1D morphological adaptation of Lower Zambezi River to dam construction

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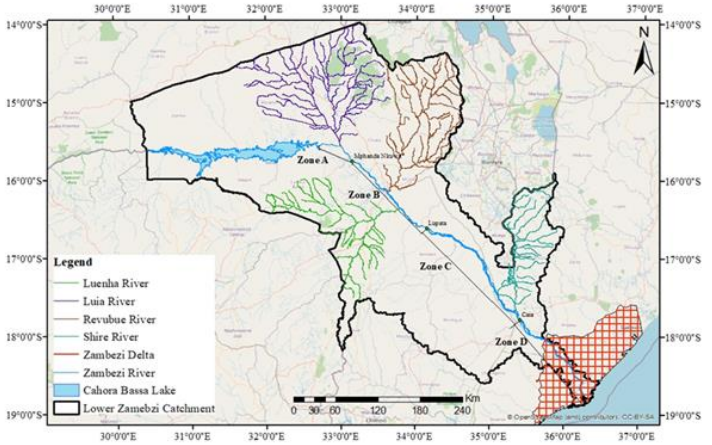
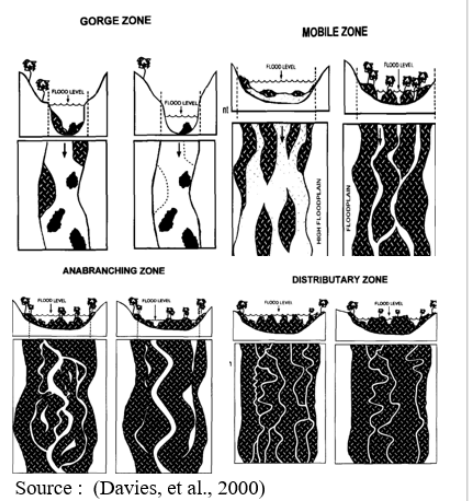
INTRODUCTION

- Lower Zambezi River, downstream of Cahora Bassa dam to the delta.
- The existing large impoundments have profoundly altered the hydrological and morphological regime.
- Scientific studies about effect of damming on the morphology of the river are still incomplete.





Source : (Davies, et al., 2000)

