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Benthic Macroinvertebrates and Seasonal Water Level Fluctuation in Wetlands of Koshi Tappu Wildlife Reserve, Nepal

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ABSTRACT

Littoral benthic macroinvertebrates (BMI) assemblage are often exposed to water level fluctuations (WLFs), which impair the structure and function of aquatic ecosystems. Here, we investigated the response of BMI to seasonal WLFs for one year. The study revealed that BMI community assemblage was significantly different with varied water levels, Non-metric multidimensional scaling (NMDS) (F = 3.39; p = 0.0001) with a 0.19 stress value. Similarity percentage analysis demonstrated BMI community dissimilarity between seasons is slightly higher than 70%. Second degree polynomial regression for BMI richness and water level showed BMI richness increased with increases in water level before becoming constant (p=0.0088, R^2=0.52). Medium water level amplitude supported BMI richness (p=0.02, R^2=0.31). Biological metric analysis demonstrated that the percentage of Diptera taxa could be the potential BMI biological metric to differentiate between different water levels. Indicator taxa analysis using monte carlo significance test, identified six taxa as indicator taxa for high, two for medium and four for low water levels. This study therefore suggests that low water level does not support BMI diversity and richness and water level amplitude as intermediate disturbance to shape BMI richness but warrants further long term researches on it.

BACKGROUND

Introduction

- Water level fluctuation (WLF) occurs in various spatial and temporal scales and effects the ecological structure and function of the littoral zone of the wetlands (Gownaris et al., 2018).
- There is limited data involving the role of WLFs for both intra-annual and inter-annual years in structuring aquatic communities (White et al., 2008).
- The knowledge on eco-hydrological associations can inform appropriate future governance of aquatic ecosystems (Doody et al., 2016), development of environmental flows frameworks (Davies et al.,2014) and priorities for future watershed management (Stein et al.,2017).

Objectives

- To (1). assess the changes in BMI community (composition assemblages, diversity, richness) in response to seasonal WLFs and (2). identify indicator taxa that are sensitive to seasonal WLFs in Koshi Tappu wetlands.

MATERIALS AND METHODS

Research conducted for a year covering 1 annual cycle of WLFs from (28th July, 2018 -11th July, 2019)

