Gendered Disaggregated Human Development of Fish-farmer Households in the East Kolkata Wetlands (TS-110)

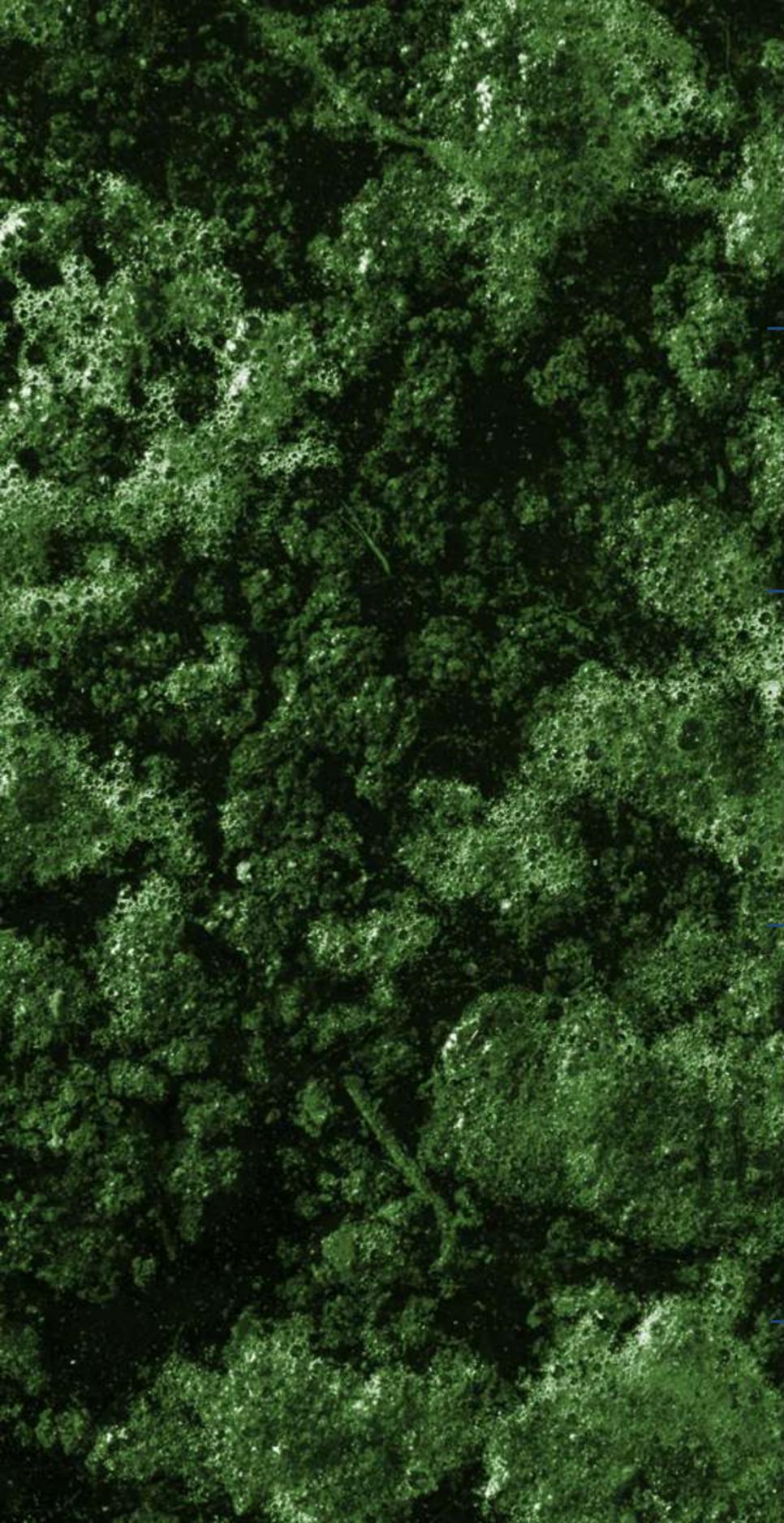## Session 1: Women/ gender in the Blue Economy

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Introduction

1. Wetlands are among the world's **most productive** ecosystems, covering **12.1 million km²** and contributing **40.6%** to global ecosystem service value (Constanza et al., 2014; Ramsar Convention on Wetlands, 2018).

2. In India, wetlands comprise **4.6% of land area**, support one-fifth of the known biodiversity (SAC, 2011), and face pressure from urbanization.

3. **East Kolkata Wetlands (12,500 ha)** are globally significant for their **integration of sewage-fed aquaculture (world's largest sewage-fed aquaculture system)** since the 1930s (Jhingran, 1991), designated as Ramsar Site no. 1208 since 2002 (Ramsar Convention Secretariat, 2002; Dey and Banerjee, 2018). This system exemplifies **"wise use"** through sustainable wastewater treatment, aquaculture, and agriculture (Kumar, 2018; Ray Chaudhuri et al., 2008).

4. They support the livelihoods of nearly **0.1 million** people **and process 750 million litres of wastewater daily**, sustaining Kolkata's peri-urban economy (Dey and Banerjee, 2018; Mukherjee and Chakraborty, 2016).

Rationale

- Beyond their ecological uniqueness, the East Kolkata Wetlands offer a range of ecosystem services, including fish production, vegetable cultivation, paddy farming, and horticulture, while functioning as a natural sewage treatment system, garbage recycler, flood regulator, and recreational site.

- Poverty is widespread in East Kolkata Wetlands - 77% of residents earn below 70% of the state average (Kundu, 2010; Kumar, 2010; Huque et al., 2016), although ecosystem valuation amounts Rs. 171 Crore (Mukherjee, 2024).

- Fish farmers face significant hardships due to pollution, siltation, encroachment, and land-use changes (Kumar et al., 2023).