METHODOLOGY

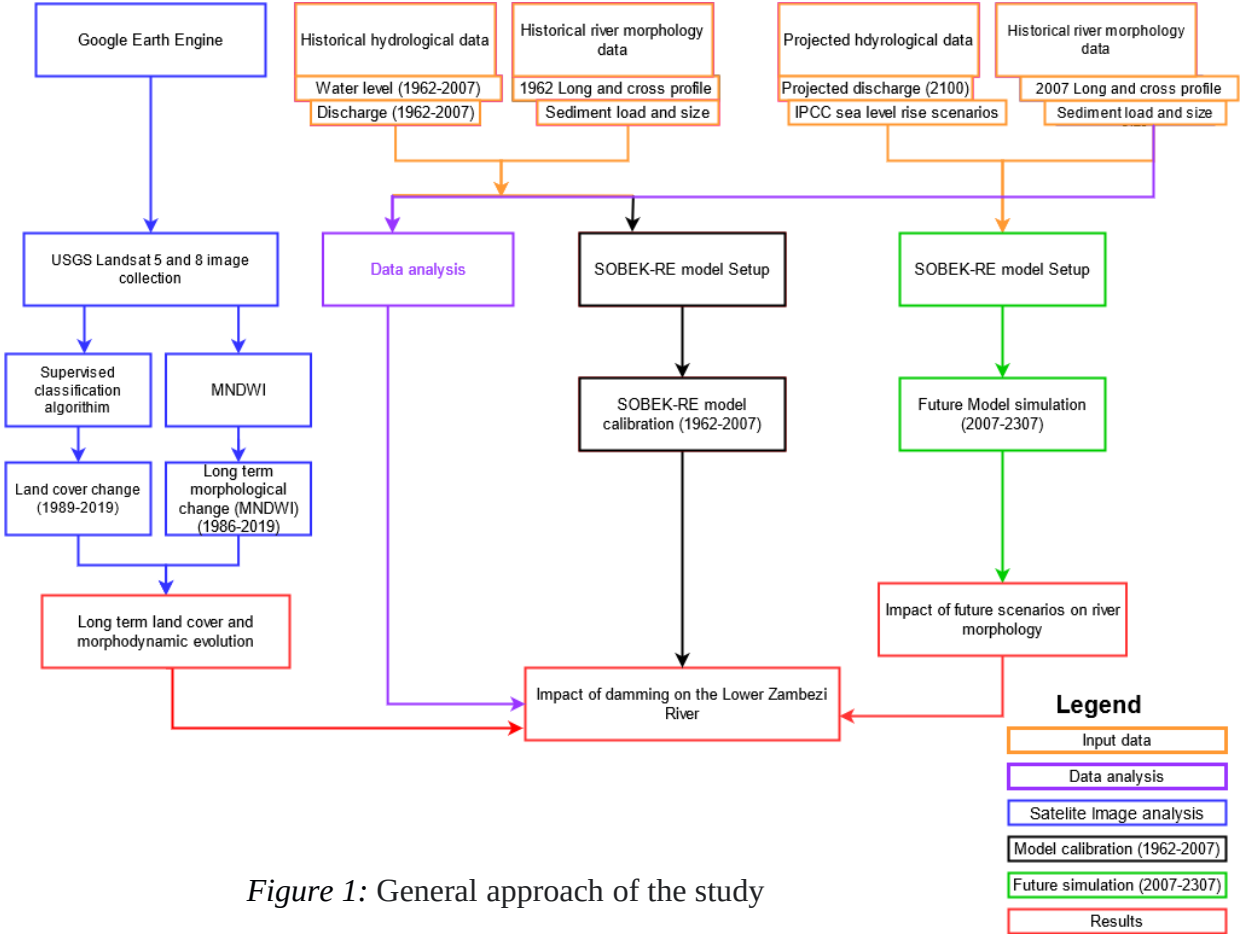


Figure 1: General approach of the study

DATA ANALYSIS AND RESULTS

Water balance

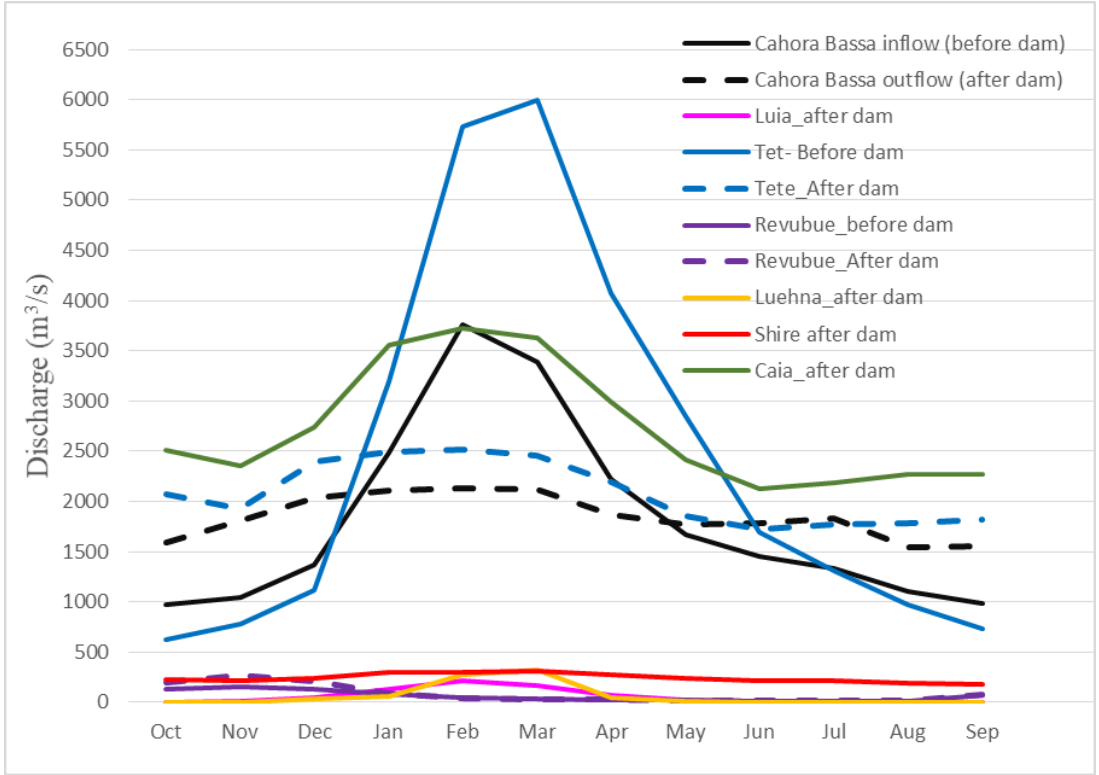