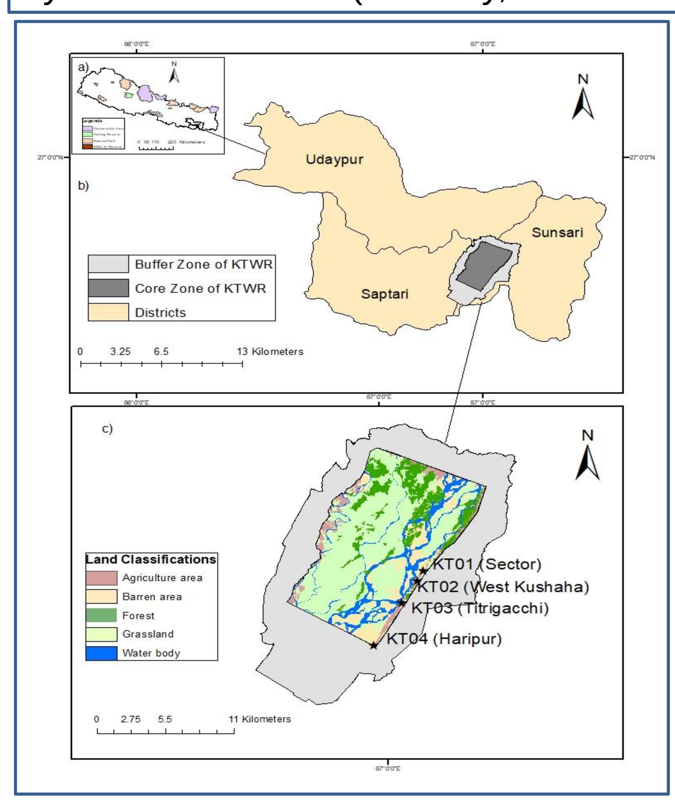


Fig.1. Map of Study Area

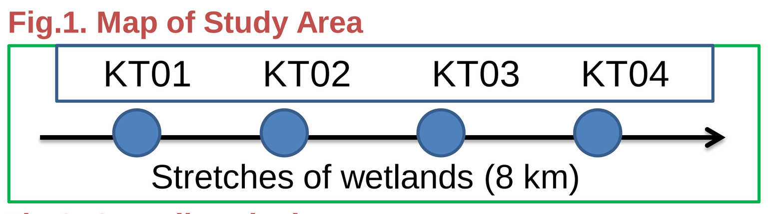


Fig.2. Sampling design

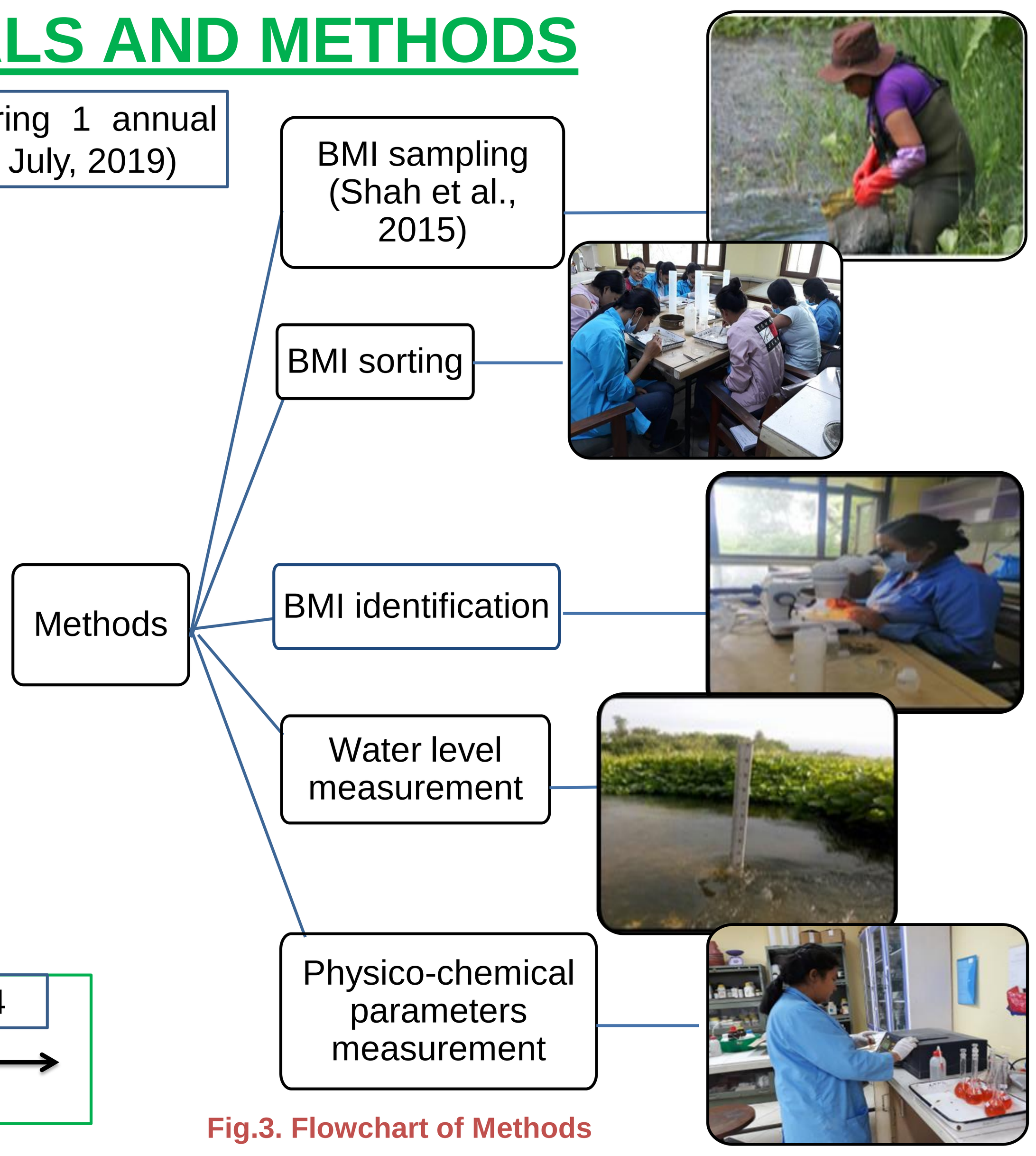


Fig.3. Flowchart of Methods

RESULTS AND DISCUSSION

1. Seasonal water level fluctuation in Koshi Tappu wetlands

- Linear correlation (r = 0.86) between water level in wetlands and the Koshi River.

