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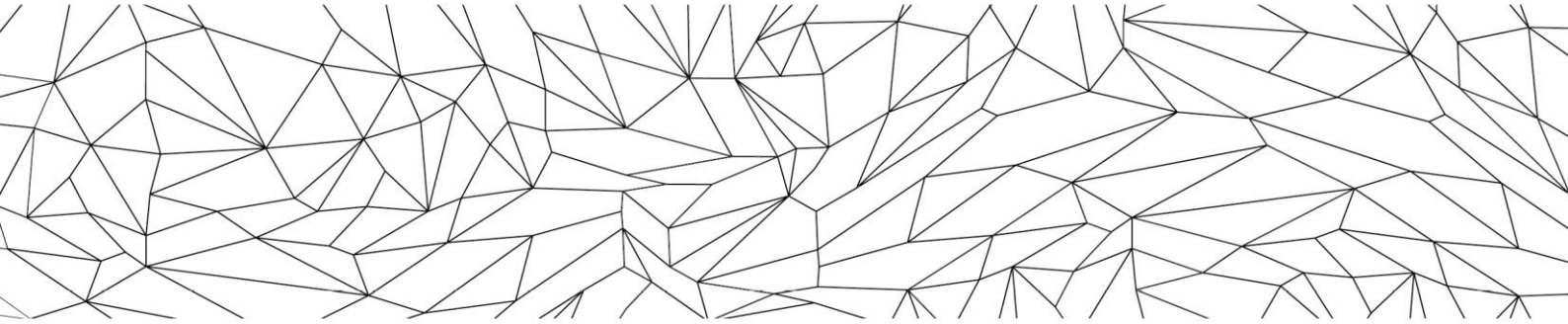

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Poverty, institutions and environmental degradation: Fishing commons governance and the livelihood of rural households amid mangrove deforestation in Puttalam, Sri Lanka

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Abstract

Mangrove forests are critical to protecting our environment against the damaging impacts of climate change. While a third of global mangrove species are found in Sri Lanka, considerable mangrove deforestation has occurred over the last few decades, primarily due to the expansion of shrimp farming. This has degraded the mangrove ecosystem and led to the depletion of fish population, in turn affecting the livelihoods of local communities who depend predominantly on fishing for their survival. This study quantitatively analyses household survey data collected from local communities in and around the Puttalam lagoon, northwest Sri Lanka, to explore the institutions that are used for fishing commons governance (using Elinor Ostrom's (1990) design principles as a theoretical underpinning) and their relation to poverty and environmental (and commons) degradation. The analysis finds that mangrove conservation is considered important regardless of poverty level and that poverty is related to greater institutional adherence. While adherence to the design principles leads to greater sustenance of the fishing commons, certain design principles are found to be more important than others. In this study, we found monitoring is the most important design principle.

Keywords: fishing commons; mangrove deforestation; Sri Lanka.

JEL classification: Q22, Q57, Q13.

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1. Introduction

The environment and livelihoods of local communities are increasingly threatened by the consequences of man-made economic activities (Allen et al., 2018; Raworth, 2017). Mangrove forests are an ecosystem widespread in the global south that offers critical protection against such activities, primarily through its ability to sequester carbon (Alongi, 2012; Jil et al., 2015). The benefits of mangrove forests extend beyond the environment, providing for the fish ecosystem and to local communities (Jil et al., 2015; Kaleel & Nijamir, 2017; Primavera, 1997; Wickramasinghe, 1997).

Sri Lanka holds a third of all mangrove species available globally (Kaleel & Nijamir, 2017). However, over the last few decades mangroves have been extensively cut down, in Sri Lanka as well as across the rest of the world, largely for shrimp farming (e.g. Gunawardena & Rowan, 2005; Jil et al., 2015). This has led to (among other detriments) a significant depletion in fish stock, thus increasing pressure on fishing commons and, consequently, on the lives of rural fishing communities (Dahdouh-Guebas et al., 2001; Wickramasinghe, 1997). If sustainable development that includes alleviating poverty and conserving the environment is going to be achieved in Sri Lanka, pursuing economic growth while protecting the environment will be essential - which means developing policies that promote industry while conserving mangrove forests and the fishing commons (GoSL, 2018; Munasinghe, 2019).

Neoclassical economic theory of environmental (and resource) economics makes such a balanced ambition rather difficult because it tends to imply that the poor are too poor to be concerned about the environment, and thus economic growth ought to be prioritised regardless of its consequences to the environment (Beckerman, 1992; Panayotou, 2000; Raworth, 2017; Shafik & Bandyopadhyay, 1992; World Bank,

1992). Neoclassical economic theory in the particular form of game theory similarly leads to the presumption that commons degradation is inevitable (Gordon, 1954; Hardin, 1968; Olson, 1965).

While this could perhaps be brandished as merely academic debate, the severity of such theories' consequences can be seen when they are used to develop policies, often leading to more harm than good. For example, these theories are used by lobbying organisations to claim they have scientific evidence that it is not worthwhile (cost effective) to develop policies that protect against environmental damage and climate change (Gowdy & Erickson, 2005).

Taking a different approach to poverty and the environment that incorporates ecological economics and institutional economics allows for a different conception of the poverty-environment nexus. This approach embeds the economy as being situated within a society that involves political activity, institutions (formal and informal rules that people adhere to), and general complexity - society itself is posited as being encapsulated within the physical capacity of the natural environment (Gowdy & Erickson, 2005; Ostrom et al., 1999; Raworth, 2017; Vatn & Bromley, 1994). In this perspective, neither environmental nor commons degradation are inevitable (e.g. Gowdy & Erickson, 2005; Ostrom et al., 1999).

This study deploys a household survey amongst fishing communities in Puttalam, Sri Lanka, seeking to quantitatively explore, using Ostrom's (1990, 1992, 2008) design principles as a theoretical underpinning, how institutions are used to protect the fishing commons (regardless of optimal self-interest), and understand how relational

poverty can affect such institutions. This study will also aim to illuminate how both institutions and poverty interact with attitudes to environmental degradation in the context of mangrove deforestation.