*Figure 2:*Mean monthly hydrograph of Lower Zambezi River and its tributaries

Channel geometry

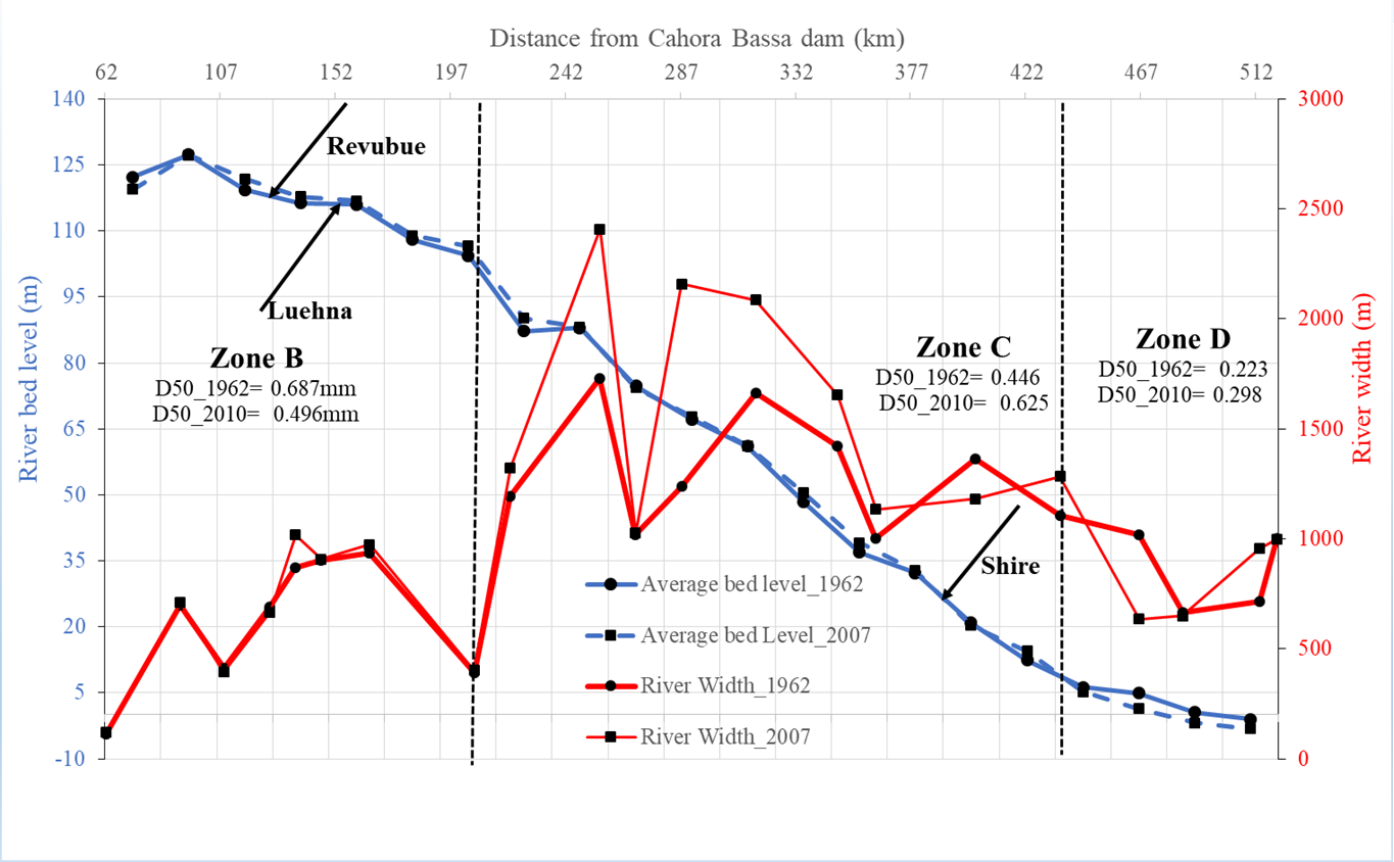


Figure 3: Longitudinal river bed level (blue lines) and width (red lines) change between 1962 and 2007