- **Limited attention has been given to the human development of fish farmers of the East Kolkata Wetlands.**

Study Area
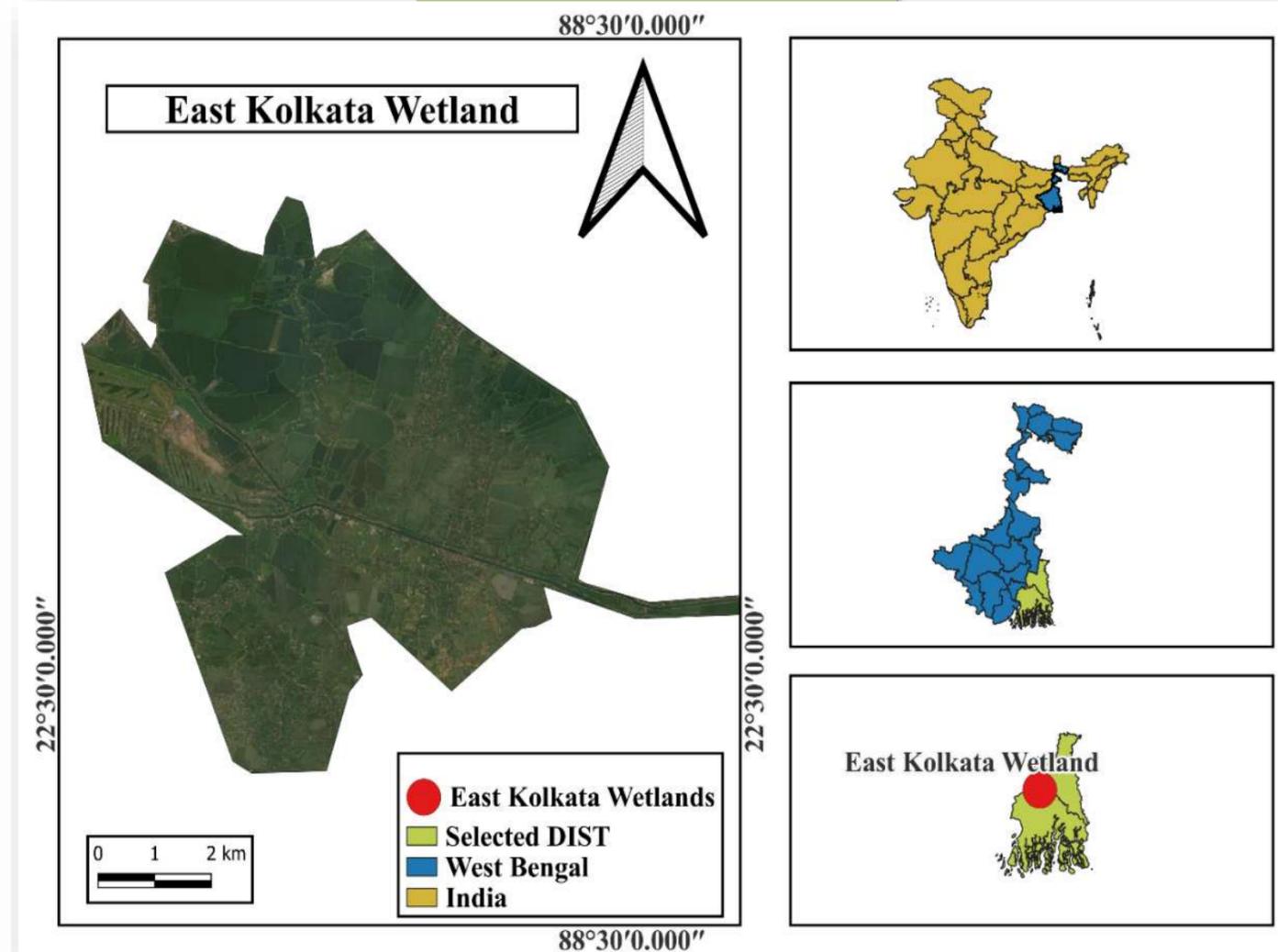
1. The East Kolkata Wetlands (22°25′–22°40′ N, 88°20′– 88°35′ E), spanning 12,500 ha in West Bengal, India, were purposively selected for their globally recognized ecosystem services.

2. The region is centred around sewage-fed aquaculture, covering 3 districts.

32 bheries served as the primary sampling units for identifying and surveying **172 fish-farming households.**

1

Purposive sampling was employed to ensure representation based on operational size.