The next section provides a historical background to the important role mangrove ecosystems have played in Sri Lanka (as they have globally), how mangroves have deforested largely due to the expansion of shrimp aquaculture (among other things), and how this has put stress on communities local to mangroves who are particularly reliant on fish for sustenance. Following this, Chapter 3 outlines the economic literature relevant to this thesis. Section 4 then specifies the aims of this study and outlines the methodology used regarding the quantitative survey deployed. The results of the quantitative analysis of the survey data collected then follow and are discussed in the context of the underpinning economic theories previously outlined (Section 5), before the thesis ends with a brief summary and conclusion (Section 6).

2. Background

2.1. Mangrove forests as an indispensable environmental resource

Man-made climate change poses a significant and urgent threat to the natural environment. By environment we mean the Earth's biosphere: the essentially common good of its land, waters, and atmosphere that enables our existence (Raworth, 2017; Vatn, 2005). So severe is this threat that, according to an IPCC report, it will require unprecedented changes to the economies of societies across the globe if the droughts, floods, and poverty that increasingly arise as a result are even simply to be reduced, let alone alleviated (Allen et al., 2018). Because the detrimental consequences of climate change disproportionately affect developing

countries, given they are generally situated in the global south and are thus more vulnerable to the risks of environmental damage, it becomes even more pressing as both a humanitarian and development issue (Leichenko & Silva, 2014; Mirza, 2003; Miyan, 2015; Olsson et al., 2014; Srinivason et al., 2008).

Mangrove forests are natural ecosystems found in what are known as inter-tidal regions – the areas that sit between the sea and the corresponding land - of countries that have a tropical climate (Kaleel & Nijamir, 2017). Being the most carbon dense of all ecosystems, mangroves do much to protect against climate change and environmental damage by sequestering and storing carbon, thus reducing greenhouse gases that cause global warming (Alongi, 2012; Jil et al., 2015). Although mangroves make up less than 1% of actual forest land area globally, they store 20 billion tonnes of carbon (approximately 2.5 times as much as greenhouse gases emitted globally in a year) (UNFCCC, n.d.). Mangroves are also critically important for an assortment of marine species, and provide resources for local communities whose livelihoods often depend on them for subsistence (Jil et al., 2015). They have even been shown to have offered life-saving protection against the Indian Ocean tsunami of 2004 (Dahdouh-Guebas et al., 2005). However, in only the last twenty years over a third of world's mangroves have been destroyed (Kaleel & Nijamir, 2017), and over half in the last fifty years, at a rate of around 1% a year (UNFCCC, n.d.).

Around 40% of all mangroves in the world are found in Asia (Kaleel & Nijamir, 2017). Mangroves in Sri Lanka make up a third of all mangrove species worldwide, spanning twenty different species. Most of these species are present near the

Puttalam lagoon alone, the second largest lagoon in Sri Lanka (Kaleel & Nijamir, 2017). Of all the coastal ecosystems in Puttalam, the mangrove ecosystem is the most valuable, protecting against coastal erosion and rising sea levels, among other climate change impacts, as well as being a source of fuel, medicine, building material, and food for the local community (Kaleel & Nijamir, 2017; Primavera, 1997).

The mangrove forests also provide a breeding ground for fish (Jil et al. 2015), making them of critical importance given the prevalence of fishing as the main occupation among the local communities in Puttalam (Ekanayake, 2016; Galappaththi & Berkes, 2015) and its presence across the entire country: 60% of the Sri Lankan population depend on fish as their sole source of protein and fishing contributes to 2.2% of Sri Lanka's GDP (Wijegoonawardena & Siriwardena, 1996). The livelihoods not only of local fishing communities, but also of those situated further away, are thus considerably reliant on mangroves.

2.2. Shrimp aquaculture led to mangrove forest degradation in Sri Lanka

Comparatively lower income countries such as Sri Lanka, as rather typical of most countries situated in the global south, require economic growth to alleviate poverty (e.g. Bhagwati & Panagariya, 2013). Shrimp aquaculture (also known as shrimp farming) has been one industry that has played a significant role in boosting economic growth and improving rural incomes both in Asia and Sri Lanka in particular (Campbell & Pauly, 2013; Galappaththi & Berkes, 2015; Munasinghe et al., 2010). In Sri Lanka, shrimp aquaculture has provided a great source of employment as well as foreign exchange, making up nearly half of all aquaculture exports (Jil et al., 2015). Coastal shrimp aquaculture in Sri Lanka comprises mostly of tiger shrimp

sold to international markets by shrimp farming communities in the northwest, such as those in Puttalam (Galappaththi & Berkes, 2015).

Despite these potential economic benefits, shrimp aquaculture is known to be one of the most environmentally damaging types of modern agriculture, depleting groundwater, polluting surface water, and destroying mangroves (Gunawardena & Rowan, 2005). With around 34% of mangrove forests in Puttalam cut down to make space for shrimp farms, shrimp aquaculture and its consequent environmental degradation (including a considerable net carbon loss) has transformed Puttalam's coastal landscape over the last thirty years (Jil et al., 2015). As can be seen from Table 1 (below), mangroves in the Puttalam lagoon area have declined by 33.6% since 1992/1994, while land use for shrimp farms has increased by a comparatively overwhelming 2,777.3% in the same time frame (net changes).

***Table 1**. Land use in 1992/1994 and 2012 in Puttalam. Ratios of the area of shrimp farm (SF) to mangrove (M), and to coconut plantation (CP), and change in land use are indicated.*

Land use	1992/1994 (ha)	2012 (ha)	Net Change (%)
Shrimp farms	39.63 (1%)	1 140.3 (20%)	+2 777.3
Salt pans	539.3 (13%)	862.1 (15%)	+59.8
Mangroves	1 093.7 (26%)	726 (13%)	- 33.6
Coconut plantations	2 535 (60%)	2 963.6 (52%)	+16.9
SF: M ratio	1: 28	1: 0.6	
SF: CP ratio	1: 64	1: 2.6	

Source: Jil et al. (2015).

While shrimp aquaculture thrived initially in Sri Lanka, garnering government support and bringing about certain economic benefits, the high profitability and foreign exchange achievable from the industry led to short-termism (Galappaththi & Berkes,

2015; Gunawardena & Rowan, 2005). As larger scale aquaculture sought high profits, they displaced smaller-scale fisheries (Galappaththi & Berkes, 2015). Yet while shrimp aquaculture brought some increased employment prospects, since most of the capital and investment required was provided from outside, the majority of shrimp farmers in Sri Lanka were outside entrepreneurs as opposed to people from the local community (Galappaththi & Berkes, 2015; Jayasinghe, 1995). If locals were to find employment in shrimp aquaculture, they were generally restricted to low paying and unskilled jobs such as labourers and guards, compared to managerial jobs for example that were more often reserved for outsiders (Gunawardena & Rowan, 2005). Thus, most of the profits earned from shrimp aquaculture tended not to benefit the local area, creating conflict between shrimp farmers and others using coastal resources such as local fishers (Galappaththi & Berkes, 2015; Gunawardena & Rowan, 2005; Jayasinghe, 1995).

