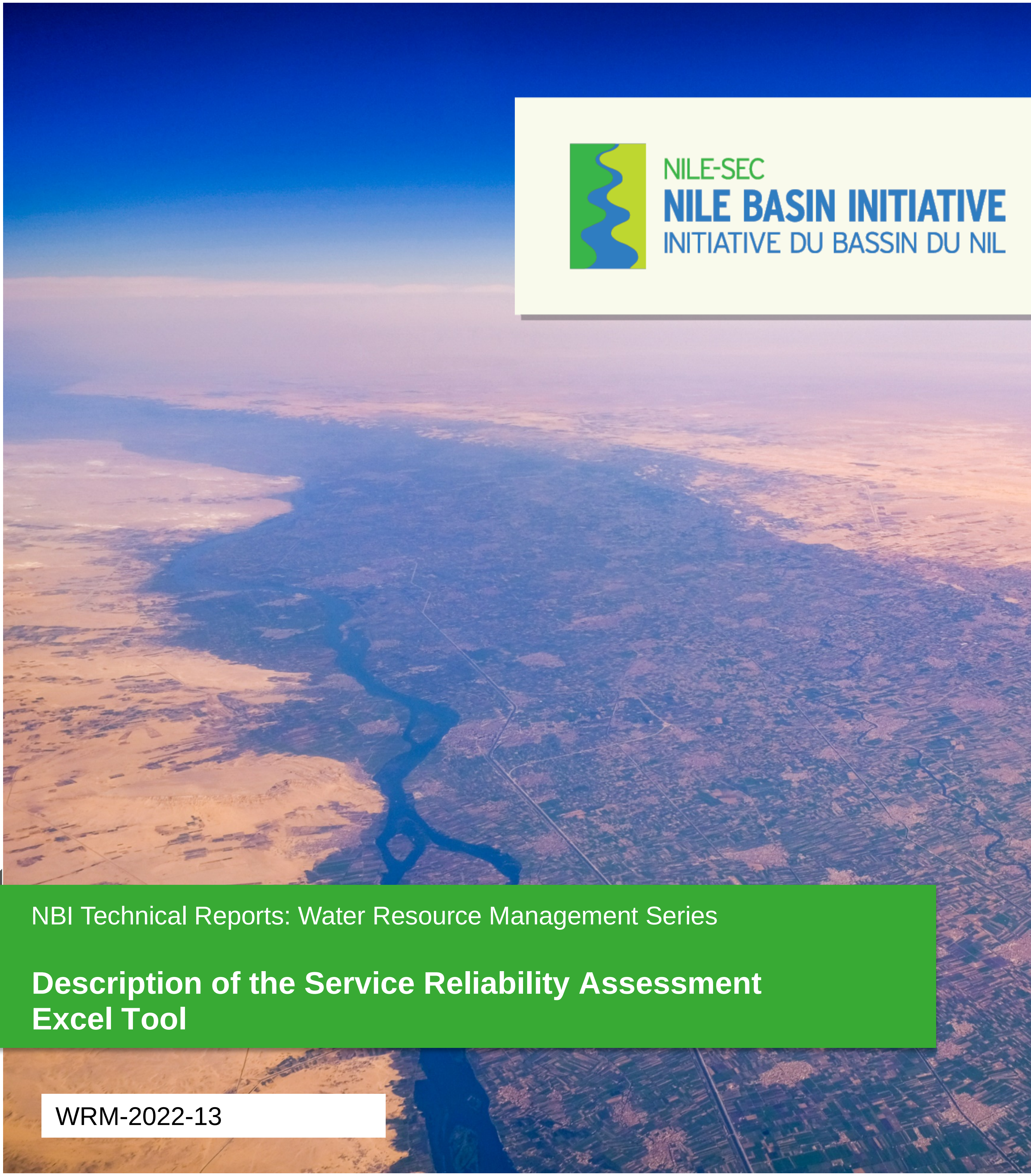

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NBI Technical Reports: Water Resource Management Series

Description of the Service Reliability Assessment Excel Tool

WRM-2022-13

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On behalf of:
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
of the Federal Republic of Germany

Document Sheet

This Technical Report series publishes results of work that has been commissioned by the member states through the three NBI Centers (Secretariat based in Entebbe- Uganda, the Eastern Nile Technical Regional Office based in Addis Ababa - Ethiopia and the Nile Equatorial Lakes Subsidiary Action Program Coordination Unit based in Kigali - Rwanda. The content there-in has been reviewed and validated by the Member States through the Technical Advisory Committee and/or regional expert working groups appointed by the respective Technical Advisory Committees.

The purpose of the technical report series is to support informed stakeholder dialogue and decision making in order to achieve sustainable socio-economic development through equitable utilization of, and benefit from, the shared Nile Basin water resources.

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Contents

Climate Services for Infrastructure

1 INTRODUCTION

The NBI developed a climate risk analysis matrix and design flood guideline which was expanded to include a service reliability assessment of infrastructures. This service reliability assessment comprises an evaluation of different services provided by infrastructures with regards to reliability by comparing the provided services to fixed thresholds. The services, thresholds and impact levels are represented in the following table.