2

Households were randomly selected

3

Sampling Framework
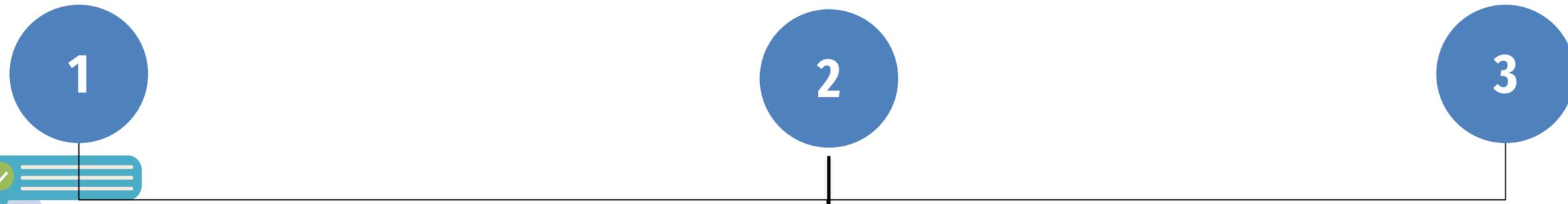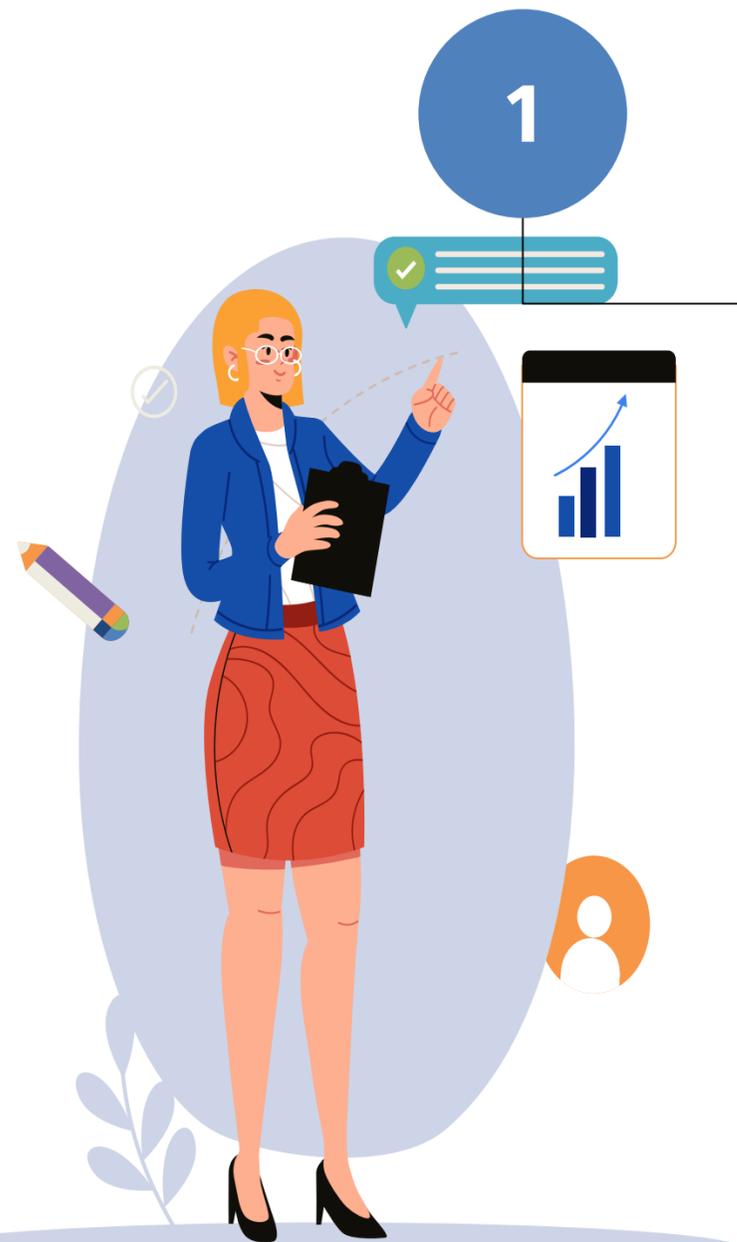
Bheri Management Regime	Number of Bheries surveyed	Number of Household surveyed
Private	22	$n_1 = 88$
Co-operative	8	$n_2 = 64$
Government	2	$n_3 = 20$
Total	32	$n = 172$

Classification of Bheries

Management Regimes	Sub-category	Description
Government 🏛		Managed by State Fisheries Development Corporation Limited, Department of Fisheries, Government of West Bengal.
Cooperative 🤝	Registered	• Fishermen groups possessing valid land deeds can apply to the Department of Fisheries (DoF) to establish registered cooperatives.
	Unregistered	• Once registered, these cooperatives become eligible for government support, such as seed inputs and loans.
Private 🪙	Shareholding	Profit shared among shareholders; owner typically gets 40%.
	Partnership	Owner paid rent; may share in profits and take part in decision making.
	Lease holding	• Leases are set for varying durations, with a one-time payment from the owner to the leaseholders. • Leaseholders gain the right to fish culture for the lease term, share decision-making responsibilities, and receive profits based on their individual shares.

Methodology

According to the **UNDP (2013)**, the **Human Development Index (HDI)** is a **composite indicator** that measures **life expectancy, education**, and **standard of living** to evaluate a population's human development and quality of life at a given time.

This method is derived from the **macro-level, secondary data-based HDI framework** developed by UNDP and has been modified to analyze a specific subset of the population. The methodology remains aligned with the broader conceptual framework of UNDP's human development assessment.

The HDI also offers a measure of **how economic policies impact overall well-being** (Osberg and Sharpe, 2005; Burchi and De Muro, 2016).

In this study, the human development of fish farmers as an occupational group was assessed using a **household-based, micro-level HDI methodology** (Gautam, 2019).

The methodology for calculating the HDI follows the approach outlined in **United Nations Development Programme's technical reports** from 1995 to 2018 (UNDP 1995, 2010, 2018), which employ a structured, macro-level framework.

This **HDI score** offers a **composite measure** of human development in the East Kolkata Wetlands, **capturing disparities in standard of living, education, and health** (Ghosh., 2011; Kovacevic, 2010; Anand and Sen, 1994) among fish-farming households.

