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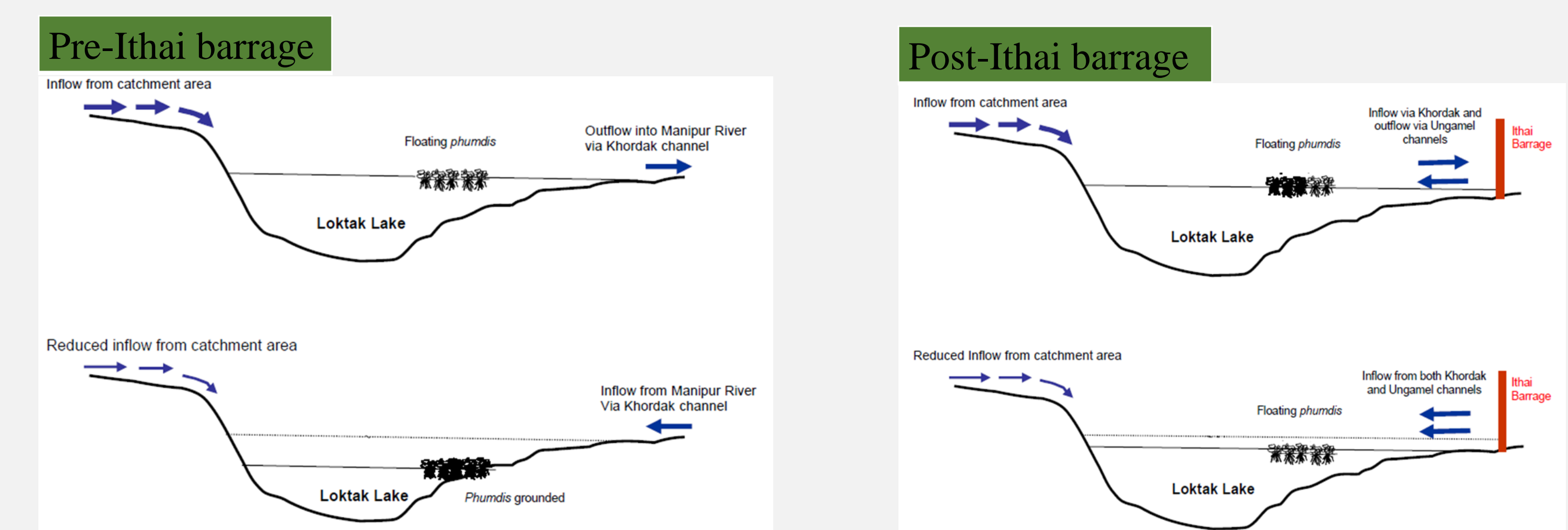
Abstract

Keibul Lamjao National Park (KLNP) is the only floating national park in the world and the only natural home of Manipur’s brow-antlered deer, popularly known as Sangai. The present study focuses on framing management approach of KLNP considering the variation of water level suitable for Sangai deer using water balance model. The model incorporates catchment discharge obtained from an integrated hydrological-hydraulic model, SWAT-MIKE SHE-MIKE 11 and outflows associated with hydropower generation, irrigation purposes, and releases through the Ithai barrage. Post-Ithai barrage construction water balance model for time period June 1999 to May 2003 have been developed considering the availability of hydro-meteorological data. The model was validated and simulated for the time period January 2015 to December 2016. A management approach has been developed without compromising abstractions for irrigation/water level demand for hydropower generation, which can be considered as a primary step for conserving KLNP.