Levels of Consequence		Type of consequence by objective of assessment						
		Service reliability					Structural integrity	
		Hydropower	Irrigation	Municipal/Industrial Water Demand	Flooding	Low flows	Physical components	Operation and Maintenance
1	Insignificant	<30% reduction in generated power for up to 30 days/year	<30% reduction in water supply for irrigation for up to 14 consecutive days/year	<30% reduction in water supply for M&I use for up to 1-3 consecutive days/year	Water level within flood buffer and exposure low or medium	<30% reduction of flow below mean minimum flow for up to 7 days/year	Virtually no effect on asset condition, no repairs required	< 0.1% increase in (average) annual cost to sustain service levels
2	Minor	<30% reduction in generated power for 30-90 days/year **or** 30-70% reduction for up to 30 days/year	<30% reduction in water supply for irrigation for 14-30 consecutive days/year **or** 30-70% reduction for up to 14 consecutive days/year	<30% reduction water supply for M&I use for 3-7 days/year **or** 30-70% reduction in for up to 1-3 consecutive days/year	Water level within flood buffer and exposure high **or** spillway active (frequent flood event 10a) and exposure low	<30% reduction of flow below mean minimum flow for 15-30 days/year **or** 30-70% reduction for up to 7 days/year	Minor damage to asset requiring 0-5% of annual maintenance budget for repairs	0.1-1% increase in (average) annual cost to sustain service levels
3	Moderate	<30% reduction in generated power for >90 days/year **or** 30-70% reduction for 30-90 days/year **or**	<30% reduction in water supply for irrigation for >30 consecutive days/year **or** 30-70% reduction	<30% reduction in water supply for M&I use for >7 consecutive days/year **or** 30-70% reduction for 3-7 consecutive days/year **or** >70% reduction for 1-3	Spillway active (frequent flood event 10a) and exposure medium **or** spillway	<30% reduction of flow below mean minimum flow for >30 days/year **or** 30-70%	Moderate damage to asset requiring 6-25% of annual maintenance budget for repairs	2-10% increase in (average) annual cost to sustain service levels

		>70% reduction for up to 30 days/year	for 14-30 consecutive days/year **or** >70% reduction for up to 14 consecutive days/year	consecutive days/year	active (rare flood event 50a) and exposure low	reduction for 15-30 days/year **or** >70% reduction for <7 days/year		
4	Major	30-70% reduction in generated power for >90 days/year **or** >70% reduction for 30-90 days/year	30-70% reduction in water supply for irrigation for >30 consecutive days/year **or** >70% reduction for 14-30 consecutive days/year	30-70% reduction in water supply for M&I use for >7 consecutive days/year **or** >70% reduction for 3-7 consecutive days/year	Spillway active (frequent flood event 10a) and exposure high **or** spillway active (rare flood event 50a) and exposure medium	30-70% reduction of flow below mean minimum flow >30 days/year **or** >70% reduction for 15-30 days/year	Major damage to asset requiring 26-80% of annual maintenance budget for repairs	11-30% increase in (average) annual cost to sustain service levels
5	Extreme	>70% reduction in generated power for >90 days/year	>70% reduction water supply for irrigation for >90 consecutive days/year	>70% reduction water supply for M&I use for >90 consecutive days/year	Spillway active (rare flood event 50a) and exposure high	>70% reduction of flow below mean minimum flow for >30 days/year	Extreme damage to asset requiring > 80% of annual maintenance budget for repairs	>40% increase in (average) annual cost to sustain service levels

2 APPLICATION OF THE IMPACT ASSESSMENT USING THE NELIP CASE STUDIES

The application of the service reliability impact assessment was carried out on 7 selected case studies of the Nile Equatorial Lakes Investment Programme. A hydrological model comprising the catchments of 7 infrastructures was run for a historical (1971-2000) and future (2036-2065) scenario using the downscaled CORDEX climate data. The results of the simulations were assessed using an excel tool which will be described in the following chapter.

3 SERVICE RELIABILITY ASSESSMENT EXCEL TOOL

The first version of the Excel Tool encompasses 12 sheets whose content will be described in the following subchapters.

3.1 Overview

The overview sheet gives general information about the project such as the catchment size and a map of the catchment and where it is located within the Nile Basin. Furthermore, there is information about the periods and scenario definition of the simulation runs.

3.2 Extreme Events

The Extreme Events Sheet has a collection of climate products derived from the historical and future rainfall time series for the entire catchment. Here you can find the intensity duration frequency (IDF) curves, the probable maximum precipitation (PMP), Radar Change Diagrams which reflect the change in intensity, duration, frequency and extent of historical and future rainfall events. Moreover, the sheet entails possible storm profiles of the PMP that can be used as input for the hydrological model to obtain the probable maximum flood (PMF).