$$HDI = \sqrt[3]{Education\ Index \times Health\ Index \times Standard\ of\ Living\ Index}$$
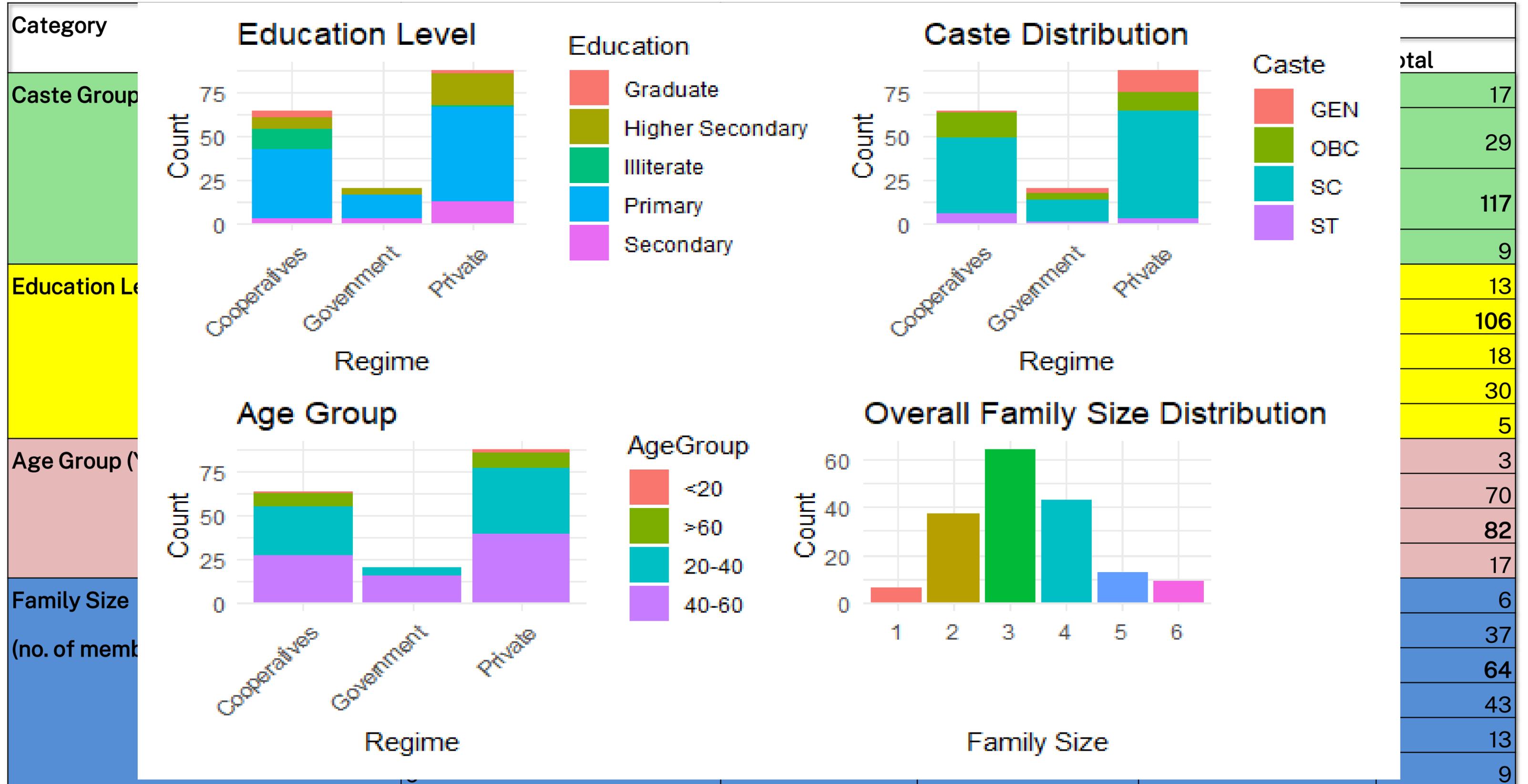
Standard of Living (0.33)	Health (0.33)	Education (0.33)
• Communication & Transport • Livestock ownership • House type, condition, ownership • Drinking water (location & source) • Sanitation (toilet, drainage) • Cooking fuel & lighting	• Disease incidence • Life insurance • Alcohol, Tobacco use • Child immunisation • Maternal health care	• Mean Years of Schooling (>25 yrs) • Gross Enrolment Rate (age 6+)
Index = (HAs × 0.5) + (HAm × 0.5)	Index = (AH × 0.5) + (CH × 0.25) + (MH × 0.25)	Index = (MYS × 0.67) + (GER × 0.33)

Analysis of Variance (ANOVA) to test **for significant differences in HDI** and its components, and **Duncan's Multiple Range Test (DMRT)** as a **post-hoc analysis** to identify specific group-wise variations were employed.
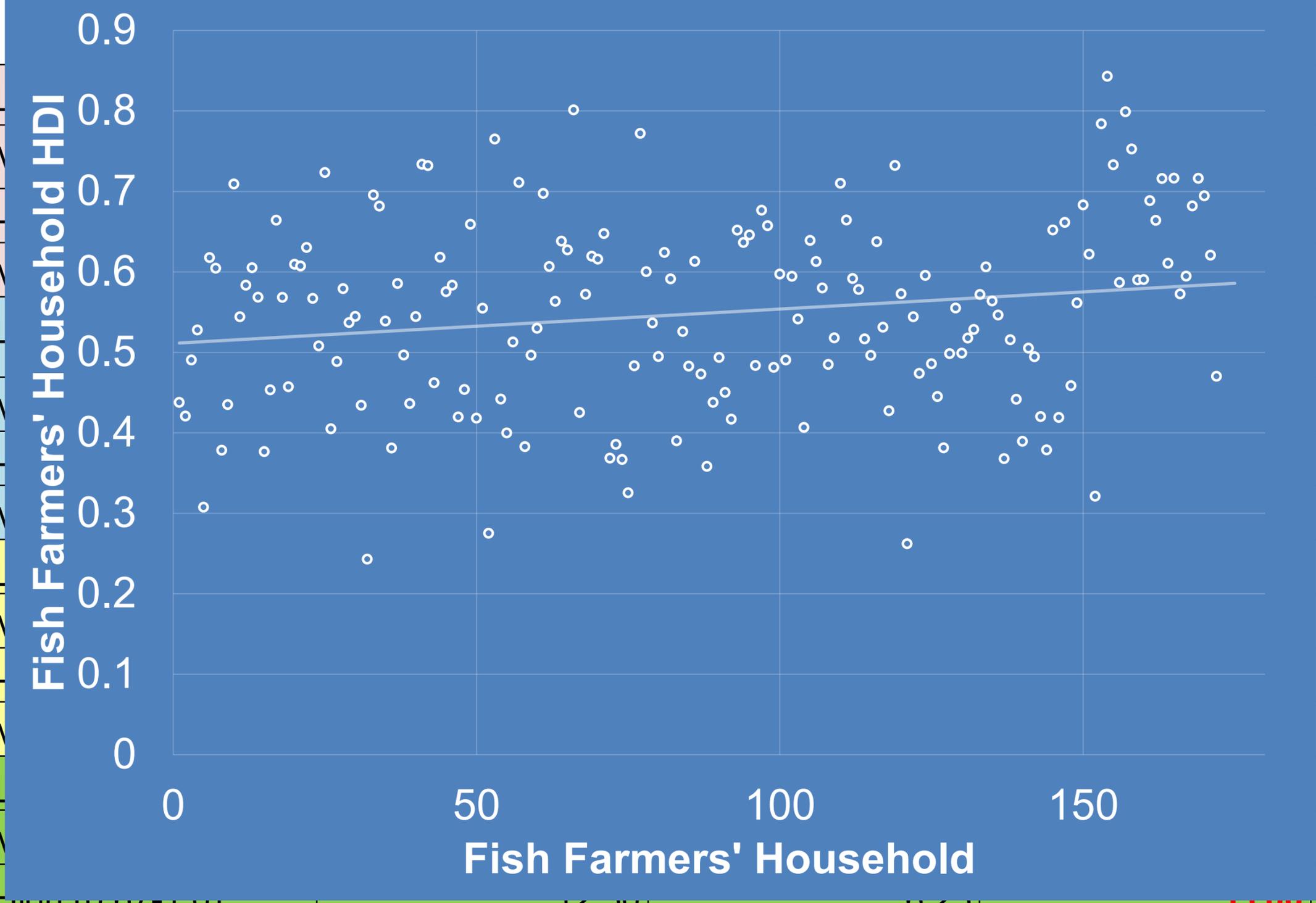
Socio-demographic profile of fish farmers