Although shrimp aquaculture displaced smaller-scale fisheries because it was able to provide greater returns in the short-term, shrimp aquaculture was not necessarily dependent on mangrove areas, unlike traditional sectors like fishing (Gammage, Benitez & Machado, 2002; Gunawardena & Rowan, 2005; Nickerson, 1999). Further, it was more often the poorest that were generally the most dependent on mangroves and the coastal ecosystem, for timber and firewood for example (Dayananda, 2004; Jil et al. 2015; Primavera, 2006). In Puttalam alone around 11% of households can be classified as living in poverty – this surmounts to around 104,000 people (Ranasinghe, 2010). Shrimp aquaculture took over despite mangroves being more economically valued over the long-term for locals than their conversion to shrimp ponds (Dayananda, 2004; Jil et al., 2015; Primavera, 2006). This highlights the

imbalance of power between those that benefit from industrial development and those that do not, rather than the actual costs and benefits (Jil et al., 2015). As traditionally small-scale aquaculture became privately-owned single-purpose enterprises, taking over land where mangroves had been cut down to make room, the conflict between mangrove protection and the shrimp industry exemplified the antagonism of the competing political regimes of global free trade and environmental protection (Martinez-Alier, 2001, 2002).

2.3. Local livelihoods now rely on conserving mangroves and the fishing commons

Despite the high initial growth of large-scale shrimp aquaculture in Sri Lanka, its growth has seen a decline since the 1980s due primarily to disease outbreaks, unsustainable operations, stakeholder conflicts, and civil war (Galappathi & Berkes, 2015; Munasinghe et al., 2010). With new land cleared for shrimp ponds, many have been left abandoned to this day (Jil et al., 2015). They have since given way to smaller-scale shrimp farms managed in local level cooperatives (known as Samithi) – which were more competitive because shrimp farmers carried over skills and knowledge from previous larger operations and thus survived despite shrimp disease outbreaks, avoiding the boom and bust of larger-scale aquaculture (Galappathi & Berkes, 2015; Primavera, 2006). Such cooperatives, where common resources are managed, are now common in aquaculture just as they are for other fishery societies in Sri Lanka.

Mangrove deforestation, because of changes in land-use for shrimp ponds, is one of the key causes for declining yield in fisheries (Wickramasinghe, 1997). It has also led to a reduction in the availability of wild shrimp (Dahdouh-Guebas et al., 2001). Thus,

shrimp farmers destroying mangroves to develop their industry has not only caused a negative feedback loop for themselves, adding to the unsustainability of large-scale shrimp aquaculture, but has also seriously affected the nutrition of fish-protein-reliant local communities (Dahdouh-Guebas et al., 2001; Wickramasinghe, 1997).

With mangroves disappearing and fish stocks threatened, protecting mangroves and the fishing commons is critical for sustaining the local environment and the livelihoods of people in the surrounding fishing communities. As the Government of Sri Lanka (GoSL) set out in their challenging 2030 vision for developing a sustainable future that includes the eradication of poverty and hunger, decent work and economic growth, all the while ensuring a green environment that fosters life both on land and below water (GoSL, 2018; Munasinghe, 2019) - among a host of other admittedly desirable factors - taking steps not only to conserve mangrove forests but also to develop policies that most encourage cooperation in preserving fishing commons will be instrumental.

3. Literature review

3.1. Conceptualising the poverty-environment nexus and the vicious-circle hypothesis

Poverty and the environment are typically described in the literature as being linked by a vicious circle. This hypothesis purports that since poverty and increasing population constraints lead the poor (often agriculturally dependent) to farm increasingly precarious land that as a result gets degraded further, the poor then achieve lower outputs because of the degradation, thus increasing their poverty and creating a vicious circle of poverty and environmental degradation (Angelsen, 1997; Dasgupta and Maler, 1994; Reardon & Vosti, 1995). This is an explicit concern as an

obstacle in Sri Lanka's 2030 strategic vision for development: "Persistent poverty can push individuals to resort to environmentally harmful activities in order to survive, such as deforestation and the use of improper techniques/methods in agriculture" (Munasinghe, 2019, p.64).

The tendency for the poor to rely more on commons resources has also been thought to contribute to the vicious-circle phenomenon. As Delacote (2009) argues, common pool resources (CPRs) are often used as insurance for poor households in developing communities because they provide a minimum income and safety net against the possibility of low returns from private labour. However, overexploitation of the CPRs and an allocation of too much labour to utilising them alone can lead to a tragedy of the commons effect. This is because too many households are in need of the CPR as insurance even though there is not enough of it to provide for all – resulting in a poverty trap (Delacote, 2009).

However, Reardon and Vosti (1995) argue that the vicious-circle poverty-environment hypothesis is too simplistic. They feel that to be able to make a useful connection between poverty and the environment a greater complexity of analysis needs to be embraced where the type of poverty and its measurement is accounted for along with its specific relation to the particular type of environmental degradation being considered. They suggest this can be done by distinguishing between the welfare poor and investment poor (essentially undertaking a relational-capability approach), and suggest a need to account for the distribution of poverty across households in a community. Further, they argue that a useful conception of the poverty-environment nexus would also consider the extent of the different directions

of causality regarding the interrelation between poverty and the environment, as well as a deeper understanding of the actual behaviour of poor rural households (Reardon & Vosti, 1995).

3.2. Institutional economics and commons governance

A common pool resource (CPR), also known as a “commons”, is a resource (be it natural or man-made) where: first, the use of it by one person reduces the amount of it available for others, like in private goods (known as the subtractability problem); second, excluding or controlling potential users of it through physical and institutional means is difficult and costly, like with public goods (known as the excludability problem) (Ostrom et al., 1999). Examples of common pool resources (CPRs) include lakes, oceans, fishing grounds, and forests (Beitl, 2012; Ostrom et al., 1999).