3.3 Data

In the data sheet the modelling results which need to be analysed can be inserted. On this sheet there is information about the elements keys in the hydrological model and two sections that contain the simulated results; the historical and the future scenario. Besides the simulation period in days (simulation timestep) there is a column for the simulated inflow, water level in the infrastructure, irrigation supply, municipal and industrial water use supply and generated hydropower. After inserting the simulation results and adjusting the date columns the following sheets will automatically analyse the results.

3.4 Inflow CDF

In the Inflow CDF sheet several statistical parameters of the simulated inflow time series are presented. The frequency of occurrence of different inflow classes is also defined and the cumulative frequency distribution is calculated. The number of inflow classes can be defined by the user.

3.5 Hydropower

In the Hydropower sheet the user can fill in the target power and the installed capacity in Watts. The power generation deficit per day is calculated by subtracting the generated power from the target power. This daily deficit is aggregated to calculate the average yearly deficit. The maximum duration of days per year where a reduction occurs are also counted. Both the average yearly deficit and the yearly maximum duration of reduction are averaged over the length of the simulation period to be used in applying the impact matrix.

On the right side of the sheet there is a calculation of the probability of occurrence of the previously calculated average deficit and the average maximum duration of reduction within the simulation period. Those results can be used together with the defined impact to apply the risk matrix.

All mentioned calculations were carried out for the historical as well as the future scenario.

3.6 HP CDF

In the Hydropower CDF sheet several statistical parameters of the simulated generated hydropower time series are presented. The frequency of occurrence of different generated hydropower classes is also defined and the cumulative frequency distribution is calculated. The number of generated hydropower classes can be defined by the user.

3.7 Irrigation

In the Irrigation sheet the user can fill in the monthly irrigation demand in m^3/s. The irrigation supply deficit per day is calculated by subtracting the irrigation supply from the irrigation demand. This daily deficit is aggregated to calculate the average yearly deficit. The maximum duration of days per year where a reduction occurs are also counted. Both the average yearly deficit and the yearly maximum duration of reduction are averaged over the length of the simulation period to be used in applying the impact matrix.

On the right side of the sheet there is a calculation of the probability of occurrence of the previously calculated average deficit and the average maximum duration of reduction within the simulation period. Those results can be used together with the defined impact to apply the risk matrix.

All mentioned calculations were carried out for the historical as well as the future scenario.

3.8 Irr CDF

In the Irrigation CDF sheet several statistical parameters of the simulated irrigation supply time series are presented. The frequency of occurrence of different irrigation supply classes is also defined and the cumulative frequency distribution is calculated. The number of irrigation supply classes can be defined by the user.

3.9 M&I

In the M&I sheet the user can fill in the monthly municipal and industrial water demand in m^3/s. The M&I water supply deficit per day is calculated by subtracting the M&I water supply from the M&I water demand. This daily deficit is aggregated to calculate the average yearly deficit. The maximum duration of days per year where a reduction occurs are also counted. Both the average yearly deficit and the yearly maximum duration of reduction are averaged over the length of the simulation period to be used in applying the impact matrix.

On the right side of the sheet there is a calculation of the probability of occurrence of the previously calculated average deficit and the average maximum duration of reduction within the simulation period. Those results can be used together with the defined impact to apply the risk matrix.

All mentioned calculations were carried out for the historical as well as the future scenario.

3.10 M&I CDF

In the M&I CDF sheet several statistical parameters of the simulated M&I water supply time series are presented. The frequency of occurrence of different M&I water supply classes is also defined and the cumulative frequency distribution is calculated. The number of M&I water supply classes can be defined by the user.

3.11 Flood

In the Flood sheet the user can fill in the flood control level and the dam crest heigh in masl. The number of days per year where the water level is within the flood buffer, as well as above the dam crest are summed up and averaged over the entire simulation period.

This allows for a classification of the risk of flooding using the impact matrix.

On the right side of the sheet there is a calculation of the probability of occurrence of the previously calculated average number of days within flood buffer and days with active spillway within the simulation period. Those results can be used together with the defined impact to apply the risk matrix.

All mentioned calculations were carried out for the historical as well as the future scenario.

3.12 Low Flows

In the Low Flow sheet the user can calculate the monthly average minimum flow in m^3/s. The flow deficit per day is calculated by subtracting the flow from the average minimum flow. This daily deficit is aggregated to calculate the average yearly deficit. The maximum duration of days per year where low flows occur are also counted. Both the average yearly deficit and the yearly maximum duration of low flows are averaged over the length of the simulation period to be used in applying the impact matrix.

On the right side of the sheet there is a calculation of the probability of occurrence of the previously calculated average deficit and the average maximum duration of reduction within the simulation period. Those results can be used together with the defined impact to apply the risk matrix.

All mentioned calculations were carried out for the historical as well as the future scenario.

4 IMPACT ASSESSMENT MATRIX

The figures calculated using the excel tool can then be incorporated into the assessment of the impact of the service reliabilities by comparing the results to different thresholds and thereby obtaining the impact levels. The impacts and likelihoods can be used to apply the risk matrix and derive the risk posed by each service.

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