| Category				Total
Caste Group				17
				29
				117
				9
Education Le				13
				106
				18
				30
				5
Age Group (Y				3
				70
				82
				17
Family Size				6
(no. of memb				37
				64
				43
				13
				9

Human development of fish farmer households of the East Kolkata Wetlands

Dimension indices	Criteria	Private Bheries	Co-op Bheries	Govt. Bheries	Total Fish Farmers n=172 (%)
Education Index 🎓📘✏️	L				9.88
	M				**59.88**
	H				30.23
	M				0.57
Health Index 🏥⚕️💉	L				13.37
	M				**74.42**
	H				12.21
	M				0.50
Standard of Living Index 🏡💰🛒	L				4.65
	M				**66.86**
	H				28.49
	M				0.58
Overall HDI 🌐📕✨	L				3.49
	M				**81.40**
	High (0.67-1.0)	12.50	6.25	**93.08**	15.12
	Mean Index Value	0.53	0.53	0.67	0.55

Distribution of HDI values in different management regimes of the East Kolkata Wetlands
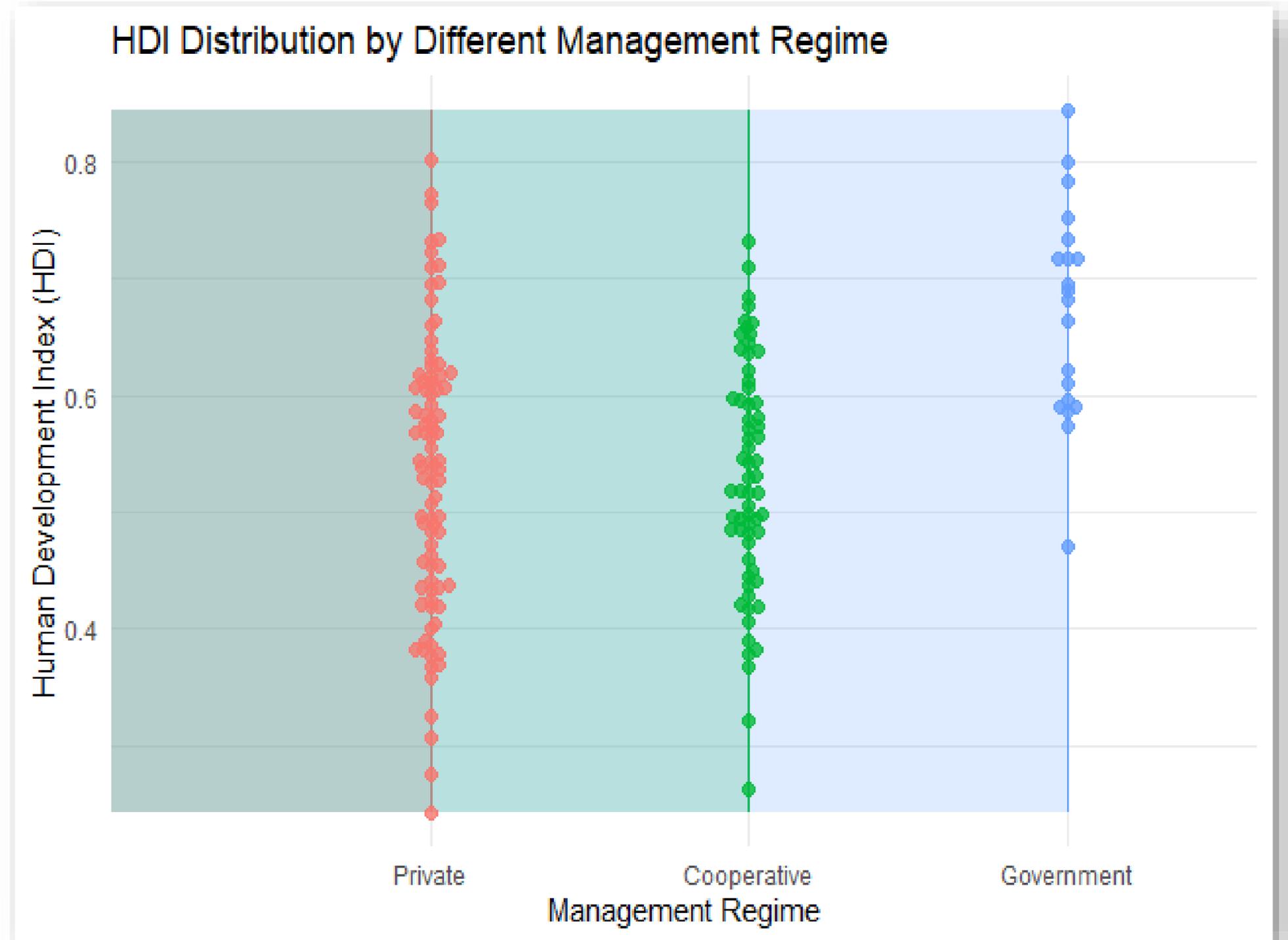
Distribution of HDI values in different management regimes of the East Kolkata Wetlands