Table.1. Water level classification

Duration	Water level class
Summer season (Jun-Sept)	High
Autumn season (Oct-Nov)	Medium
Winter season (Dec-Feb) Spring season (Mar-May)	Both Low (As no significance difference in water level of both seasons (TukeyHSD test)

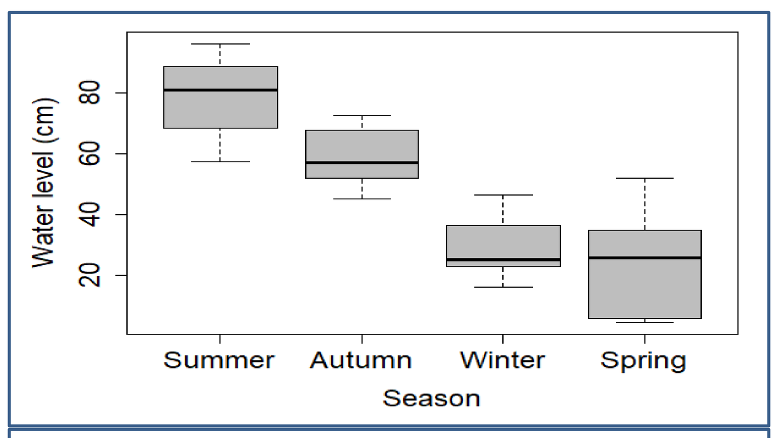


Fig.4. Box and whisker plot showing WLFs for one year

2. BMI community assemblages with seasonal WLFs

- 54 BMI families belonging to 14 orders were recorded.

Table.2. BMI Families and orders in different water level

Water level	BMI Families	BMI Orders
Low	42	12
Medium	43	13
High	47	14

Table.3. Similarity percentage analysis showing cumulative contribution (C.C) of most influential BMI taxon to different water levels

High and medium		High and low		Medium and low	
BMI taxon	C.C	BMI taxon	C.C	BMI taxon	C.C
Atyidae	0.21	Dytiscidae	0.15	Dytiscidae	0.20
Dytiscidae	0.41	Atyidae	0.28	Atyidae	0.37
Baetidae	0.50	Chironomidae	0.39	Chironomida	0.48
Planorbidae	0.59	Planorbidae	0.47	e	0.57
Chironomidae	0.66	Thiaridae	0.55	Baetidae	0.63
Bithyniidae	0.72	Sphaeriidae	0.62	Planorbidae	0.69
		Hydrophilidae	0.67	Bithyniidae	0.74
		Bithyniidae	0.73	Sphaeriidae	