Sediment

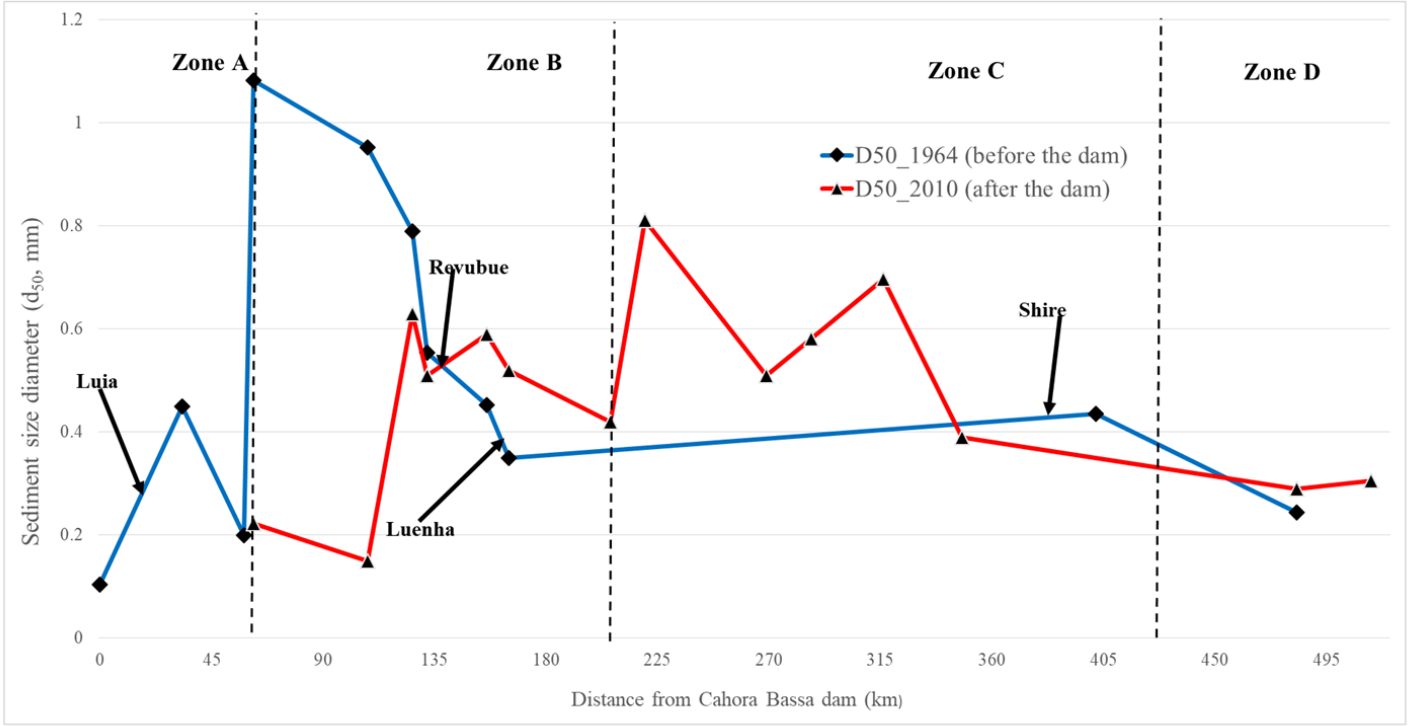


Figure 4. Sediment size diameter (d50) of the Lower Zambezi River in 1964 and 2010

Bed Level

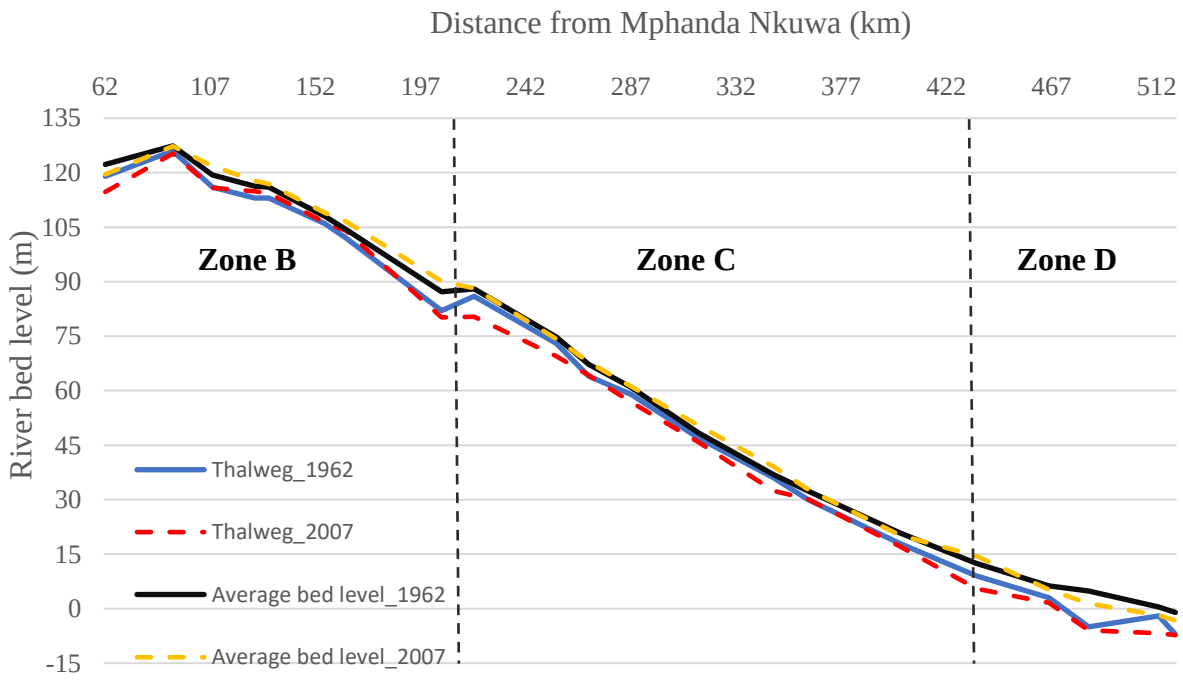


Figure 5: Longitudinal thalweg and mean bed level profile of the Lower Zambezi River in 1962 and 2007