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.344	2	0.172	14.336	<0.001*
Within Groups	2.028	169	0.012		
Total	2.373	171			

One-way ANOVA Test of significance in HDI among fish farmers of different management regimes (n=172)

Duncan[a,b]			
		Subset for α=0.1	
Regime	N	1	2
Cooperative	64	0.5300	
Private	88	0.5331	
Government	20		0.6713

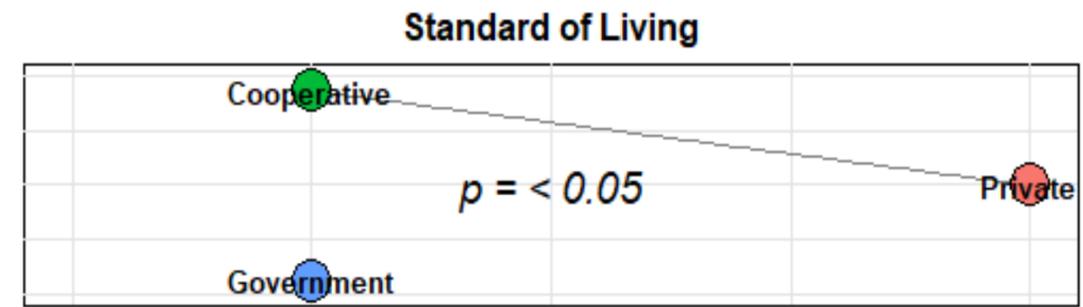Duncan Post-Hoc Test for comparisons of HDI between groups

Network plot showing homogeneous subsets of management regimes for each human development variable (Edges represent statistically non-significant differences between connected regimes based on Duncan's post-hoc test at 5% significance level)
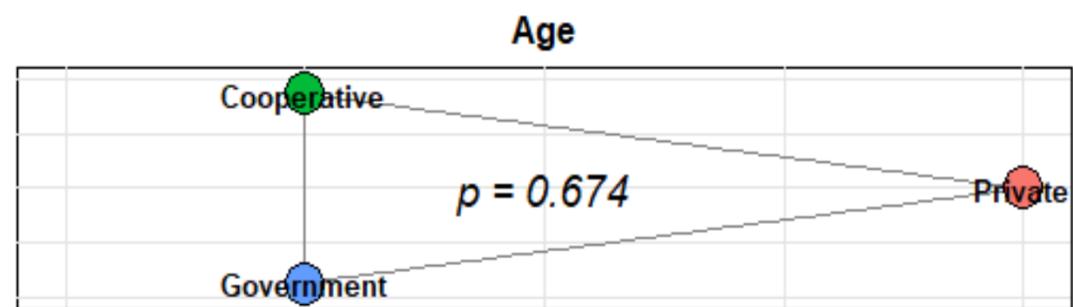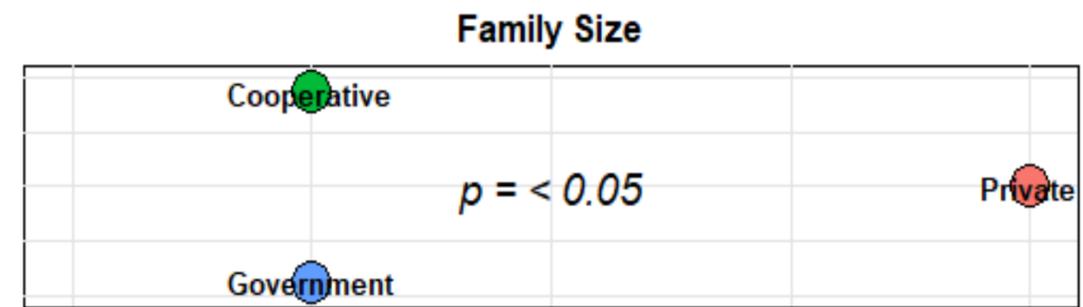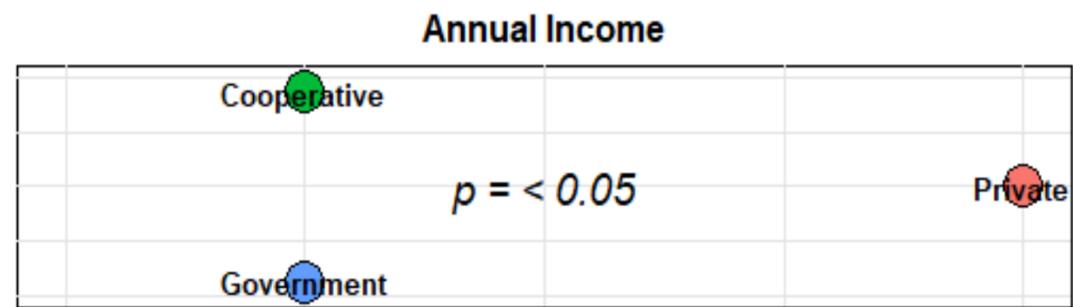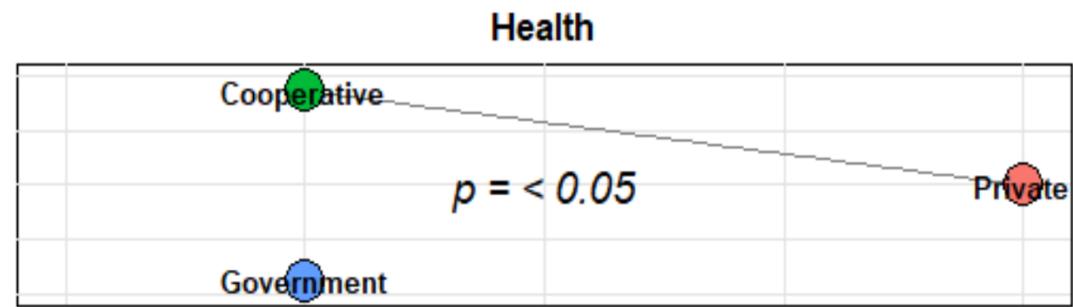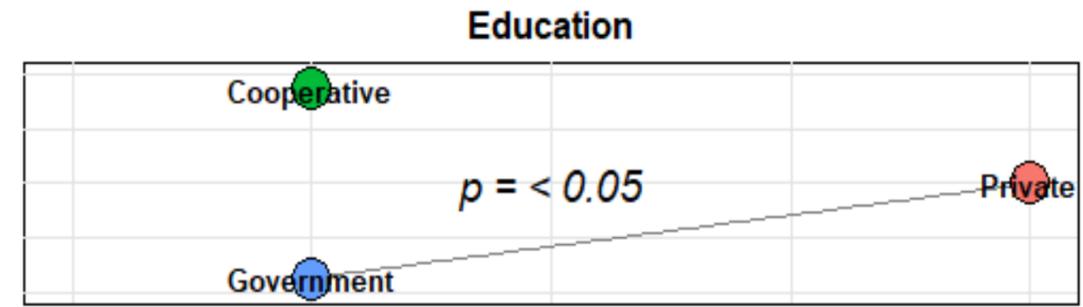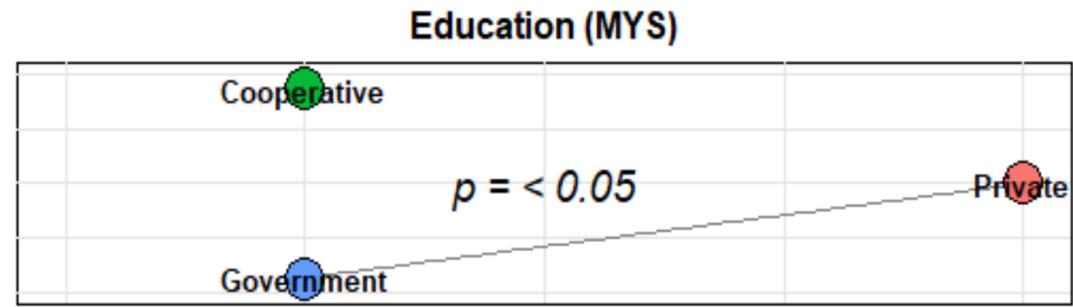
Distribution of HDI values in different management regimes of the East Kolkata Wetlands

