

## Hydraulic Modelling of the Kariba Dam Plunge Pool. Determination of the optimum pool profile with respect to the spillway discharges (2010)

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Client : ZRA – Zambezi River Authority

### Introduction

The Kariba Dam is located in the Zambezi river basin between Zambia and Zimbabwe, Africa. It is one of the largest dams in the world, standing 128 m high and 617 m long.

The double curvature concrete arch dam was constructed between 1955 and 1959. Lake Kariba, the reservoir created by the dam, extends for 280 km with a storage capacity of approximately 180 km<sup>3</sup> (Figure 1).



Figure 1: View of the Kariba dam with gated spillway

The Kariba plunge pool is extraordinary because of its depth. As a result of long spilling periods during several years, the jets generated by the sluice spillway progressively scoured a deep and steep-sided plunge pool hole with a current bottom at about 70 m below the original riverbed and about 80 m below the normal tailwater level (Figure 2).

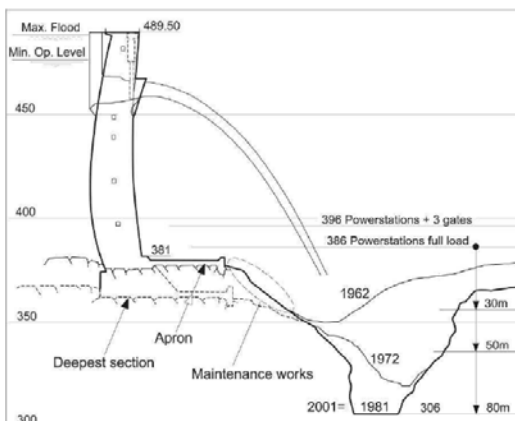


Figure 2: Plunge pool development and jet trajectories downstream of the Kariba dam

### Aims of investigation

- Determining the ultimate plunge pool geometries regarding spillway discharges by means of a physically based approach.
- Propose optimized solutions regarding the safety of the structures and the operation of the facilities.

### Hybrid Modelling

A hybrid approach to the problem was proposed, thereby combining numerical and physical modelling.

The physical model provides the general flow characteristic in the plunge pool and surface pressures, whereas the numerical model further includes the prototype rock characteristics and the jet features. With this approach, the strengths of these two model types are optimally combined.

### Physical Model

The physical model (Figure 3) including relevant components for the jet and scour modelling of Kariba Dam is constructed with a scale factor of 1:65.



Figure 3 : Photos of the physical model

Discharge features:

	Prototype [m <sup>3</sup> /s]	Model [l/s]
1 spillway gate	1'500	44
6 spillway gates	9'000	264
Power Plants	2 * 700	41
Total discharge capacity	10'400	305

### Comprehensive Scour Model - CSM

A physically-based engineering model, the CSM, has been initiated by Dr E. Bollaert at the Laboratory of Hydraulic Constructions. The model has been continuously developed and adapted to real-life dam scour problems at AquaVision Engineering.

The CSM is the first completely physics based model describing time evolution of rock scour in plunge pools (Figure 4).

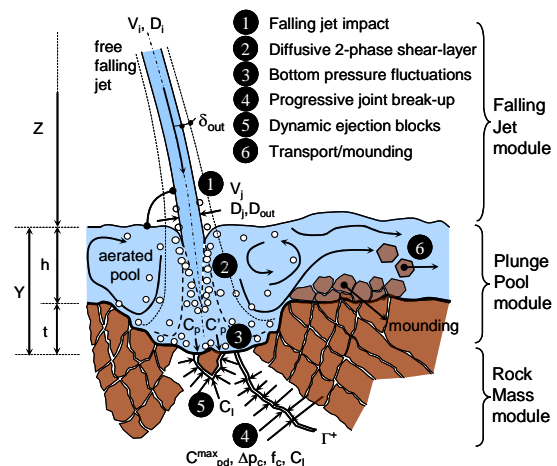


Figure 4 : Modules of the Comprehensive Scour Model

### Project Main Milestones

The project is composed by 4 Work Phases where different Plunge pool geometries and configurations will be tested.