Ostrom (1990, 1992, 2008), by analysing hundreds of private, government, and community CPR arrangements, developed eight design principles that are characteristic and predictive of commons that have survived and surpassed supposed tragedy over the long-term. These design principles were what appeared required for communities to develop institutions that allowed successful self-governance of their CPRs and which were appropriate to their specific political, economic, and social context (Sarker et al., 2015).

Sarker et al. (2015) illustratively summarise Ostrom’s (1990, 1992, 2008) eight design principles for sustaining CPRs in the context of fisheries as follows:

1) *Well-defined boundaries*. Two types of boundaries are generally required: a resource boundary and a user boundary. The resource boundary identifies the

geographical boundary in the waters where fishers can operate, whilst the user boundary defines who qualifies to be able to fish within the resource boundary.

2) *Congruence between appropriation and provision rules and local conditions*. This involves giving consideration to local conditions such as “shipping restrictions, size restrictions, and catch limits (appropriation issues) in order to conserve resources (provision issues)” (Sarker et al., 2015, p.34). This could involve for example restricting fishing to a particular time of day and limiting the amount of catch allowed.
3) *Collective-choice arrangements*. This is the tailoring of institutions to local circumstances by CPR users who interact with each other. Sarker et al. (2015) provide the example of fishers adapting their collective fishing strategies depending on weather conditions, decided through board meetings with members and without external authorities.
4) *Monitoring*. This can involve the monitoring of resource conditions, but also of adherence to the collective choice arrangements made by members (to which peer-pressure often substantially reduces costs).
5) *Graduated sanctions*. When users are found to break agreed rules, they receive punishment. The severity of the sanctions administered relate to the seriousness of the violation. This could involve, for example, threats of membership cancellation or actual cancellation after repeat offenses (for a set amount of time or even permanently).
6) *Conflict-resolution mechanisms*. This is the ability for users to resolve conflicts quickly and inexpensively. This could be decided through meeting discussions and majority-decision, but are often avoided by abiding to the other principles.

7) *Minimal recognition of rights to organise (self-determination)*. This requires that state authorities, nationally and locally, approve of local users devising their collective organisational agreements. This could take place in the form of granting licenses through legislation, for example.
8) *Nested enterprises*. While primarily relevant to CPRs that are part of larger systems, this principle can be considered an extension of self-determination, involving the layering and interweaving of supportive governance-activities, be it at local, regional, or national levels. For example, at the local level, fishery cooperative associations decide their own resource rules about resource use, and local authorities may provide a legal-framework that supports this without necessarily interfering in any specific management. Similarly, at the national level, national fishing bodies may advise the state on fishing policy, and this would be aligned with supporting the CPR at the more local level. Without this alignment, establishing rules at one level and not others would create a system too conflicted to realistically survive in the long-run (Ostrom, 1990).

Despite these eight design principles being broadly construed, there appears great complexity in how even the same outcome intention of each principle is implemented (Ostrom et al., 1999). Take the boundary-rule for example. Schlager (1990, 1994) looks at 44 different inshore fisheries around the world and finds that while 33 of these had at least one rule on the use of the fishing commons and its excludability, they all used a different combination of 14 different variants of boundary-rules (although nearly all of them did restrict fishing to those living in the local community) (Ostrom et al., 1999). Restrictions on fishing-gear were also quite prevalent. While fishery economists most commonly recommend a central-authority presence as a

policy for effective maintenance, none of the fisheries examined incorporated such a rule (Ostrom, 1990; Schlager, 1994).

Due to the sheer complexity of the actual materialisation of different types of rules within these eight design principles, there is a great difficulty in analysing them individually through a quantitative manner – examining the overall aspect of the design principles is a considerably more feasible matter. Nevertheless, the matter is further complicated because institutional systems of commons governance are complex, polycentric, and adaptive - so there is no guarantee the particular rules chosen to be implemented from a diverse range of options will work. More than likely they will achieve a less than optimal outcome - but that does not necessarily mean susceptibility to tragedy - merely that finding a sustainable solution is not easy (Ostrom et al., 1999).

Galappaththi and Berkes (2015) use Ostrom's design principles to evaluate commons management in aquaculture (a broadly understudied area for commons research). They find that rules help to establish boundaries to resolve the exclusion and subtraction problems that commons, by their very nature and definition, present. Galappaththi and Berkes (2015) undertake a social-ecological systems analysis of Ostrom's design principles to do this, using qualitative methods (focus groups), and find that adherence to the design principles results in effective commons governance for small-scale aquaculture.

However, little research exists implementing a quantitative analysis of adherence to Ostrom's design principles and the sustainability of CPRs – particularly regarding

studies that examine their relation and interaction to poverty and environmental degradation. Further, a quantitative exploration of whether some of the design principles can be considered more important than others when it comes to commons conservation also remains to be seen. This study seeks to fill this gap in the literature.

4. Methodology

4.1. Research hypotheses

This study aims to explore the relationship between environmental degradation (i.e.. mangrove deforestation), poverty, and how institutions affect the regulation of CPRs, as well as whether poverty interacts with any effects of institutional governance. More specifically, this study will seek to answer the following questions:

1) Does poverty constrain the importance of mangrove conservation?
2) Do particular institutional arrangements (e.g. Ostrom's design principles) affect the extent of fishing commons sustainability?
    a. Are some design principles more effective at encouraging commons sustainability than others?
    b. Is there an interaction effect between poverty and design principle implementation upon the success of commons governance?

Incorporating the institutional and ecological economics approaches, we hypothesise that:

1) The poorest are found in favour of environmental (mangrove forest) protection when taking a relational poverty perspective (unlike the neoclassical theories of the vicious circle hypothesis and EKC predict).