Satellite image analysis

Land cover change

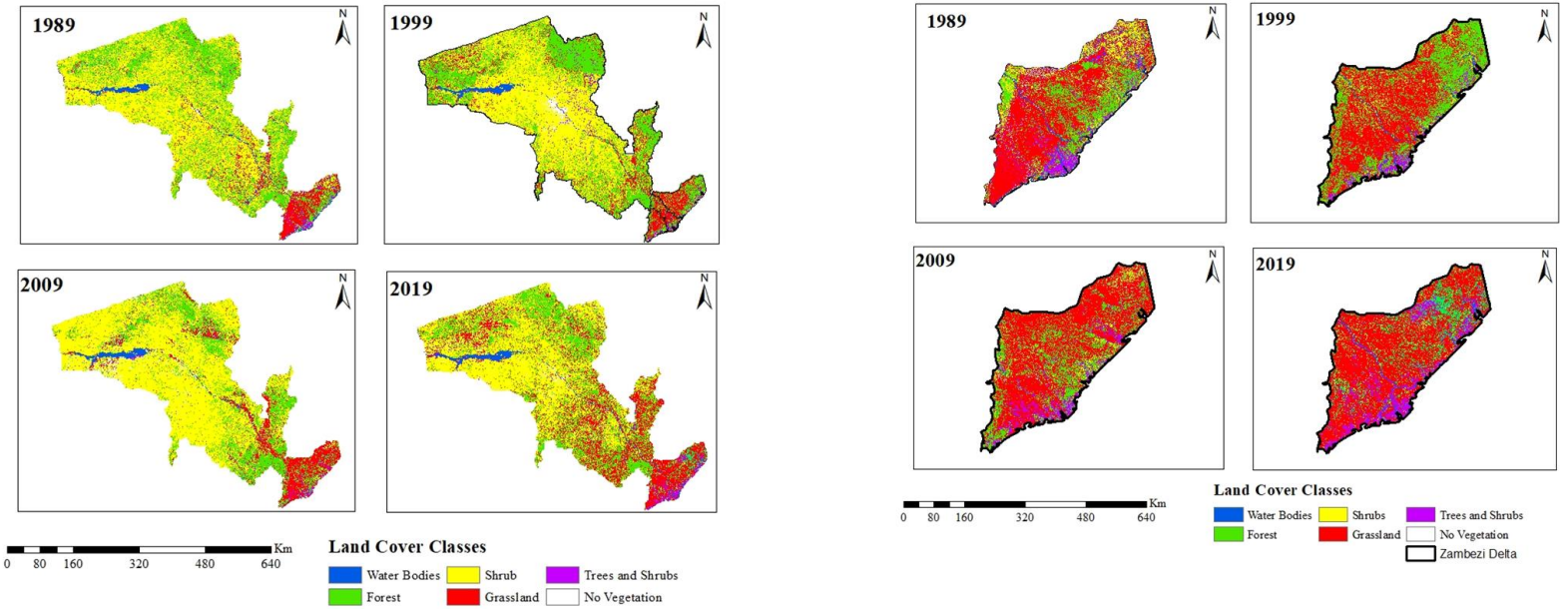


Figure 6: Land cover map of the Lower Zambezi River basin in 1989-2019

Long term morphological change

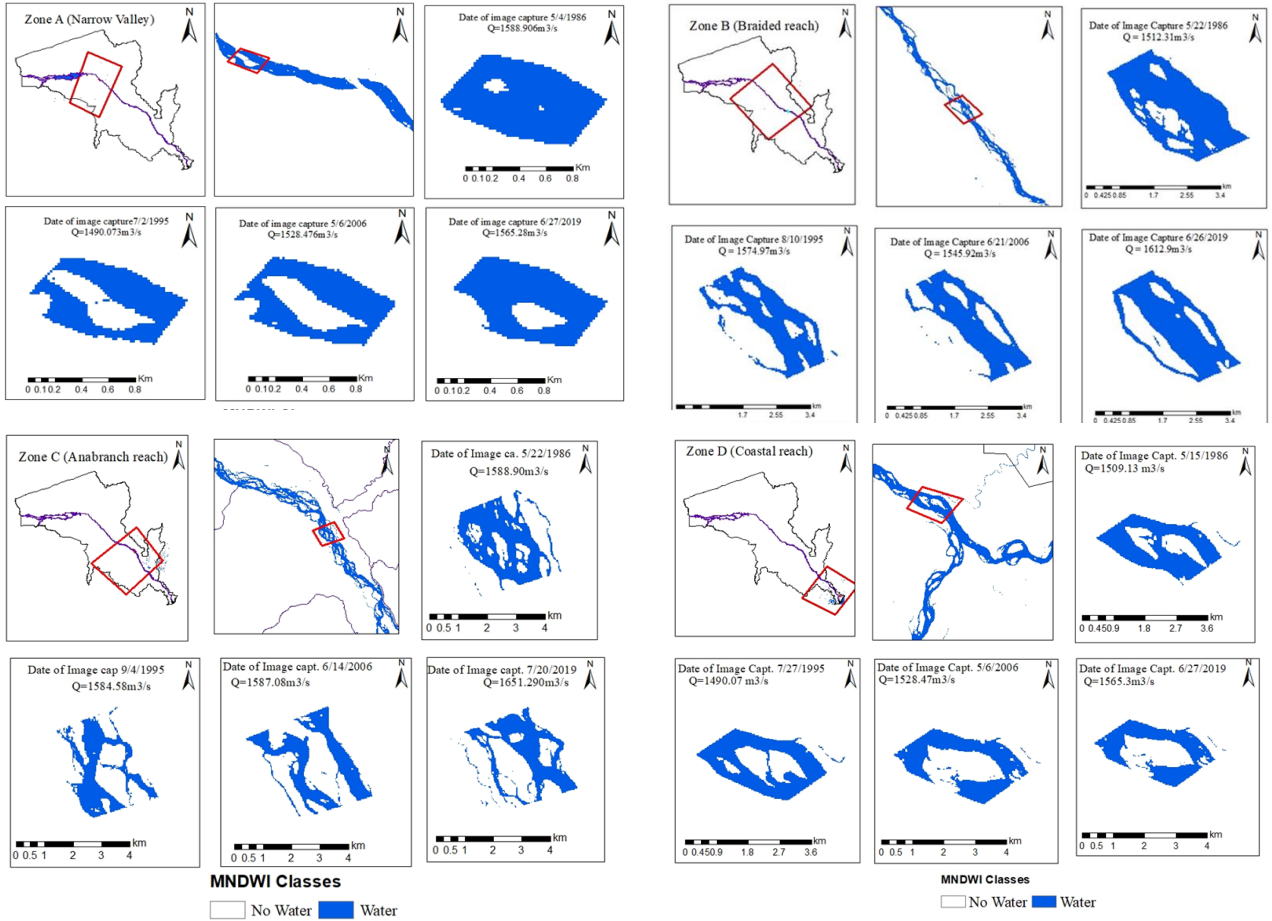
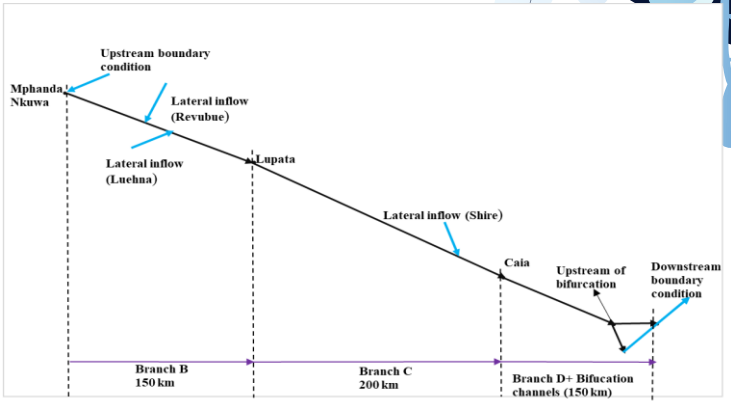