Keywords: Keibul Lamjao National Park, Water balance model, MIKE SHE-MIKE11-SWAT

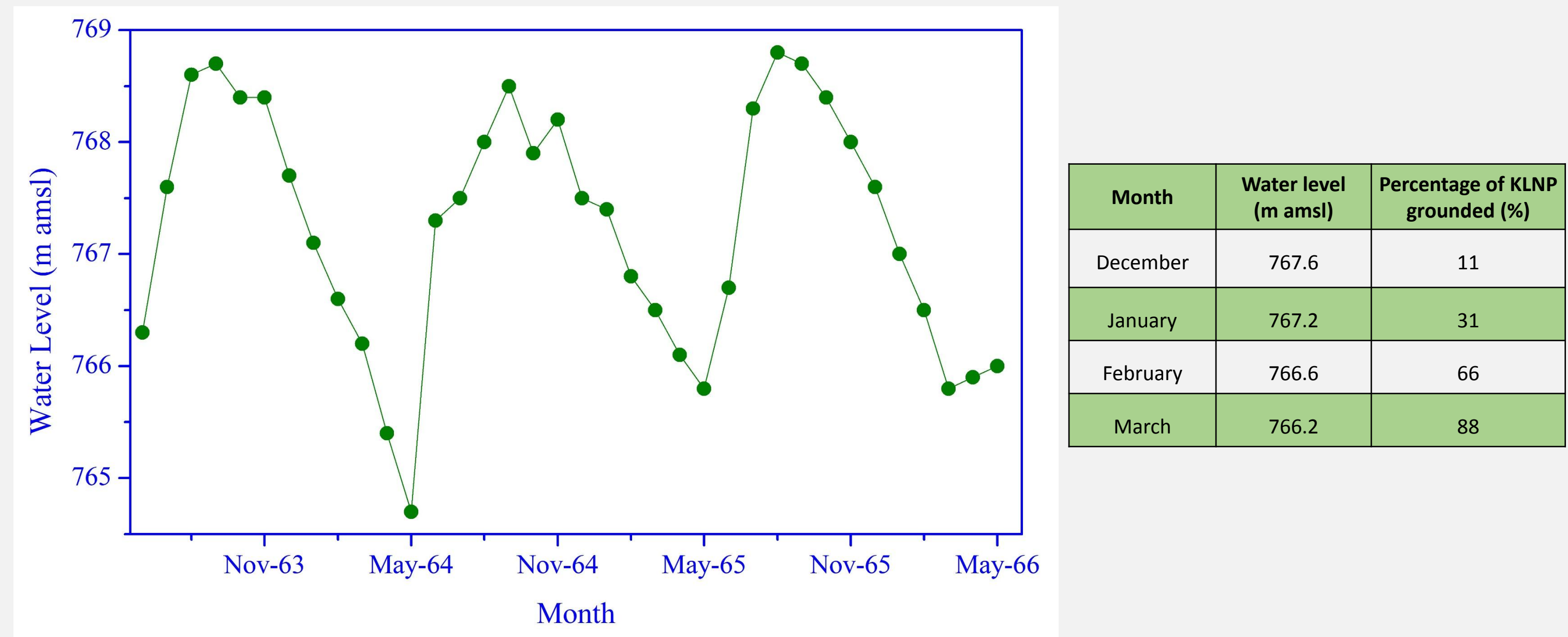
1 Introduction

Keibul Lamjao National Park (KLNP) is located at the south-western corner of Loktak Lake, Northeast India. The KLNP consist of contiguous 40 sq.km area of Phumdis, a floating island covered with vegetation. A matured Phumdis is about 1 -2 m thick, solid and strong enough which can support the weight of thatched houses built on it. The survival of KLNP depends on the typical ecological phenomenon of sinking during the lean season, gathering nutrients from the ground and staying afloat during the rainy season. The national park is the only natural home of Manipur’s brow-antlered deer, popularly known as Sangai. Management interventions linked to the Loktak Hydroelectric Project and deteriorating water quality are the principal triggers that are seen to be responsible for the damage of KLNP. This study focuses on framing management approach of KLNP considering the variation of water level suitable for Sangai deer using water balance model.



2 Pre- Ithai barrage water level

Pre-Ithai lake level shows the distinctive influence of the monsoon during the rainy and the lean seasons. Grounding of KLNP is essential for Sangai deer as they have rutting period from late January to March. The Sangai deer are able to move unhindered during this critical time when the maximum area of KLNP are grounded.