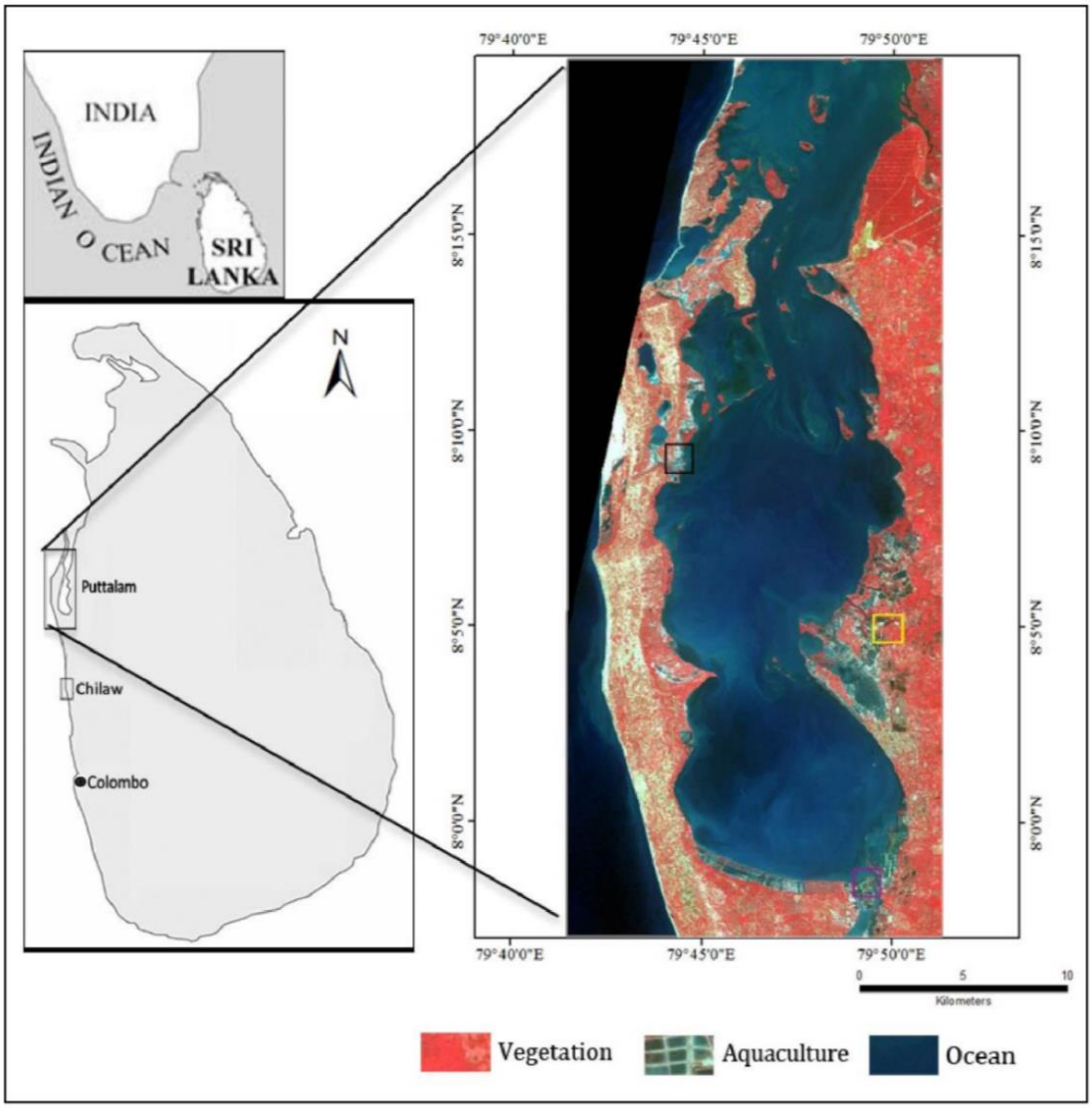
2) With certain institutional practices, such as adherence to Ostrom's design principles, the fishing commons can be more effectively managed to maintain fish stock (rather than, as neoclassical theories predict, requiring private property rights or central regulation to avoid otherwise inevitable degradation and poverty traps).

4.2. Study area

Puttalam is a district located in northwest Sri Lanka (see Figure 1 below). With a population of around 762,400, it represents a diverse melting pot of Sinhalese, Tamil, and Moor ethnicities, as well as the Buddhist, Hindu, Christian, and Muslim religions (Ekanayake, 2016; Galappaththi & Berkes, 2015; GoSL, 2012). The primary economic activities that are present in Puttalam are fishing, agriculture, and aquaculture - community incomes generally include cement and salt manufacturing, fishing, vegetable and fruit farming, and trading (Ekanayake, 2016; Galappaththi & Berkes, 2015).

Puttalam is a relatively isolated rural area whose land comprises primarily of wetlands, mangroves, and lagoons. It is among the driest areas in Sri Lanka and highly relies on rain from the north-eastern monsoon. Nevertheless, it exhibits large expanses of natural vegetation on its coast, along with many prawn and salt farms, but fish stocks have been decreasing since the 2000s (Ekanayake, 2016; Galappaththi & Berkes, 2015; IUCN, 2008).

Figure 1. *Map of Puttalam Lagoon area, Sri Lanka.*



Source: Jil et al. (2015).

Most land in Puttalam was historically owned by the Sri Lankan government (GoSL) and rented out to large companies, predominantly for shrimp aquaculture. However, over time leasing land for such purposes has slowed and has even, in some cases, been completely abandoned due to disputes over land-ownership (Galappaththi & Berkes, 2015).

Despite the decline in large-scale shrimp aquaculture, over a third of mangrove forests around the Puttalam lagoon have been cut down over the last three decades (Jil et al. 2015). While shrimp farm expansion has been the main source of this deforestation, regardless of the diverse environmental and community benefits that mangroves provide, other factors have also contributed to their loss - namely agriculture, housing construction, the ever-increasing tourism industry, coastal erosion, personal household use (such as timber, fuel, and fishing equipment materials), and the 2004 tsunami (Kaleel & Nijamir, 2017).

4.3. Participants and procedure

This study deployed a household survey that was administered amongst local fishing communities in the Puttalam district of Sri Lanka. The fieldwork was undertaken on 17th August 2019 by an experienced team of local researchers from the University of Sri Jayewardenepura who had been fully briefed on the project. Able to fluently converse with survey respondents, they collected data by going from household to household across three villages – Kandakuliya, Kudawa, and Asirigama. To ensure the roads selected broadly represented households of the entire village, the expertise and knowledge of locals were drafted in to help guide them. Kandakuliya was selected because it was a village that was most prominently related to the fishing industry in Puttalam, while Kudawa and Asirigama were selected because they were villages that in addition had experienced considerable growth of their tourism industry. As many participants were surveyed in the given timeframe that resources would allow (1 day).