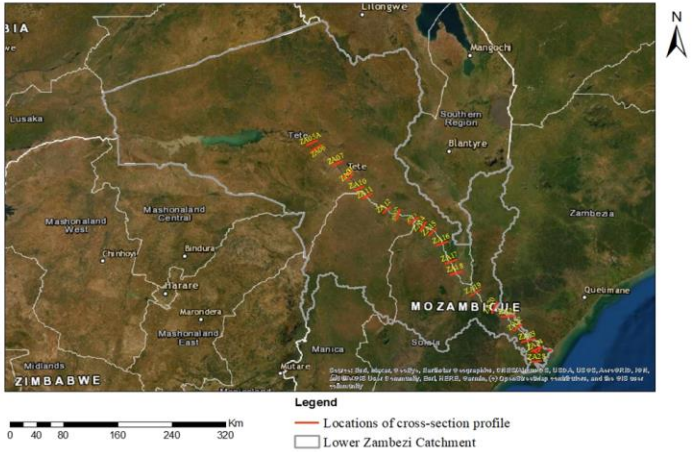
Figure 7: MNDWI map of the Lower Zambezi river basin

MODEL AND RESULTS

Model Setup

- Schematized in 1D approach
- Cross-sectional profile (tabulated form)
- Boundary conditions has been defined
- Sediment and flow initial condition has been set
- 800m grid size
- 1 day computation time
- The Engelund and Hansen (1967) formula





Model Calibration

Figure 8: Model output and measured water level of 2007 at Marromeu station for different bed friction values without considering morphology simulation

Calibration ……Cont'd

Figure 9: Measured and simulated water level at Marromeu in 2007 including morphological simulation and dredging for a different Chézy's value