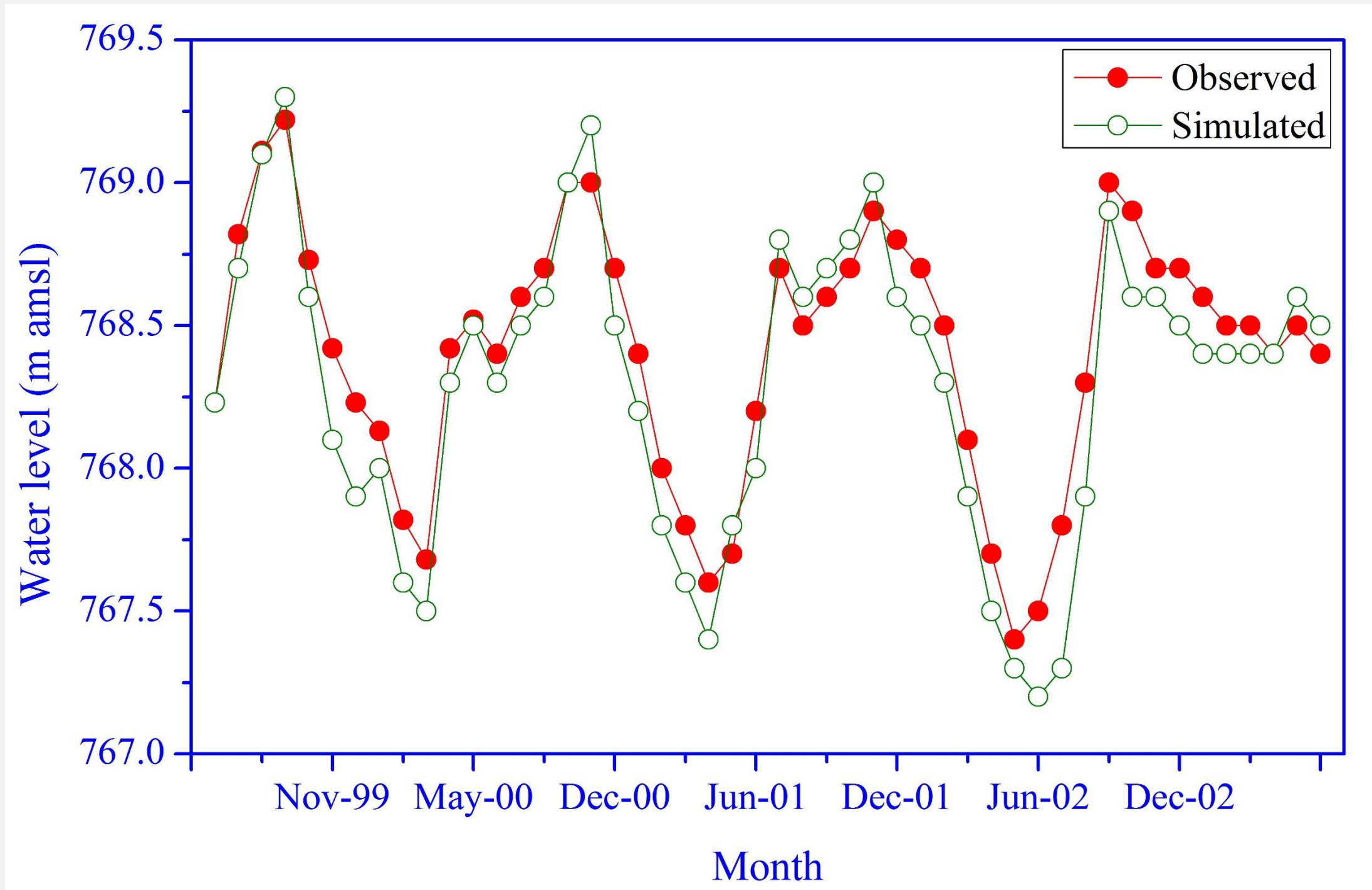


3 Modelling of Post Ithai barrage water level

The Ithai barrage was constructed to impound water in Loktak Lake in order to harness hydropower and irrigation facilities. After the construction of barrage, the minimum water level is regulated to prioritize hydropower over the ecological condition of the KLNP. At present, only 1% of Keibul Lamjao National Park is grounded during low flows leading to the deprivation of nutrients and effecting the habitat of Sangai deer.

$$V_t = V_{t-1} + (R_t \times A_{t-1}) + D_t - (ET_t \times AP) - (E_t \times (A_{t-1} - AP)) - H_t - I_t - DM_t - IB_t$$