Data was collected from people in the local community whose primary occupation related to fishing. Participants were required to be over 18 years of age and to have lived/worked in the local area for 5 years or more. Data was collected from 115 participants who met these criteria (56% were male, 44% were female). 52% were the head of their household, and these were near unanimously men (only 1 woman headed their household). The average household size was 4 individuals; the average monthly household income range was Rs. 30,000-39,000 (equivalent to $166-216 USD). Respondents were primarily comprised of individuals from the villages of Kandakuliya (49%) and Kudawa (43%). The remaining identified as being from Asirigama (7%) and Kurinjampitiya (2%). The average age was 41 years old, though this ranged from 20 to 68 years old. For a further demographic breakout of survey participants see Table 2 (below).

Table 2. *Demographic profile of survey participants.*

Village	Gender		Age					
	Male	Female	18-24	25-34	35-44	45-54	55-64	65+
Kandakuliya	32	24	1	10	29	14	2	0
Kudawa	25	24	2	8	24	9	5	1
Asirigama	5	3	0	2	2	2	2	0
Kurinjampitiya	2	0	0	0	1	1	0	0

The majority (77%) had lived their entire life in the local area. While all were selected due to their primary occupation being related to fishing, around 30% also had other sources of employment (predominantly related to tourism, but also agriculture).

The survey itself (see Appendix for full questionnaire) comprised of four parts:

1) *Introduction, informed consent, and screeners*. This introduced respondents to the project, gathered their informed consent, and screened them to check their suitability.

2) *Poverty assessment*. This assessed the relational poverty level of participants, providing a perspective that goes beyond simply income, delving into their ability to live with agency and cover their needs. This section was developed following Ekanayake's (2016) baseline socioeconomic survey in six fishing villages around Puttalam lagoon. The responses regarding 12 different household poverty indicators were quantified into a scoring system, following a similar method to the Participatory Poverty Assessment (PPA) method used in Ravnborg (2003) and Etongo, Djenontin and Kannien (2016). The scores for each indicator were averaged to develop a household poverty index (HPI) score based on relational categories of wealth and wellbeing (see Table 3 for list of indicators and scoring system). Such a participatory method allows a context for putting Sen's (1999) capability approach into practice, providing room for the perspective of the poor. PPA is also a method more nuanced and appropriate to rural and fishing populations beyond ones that are based simply on income alone because of the asset-based and informal nature of their economy (Alkire, 2002; Frediani, 2007).

***Table 3**. Household poverty indicators and scoring system in Puttalam, Sri Lanka.*

Indicator	Score	Description
Access to land	50	Own land
	100	Do not own land
House ownership	50	Own their house
	100	Do not own their house
Food security	0	The household has not experienced a period of food shortage during the last year
	50	The household has experienced a period of food shortage during the last year which lasted less than two months
	100	The household has experienced a period of food shortage during the last year which lasted more than two months
Healthcare	0	Nobody in the household had health problems in the last year
	50	Somebody in the household had health problems in the last year but were able to pay for a doctor with their own money
	100	Somebody in the household had health problems during the last year but were unable to pay for a doctor with their own money
Institutional credit	50	Has obtained credit from an institution during the last five years
	100	Has not obtained credit from an institution during the last five years
Livestock and animal ownership	50	Own livestock or animals
	100	Do not own any livestock or animals
Transportation	0	Owns a car, lorry, three-wheeler, tractor
	50	Owns a motorcycle
	100	Owns a pedal bike and often goes on foot
Household gadgets	0	Owns a TV or computer
	50	Owns a radio
	100	Does not own electrical appliances
Cooking fuel source	0	Uses with LP gas when cooking
	50	Uses kerosene when cooking
	100	Uses fuel wood when cooking
Fishing vessel ownership	0	Owns a motorboat or large rowing boat (Vallam) for fishing
	50	Owns a small rowing boat (Theppam) for fishing
	100	Does not own a boat for fishing
Fishing gear ownership	50	Owns fishing gear
	100	Does not own fishing gear
Non-fishing sources of income	0	Somebody in household is a shopkeeper or involved in the sale of agricultural produce or livestock
	50	Somebody in the household is involved in the sale of materials such as timber
	100	Household does not have source of income outside of fishing

Source: Etongo et al. (2016), Ravnborg (2003), and author's adaptation based on Ekanayake (2016).

3) *Institutional analysis on fishing commons use.* This section assessed the extent that local fishery commons governance is congruent with Ostrom's (1990) design principles for managing CPRs. It is derived from a combination of quantitative survey items devised via a Q-sort methodology by Hoffman (2013), who used them to assess CPR theory of water management, as well as from Sarker, Ikeda, Abe, and Inoue's (2015) qualitative application of Ostrom's design principles for managing coastal fisheries commons in present-day Japan. It allowed for a quantitative view on what design principles are being applied and, through further analysis, could shed light on how these relate to other variables such as poverty and environmental degradation.
4) *Environmental degradation assessment.* The final section of the survey assessed both the perceptions of locals to their environment, as well as their self-reported activity of mangrove reliance. It was based on UNEP's (2011) economic analysis of mangrove forests in Kenya and AMSAT International's (2011) baseline survey on fishery livelihoods in Timor-Leste.

Quantitative analysis was undertaken on the data collected from the survey using R statistical software. The analysis principally involved descriptive statistics, correlations, and a two way ANOVA.

5: Results and discussion

5.1. Poverty and mangrove conservation

A household poverty index (HPI) was created through a participatory poverty assessment (PPA), see Table 3 (above), that took a capability approach to poverty as a relational phenomenon. This was a continuous variable that ranged from a score of 25.0 to 79.2; the median HPI score was 50.0. For usability purposes

requiring adequate sample size, the HPI has separated respondents into groups based on threshold values (see Table 4).

Table 4. *Description of household poverty index and threshold values (n=115).*

	Minimum	Maximum	Median	Average	Threshold values (by terciles)	Threshold values (by median)
Household Poverty Index (HPI)	25.0	79.2	50.0	48.7	Non poor: <42.8 Fairly poor: 43.8 to 54.2 Poorest: >54.2	Less poor: <50 More poor: ≥50

A key reason for developing the HPI was to look at the relationship between poverty and the environment, in this case attitudes towards mangrove conservation**.** Overall, conservation of mangroves was rated as (very or somewhat) important by nearly all respondents, with 75% considered it to be "very important". This was the case regardless of the HPI group of the respondent, see Table 5 (below). The importance of mangrove preservation showed no correlation with either the HPI nor a straightforward income-based assessment.