Calibration ……Cont'd

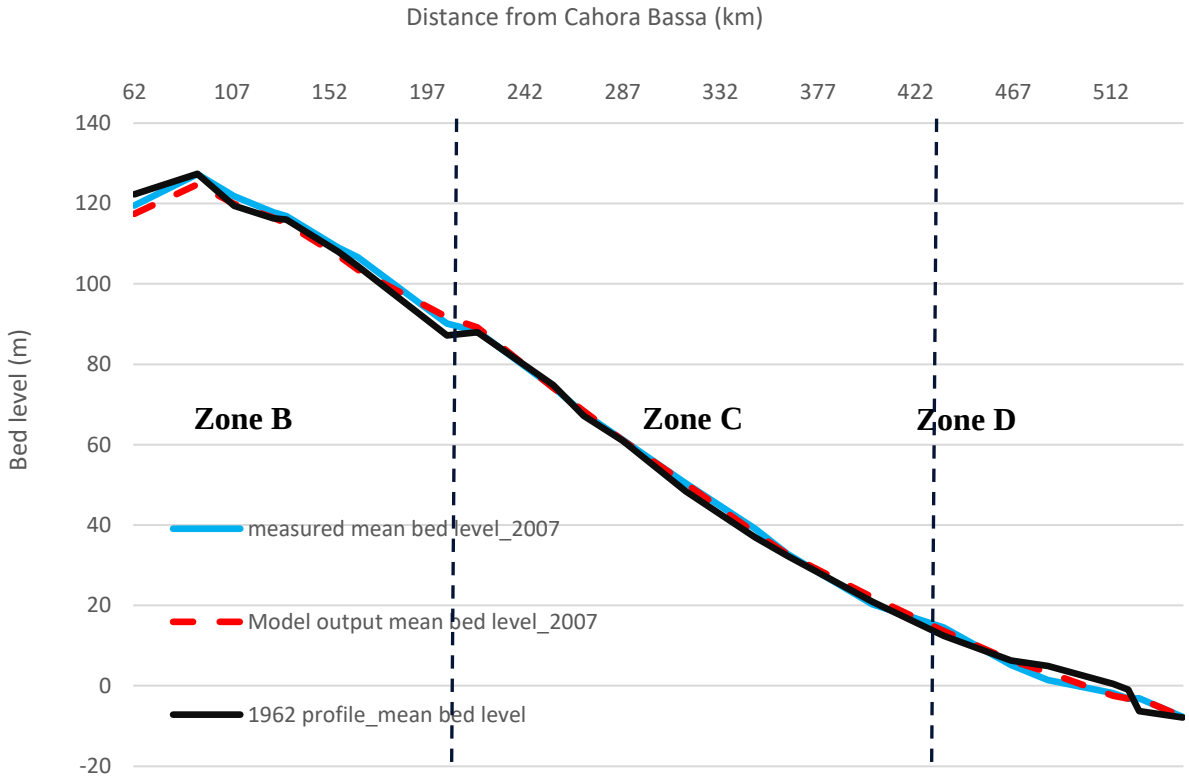
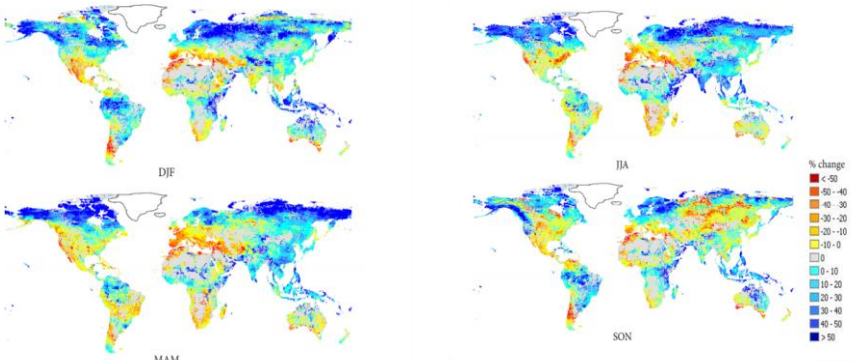
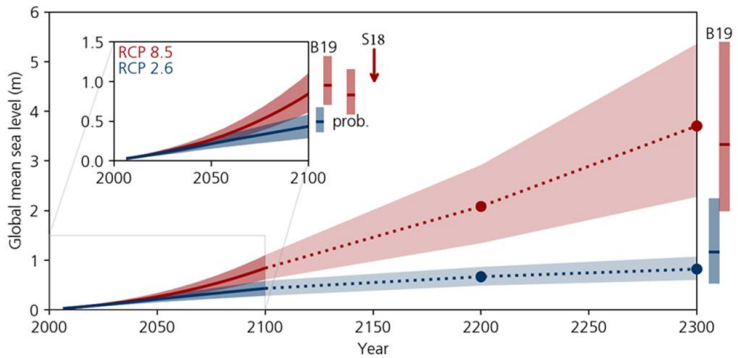


Figure 10: Measured and model output average bed level of 2007 and the 1962 bed level profile