- Similar studies on different reservoirs and wetlands have reported comparable HDI trends across various regions.

a. **Waghmare (2020) in three reservoirs of Maharashtra; Gautam (2019) in Rihand and Upper Wardha Reservoir also belonged to the medium HDI category.**

b. **Velumani (2017), recorded an HDI of 0.57 for fisher households of Krishna Raja Sagar, Karnataka**

c. **Shaikh (2014) recorded a lower HDI of 0.51 for the Ujjani Reservoir, Maharashtra.**

d. **Palita (2014) and Nikumbe (2011) found lower HDI values in the Hirakud Reservoir, Odisha (0.45), and Girna Reservoir, Maharashtra (0.32), respectively.**

e. **Bunkar et al. (2022) reported an even lower HDI of 0.31 for Rana Pratap Sagar, Rajasthan.**

- Trinh (2023) found that investment in **education directly improves standard of living, which is observed in the government-managed bheri fish farmer households in the present study**. **Better average income in government-managed bheries has resulted in a higher human development score, a pattern also reported in several other studies** (Grimm et al., 2008; Ranis et al., 2000).

- Aligns with prior findings that **stronger institutional support and public governance can enhance human development outcomes in small-scale fisheries** (Ostrom, 1990; Pretty, 2003; Jentoft and Chuenpagdee, 2009) such as in the East Kolkata Wetlands.

- Other studies have reported similar patterns in India, where **government employment substantially improved family well-being (Desai et al., 2022; Glinskaya and Lokshin, 2007; Mann and Kapoor, 1988) and served as a key marker of human development.**