Table 5. *Importance of mangrove conservation by poverty level.*

	Mangrove conservation importance	
	"Very" or "somewhat"	"A little" or "not at all"
Non poor	95%	5%
Fairly poor	93%	7%
Poorest	93%	7%

This finding suggests that there is no empirical relationship between environmental demand preferences and income, and that the environment is not acting as a luxury good for the poor. This contrasts to conventional explanations of the EKC (e.g. Copeland & Taylor, 2004; Dinda, 2004). It also implies, particularly if one values the perspective of the poor, that the poor are not too poor to be green and thus a more

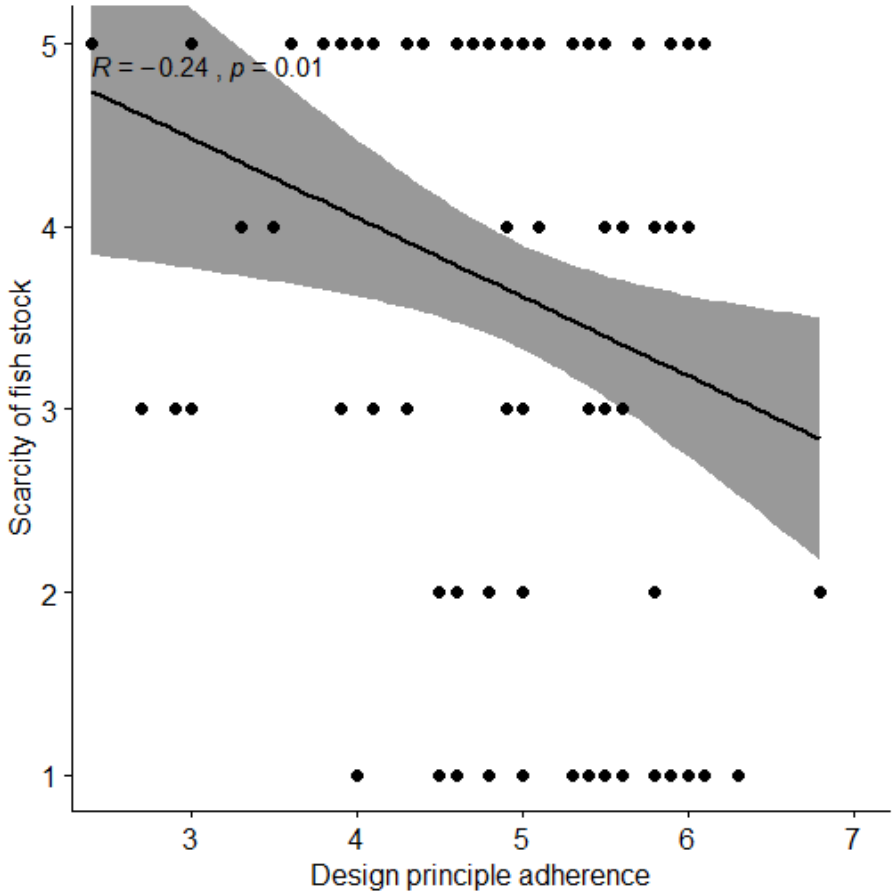
ambiguous approach to growth would be more suitable (van den Bergh, 2001). Growth should not be pursued as a priority for the poor regardless of its impact on their environment, as has previously been argued in mainstream development perspective (e.g. Shafik & Bandyopadhyay, 1992; World Bank, 1992). Instead, the high importance of mangrove conservation across all poverty ranges suggests that the environment should be accounted for considerably when undertaking valuations (Gunawardena & Rowan, 2005; Vatn, 2005).

5.2. Institutions and common pool resource governance

5.2.1. Ostrom's design principles and governance of the fishing commons

Ostrom (1990, 1992, 2008) developed eight design principles argued to be the institutional foundations for sustaining CPRs. This had been developed via a widescale qualitative approach. Here the relation of these design principles in sustaining CPRs was examined quantitatively. Our data finds that increased adherence to Ostrom's design principles is overall indeed related to increased CPR sustenance, in this case fish availability ($r=0.24$, $p=0.01$), see Figure 2 below. Those adhering more to design principles were also correlated with attributing greater importance to the need for controlling overfishing ($r=0.20$, $p=0.03$).

Figure 2. *Scatterplot of design principle adherence and the scarcity of fish stock. The line is of best fit, with the grey shaded area representing 95% confidence intervals.*



This finding suggests that CPRs can effectively be governed and, unlike neoclassical theory, are not an inevitable case for degradation (e.g. Hardin, 1968). Further, Ostrom's (1990, 1992, 2008) design principles can be administered to contribute to this sustenance, illustrated in a quantitative relation, to achieve an outcome of CPR preservation rather than its degradation through overexploitation via purely self-interested actions. This sustenance can be achieved without the need for the privatisation of property rights or even the presence of a central governing authority.

Table 6. *Design principle presence and their correlation coefficients with fish catch availability.*

Design principle	Relative presence (average rating)	Fish catch availability (correlation coefficient, *r*)
Monitoring	4.6	0.31**
Conflict resolution mechanisms	5.3	0.29*
Well-defined boundaries	5.9	0.22*
Congruence with local conditions	4.4	0.16
Graduated Sanctions	5.1	0.05
Nested enterprise	4.1	0.05
Collective choice agreements	5.3	0.03
Self determination	4.7	0.03

