3	**No climate change**	***Combined***	**0**	**0.26666667**	**0**
LS3	**High probability**	***Combined***	**0**	**0.13333333**	**0**
LS3	**Low probability**	***Combined***	**0**	**0**	**0**
LS6	**No climate change**	***Combined***	**0**	**0.66666667**	**0**
LS6	**High probability**	***Combined***	**0**	**0.66666667**	**0**
LS6	**Low probability**	***Combined***	**0**	**0**	**0**
LS9	**No climate change**	***Combined***	**0**	**0**	**0**
LS9	**High probability**	***Combined***	**0**	**0.2**	**0**
LS9	**Low probability**	***Combined***	**0**	**0**	**0**

As one of its elements, in Module 5 CIVAT carries forward the overall impact score for each scenario assembly for each scenario assembly and each time period (Table 7). As another element, it captures the adequacy / inadequacy of adaptive capacity for each impact projection and scenario assembly using the same 5-level scoring system. Adaptive capacity elements adopted from the IPCC and include economic resources, technology, information and skills, infrastructure, institutions and equity. In the absence of quantitative data, scores for adaptive capacity are established through participatory methods by building on stakeholders' understanding of the scenario assemblies built up through a workshop process and their familiarity with baseline capacity available.

Table 7: Structure of the adaptive capacity and vulnerability scoring module 5 in CIVAT.

MSIOA SCENARIO	CLIMATE	VULNERABILITY ELEMENT	TIME PERIOD Baseline	2016-2035	2046-2065
LS1	**No climate change**	**Aggregate impact**	**0**	**0.13333333**	**0**
		Economic resources			
		Technology			
		Information and skills			
		Infrastructure			
		Institutions			
		Equity			
		Combined adaptive capacity	**0**	**0**	**0**
		VULNERABILITY	**0**	**0.06666667**	**0**
LS1	**High probability**	**Aggregate impact**	**0**	**0.13333333**	**0**
		Economic resources			
		Technology			
		Information and skills			
		Infrastructure			
		Institutions			
		Equity			
		Combined adaptive capacity	**0**	**0**	**0**
		VULNERABILITY	**0**	**0.06666667**	**0**
LS1	**Low probability**	**Aggregate impact**	**0**	**-0.1333333**	**0**
		Economic resources			
		Technology			
		Information and skills			
		Infrastructure			
		Institutions			
		Equity			
		Combined adaptive capacity	**0**	**0**	**0**
		VULNERABILITY	**0**	**-0.0666667**	**0**

In order to make operational use of the information developed through the thematic impact assessments, in the context of the workshop, three sets of *thematic worksheets* were prepared, each covering a specific theme for a given scenario assembly.

The worksheets are used in the workshop setting in a participatory exercise where following an introduction and broad overview of the MSIOA scenarios, climate change projections, and the CRDP approach participants work their way through the scenarios for each theme in a World Café exercise. The purpose of the exercise is to introduce stakeholders to the details of possible impacts per theme associated with each scenario in three 'stations'. At each station they receive a printout of the relevant CIVAT modules, and a thematic expert walks them through the highlights of the given development scenario, reminding them of the MSIOA scenario details and projected impacts.

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