The gendered correlation between the health indicators and the human development

Heatmap of Correlation Coefficients between Health Indicators and HDI
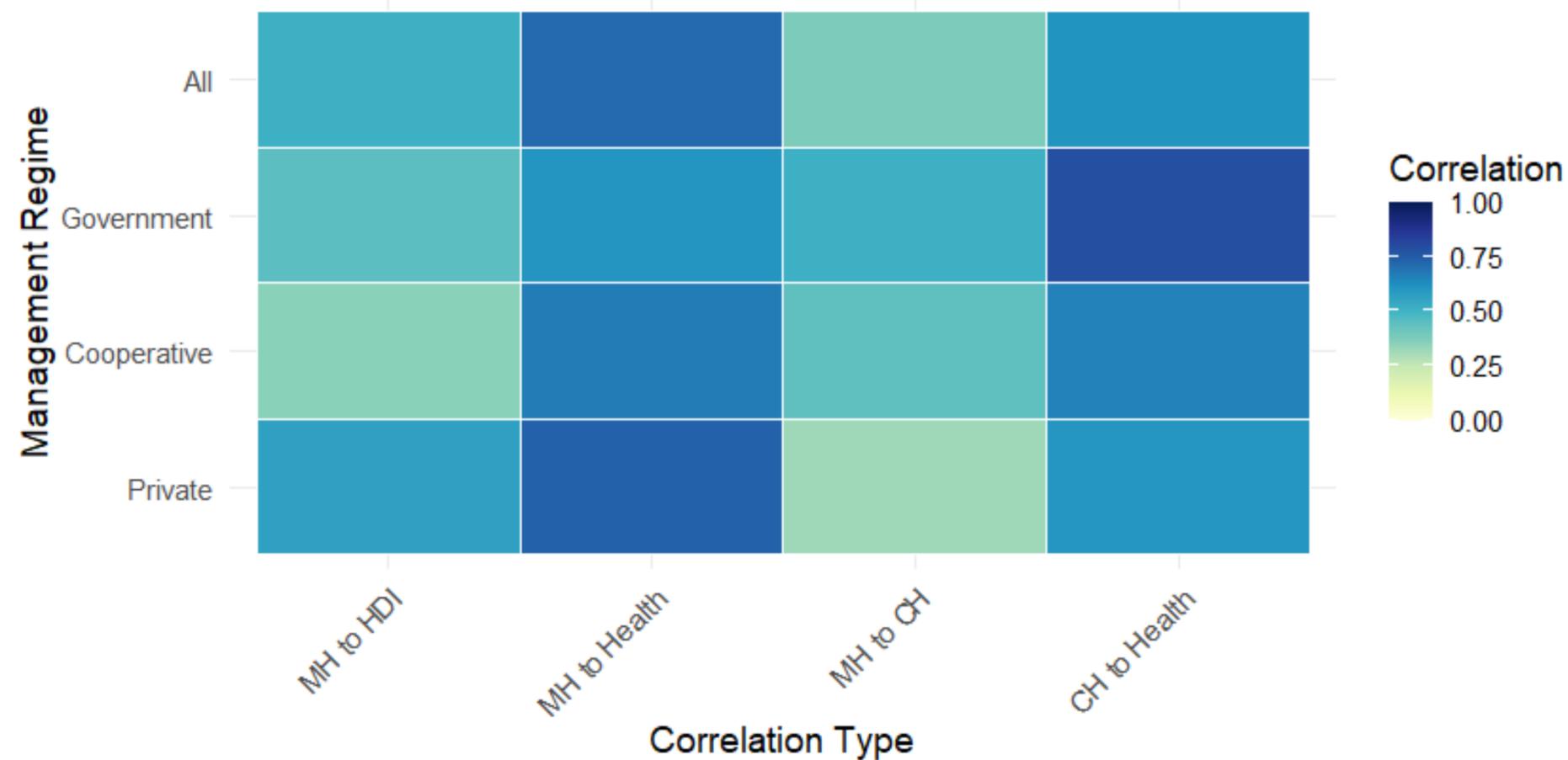
1. **MH showed** a moderately strong positive correlation with the health index (r = 0.72) and with HDI (r = 0.52).

2. Among regimes, **government-managed bheries recorded the highest correlations,** particularly CH with Health (r = 0.79) and MH with CH (r = 0.52).

3. In contrast, **private and cooperative regimes exhibited weaker relationships,** with MH to HDI correlations of r = 0.57 and r = 0.36, and CH to Health correlations of r = 0.61 and r = 0.66, respectively.

- Boutayeb & Serghini (2006) found **high correlations between health indicators and human development in Arab countries, identifying maternal and infant mortality as critical challenges linked to women's low social and economic status and limited healthcare access.**

-

- Grech (2018) established that **sex ratio at birth correlates with multiple health and socioeconomic indicators**, suggesting it may serve as a sentinel health indicator.

The gendered correlation between the health indicators and the human development

- Varkey et al. (2010) demonstrated that **women's empowerment, measured through the Gender Empowerment Measure**, significantly associates with **key health indicators including infant mortality, fertility rates, and low birth weight at national levels, with the strongest correlation found between women's empowerment and infant mortality (R² = 0.601).**

- Сергеевна et al. (2015) examined the **interdependence between human development indices and gender equality indicators, highlighting how gender segregation across sectors influences differential human capital development b/w men and women**.

- A comprehensive study of 188 countries found significant **negative correlations between the Human Development Index (HDI) and maternal mortality rates**, with similar patterns observed for **infant and child mortality indicators** (Almasi-Hashiani et al., 2016).

- District-level analysis in India revealed **very strong correlations between maternal mortality ratios and development indicators**, with correlation coefficients ranging from 0.92 to 0.99 (Roychowdhury & Jones, 2014).

- The observed correlations between **maternal health, child health, and HDI** across different fisheries management regimes align with existing literature (Bloom et al., 2004; Bhutta et al., 2014; Sehgal et al., 2025).

- In the present context, **management regime-wise disparities in maternal and child health have been documented**, emphasizing the need for **targeted, gender-sensitive health interventions to improve human development outcomes** (Kumar and Rani, 2019; Saikia et al., 2016) in wetland-based fisheries communities.

Conclusion and Recommendations

1. **Overall HDI** of fish farmers in East Kolkata Wetlands: **0.55**, lower than (0.624) and national averages (0.644).

2. **Government bheries** recorded **highest HDI (0.67)**; consistent pattern of higher HDI in government-managed bheries show that targeted institutional investment can drive social transformation in marginal wetlands communities.

3. **Private & cooperative bheries** face **poor health services**, **weak education access,** and **substandard living conditions.**

A. Implement **regime-specific interventions** for private and cooperative bheries.

B. Invest in **education and skill development**, with focus on women and youth.

C. Improve **infrastructure, sanitation, and welfare delivery.**

D. Promote **inclusive and gender-responsive governance** aligned with wetland conservation.

E. Strengthen **institutional collaboration** among local bodies, research institutions, and wetland authorities.

F. Address **gender disparities in health and literacy** through targeted schemes for women fish workers.

G. Ensure **participatory decision-making** by including fish farmers.

H. Enhance **digital literacy and financial inclusion.**

I. Conduct **future research** on direct linkages between HDI and aquaculture productivity.

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Thank you

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