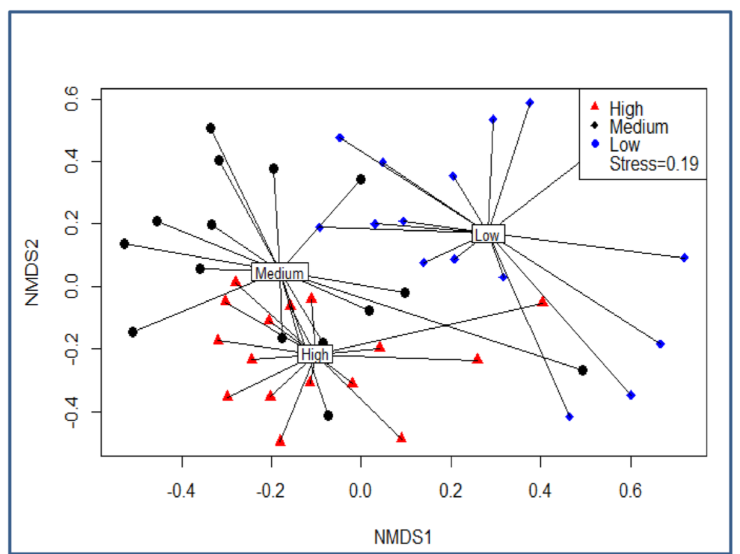


Fig.5. NMDS representing multivariate distances among different water levels

3. BMI and WLFs

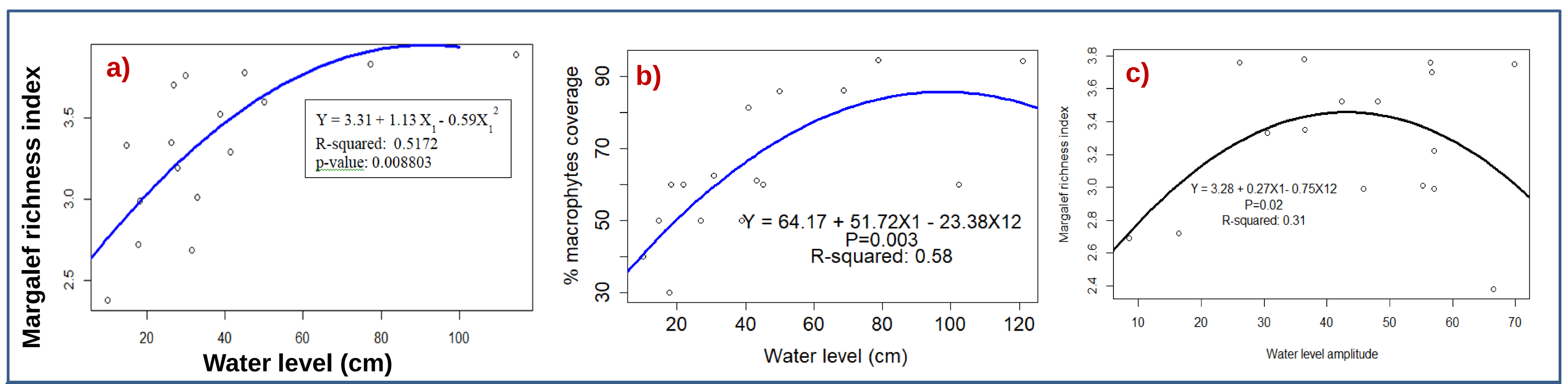


Fig.6. Second degree polynomial regression with water level and a) BMI richness b) Percentage coverage of macrophtyes c) with water level amplitude and BMI richness

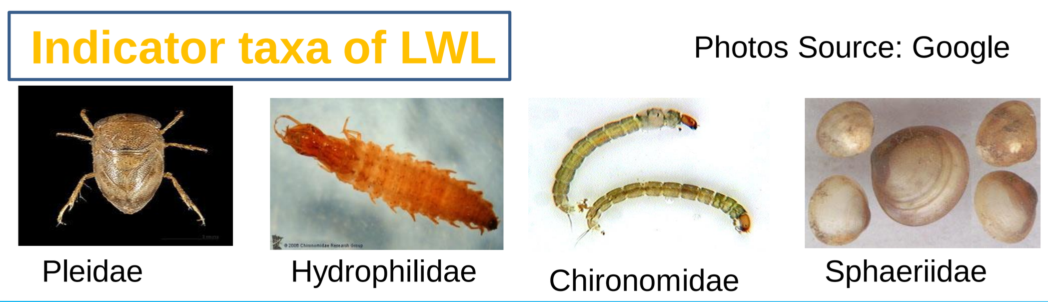
- BMI richness is low with low water level (LWL); tends to increase with increase in WL, becomes constant at some water level and slightly tends to decrease in high water level (HWL) (Fig.6a)
- Substratum (macrophytes percentage) availability decreases as water level declines, which in turn decreases BMI richness as macrophytes is habitat for them (da Silva & Petrucio, 2018) supporting the habitat squeeze effect (both Fig.6a and b)
- Water level fluctuation as intermediate disturbance to shape BMI richness (Fig.6c)

4. Indicator Taxa Analysis (Monte carlo significance test)

Indicator taxa of HWL

Indicator taxa of MWL

Indicator taxa of LWL



Photos Source: Google

CONCLUSION

BMI can be used as an ecological indicator in research that develops environmental flows frameworks. LWL can impair wetland's ecosystem structure and function so that at least MWL should be maintained to sustain wetland ecosystem integrity. Some evidence of habitat squeeze effect was demonstrated as well as intermediate disturbance hypothesis but this requires further long term researches.

References

- da Silva, A. L. L., & Petrucio, M. M. (2018). Relationships between aquatic invertebrate communities, water-level fluctuations and different habitats in a subtropical lake. *Environmental Monitoring and Assessment*, *190*(9), 548.
- Doody, T. M., Cuddy, S. M., & Bhatta, L. D. (2016). Connecting flow and ecology in Nepal: Current state of knowledge for the Koshi Basin. *Sustainable Development Investment Portfolio (SDIP) Project. CSIRO, Australia*, 1–194.
- Gownaris, N. J., Rountos, K. J., Kaufman, L., Kolding, J., Lwiza, K. M. M., & Pikitch, E. K. (2018). Water level fluctuations and the ecosystem functioning of lakes. *Journal of Great Lakes Research*, *44*(6), 1154–1163.

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