FUTURE SCENARIOS AND RESULTS

Climate change impact on the discharge of Zambezi





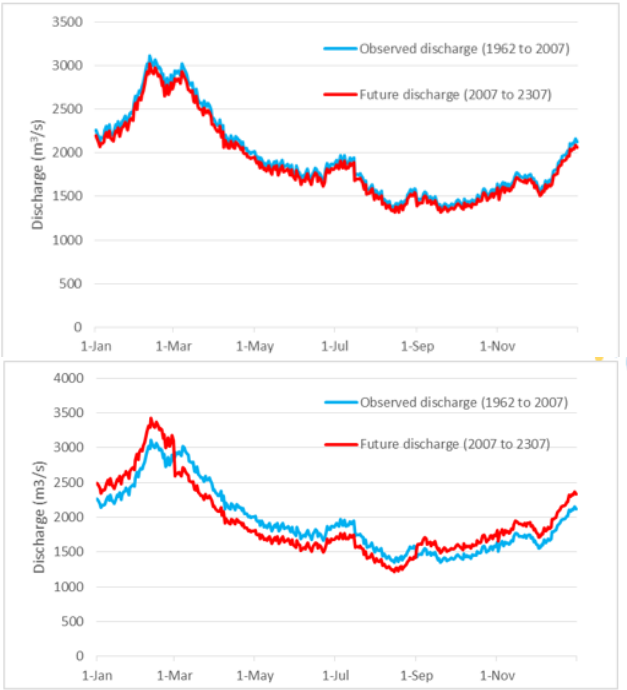
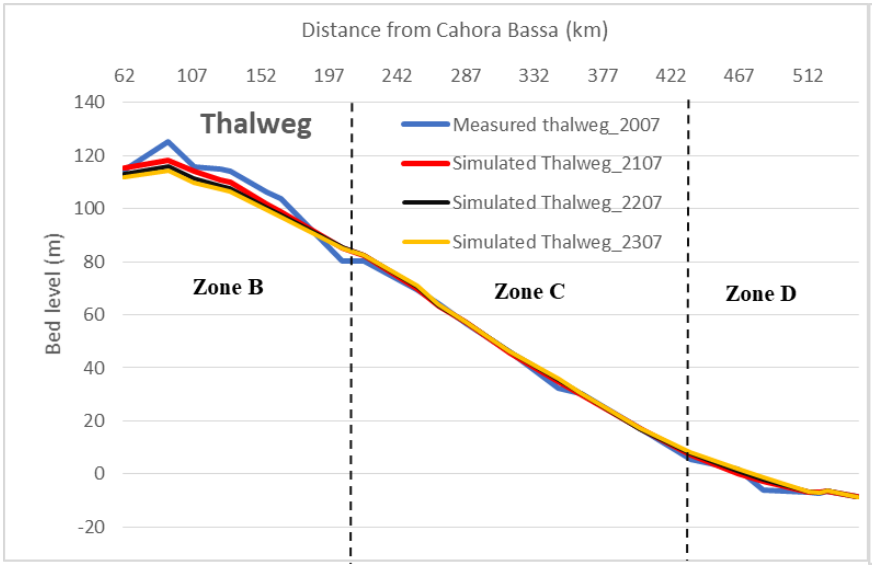


*Figure 12: G*lobal seasonal discharge change by the end of 2100 (Sperna Weiland, et al., 2012), IPCC sea level rise and typical year discharge data of the Cahora Bassa outflow for observed (1962-2007) and future (2007 to 2307)

Observed discharge series and RCP 2.6 (1.1 m) mean sea-level rise



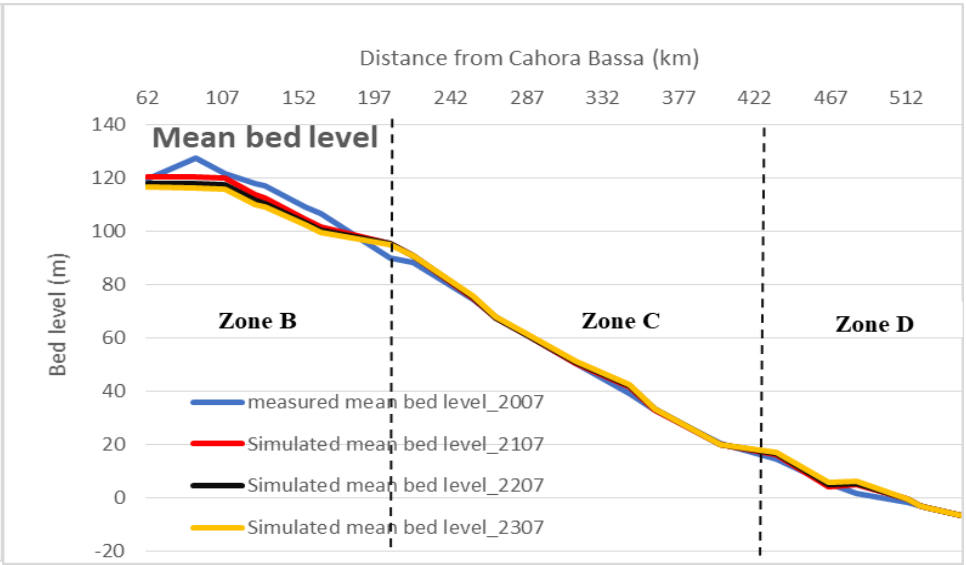


Figure 13: Measured and simulated average bed level between 2007 and 2307 for scenario-I

7. Conclusion and Recommendations

- The Impact of the Cahora Bassa dam is evident in the first 200 km of the river.
- The model reproduces the average bed level of the river at acceptable accuracy.
- There will be significant erosion in Zone B while the bifurcation channels remain stable for all future simulation scenarios.
- The lack of sediment supply in the delta and the expected high sea-level rise will cause delta drowning.


QUESTION?
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