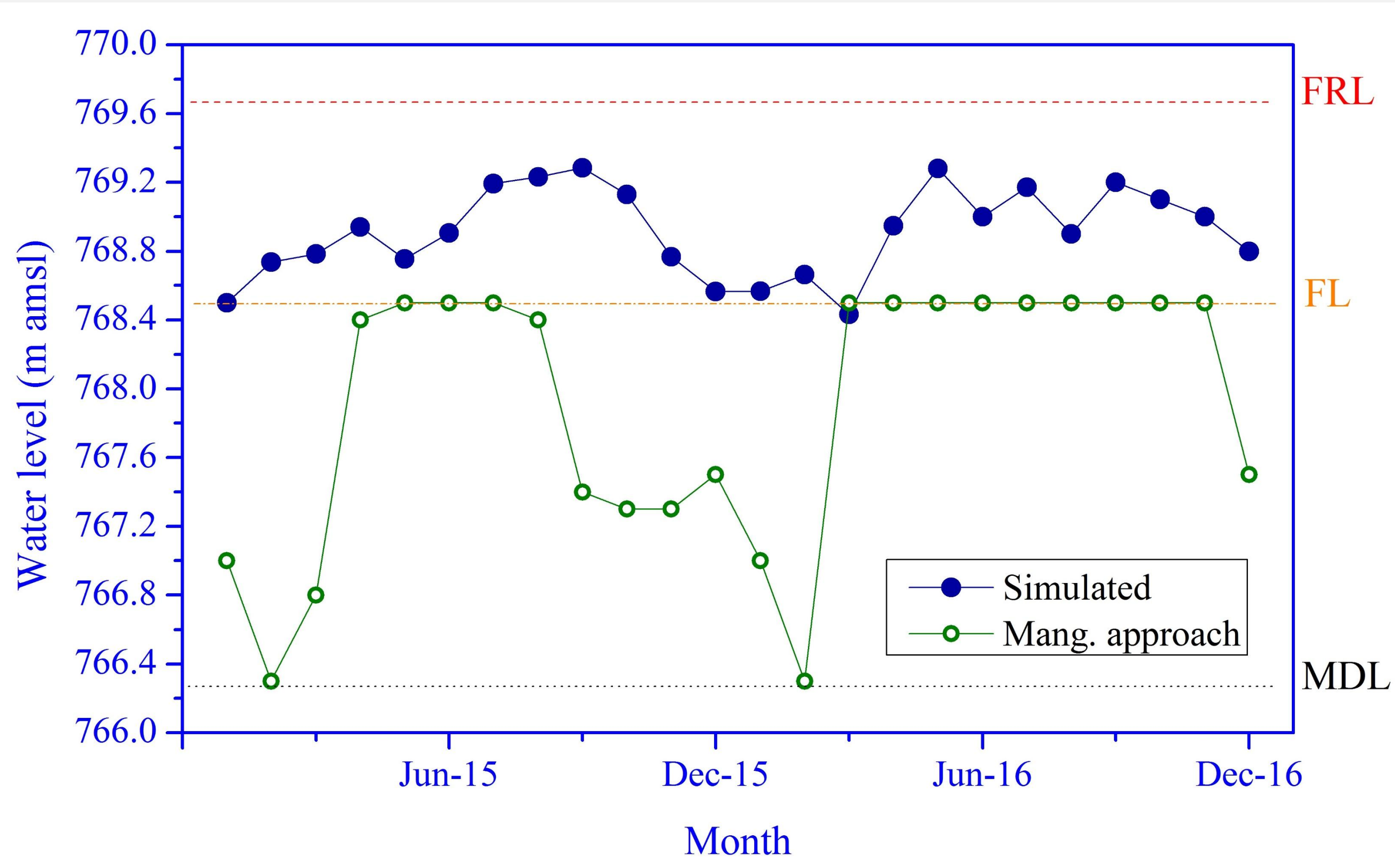
where, V is the lake volume;
t indicates the present month; t-1 indicates the previous month volume for present month;
R is rainfall; D is discharge from catchment simulated by model;
ET is evapotranspiration; AP is area of Phumdis;
H is abstraction for hydropower; I is abstraction for Irrigation;
DM is abstraction for domestic consumption; IB is releases through Ithai barrage



Nash-Sutcliffe efficiency = 0.82; Coefficient of Determination = 0.93

4 Management approach of Keibul Lamjao National Park

- The management approach was designed by simulating water balance model without compromising abstractions for irrigation/water level demand for hydropower generation.
- The requirement to irrigate 46,000 ha with the demand of $61.3 \times 10^6 \text{ m}^3$ is fulfilled as planned by the Loktak Lift Irrigation and the Imphal barrage projects.
- Barrage is set to open when the water level in any month are above the flood level (FL). It is also opened during the lean season after maintaining minimum drawdown level.
- Throughout the simulation, KLNP grounded during December to March is about 15, 29, 85 and 29 % respectively, which will help in absorption of nutrients from the ground.
- This approach will help in the management of KLNP, thereby improving the habitat of Sangai deer. In addition, the approach will prevent inundation of nearby area without compromising hydropower and ecological condition of the lake.



5 Conclusion

- The simulation of water balance model has enabled the development of management approach of KLNP suitable for habitat of Sangai deer.
- Enhanced abstraction for irrigation coupled with releases through barrage to prevent inundation of surrounding agricultural areas, would have positive impacts on the lake ecosystem when the minimum drawdown level of the lake is still maintained.

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