** p < .05; ** p < .001*

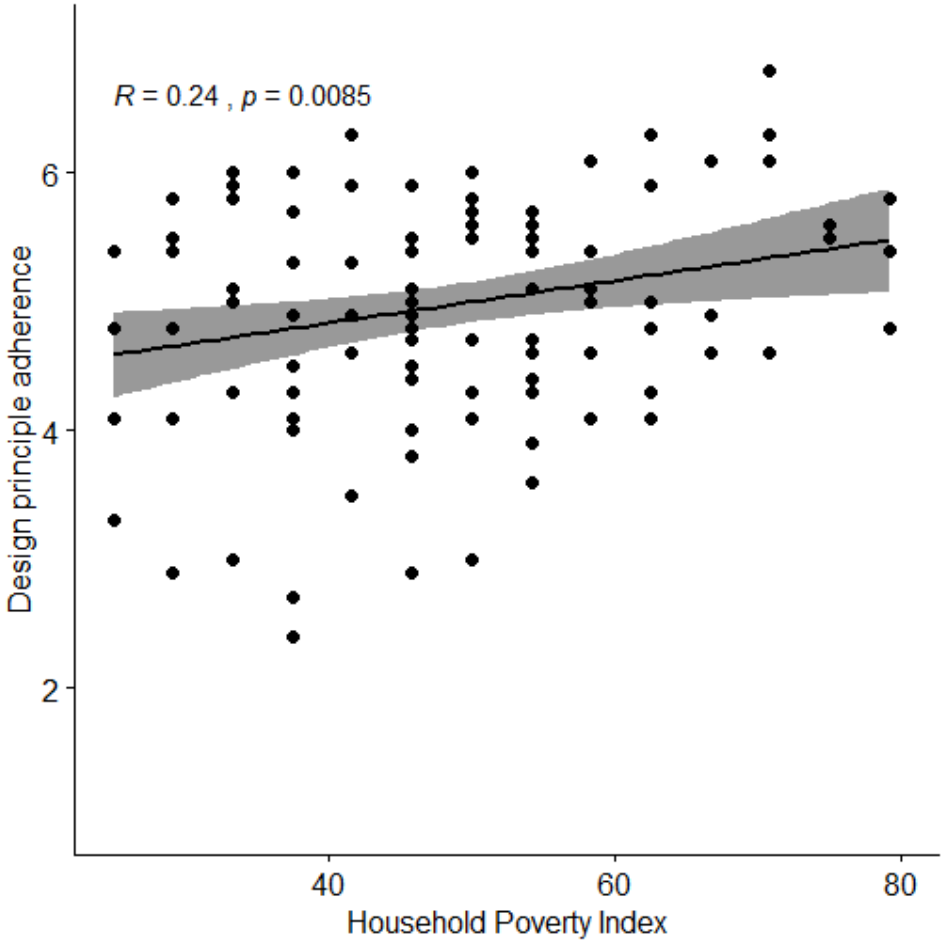
However, previously, Ostrom's (1990, 1992, 2008) design principles - admitting to incredible complexity - had not been examined in their relative contributions to CPR sustenance. This study aimed to shed light on this. Our data sought to give the design principles a quantitative inspection, looking at each of the 8 design principles individually in their relation to the preservation of the fishing commons. Upon closer examination some design principles appear more strongly correlated with CPR abundance than others (see Table 6 above).

Out of these 8 design principles, only 3 were statistically significantly correlated with fish availability. *Monitoring* is the most highly correlated design principle, followed closely by *conflict resolution mechanisms*, and then *well-defined boundaries*. Of these 3 design principles that appeared relevant to CPR sustenance in this context, *monitoring* was actually the design principle that was perceived least present despite being the most important.

5.2.2. Poverty and design principle adherence in commons governance

This data also sheds light on the relationship between Ostrom's design principles and poverty. If use of CPRs were an inevitable tragedy and leading to a poverty trap, then one would expect poverty to be negatively correlated with design principle adherence since, going both ways as the vicious-circle hypothesis purports, poverty would lead to degradation of the commons and thus difficulty maintaining and abiding by institutions, but also increased difficulty in institutional abidance would lead to commons degradation and thus more poverty (Delacote, 2009). However, we find the opposite to be the case (see Figure 3 below): poverty is positively correlated with increased design principle adherence ($r=0.24$, $p=0.01$).

Figure 3. *Scatterplot of the Household Poverty Index (HPI) and design principle adherence. The line is of best fit, with the grey shaded area representing 95% confidence intervals.*

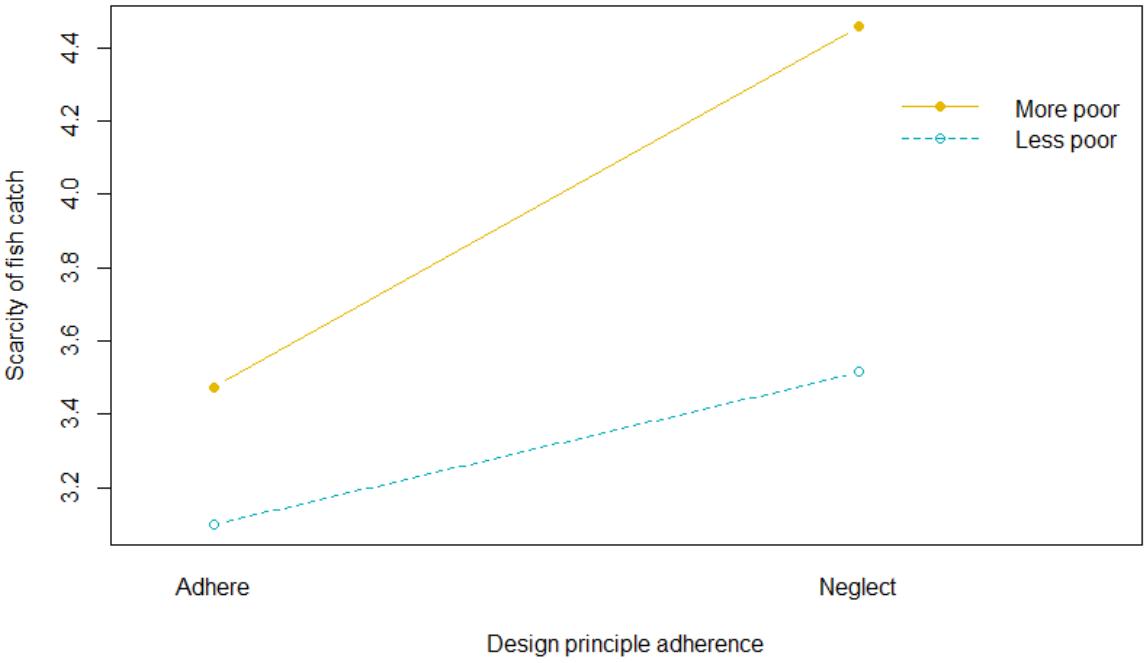


This result provides support for a more complex approach to the poverty-environment nexus rather than a blanket theory of commons degradation leading to a poverty trap. Instead, approaches as purported by Reardon and Vosti (1995) that account for the complexity and specifics of the situation ought to be considered. However, while our data finds a statistically significant and positive correlation between the HPI and adherence to the design principles, because of its reliance on correlational analysis (given both variables were measured via a self-report survey), it is difficult to determine the causality - more specifically, whether it is increased poverty that leads to a need to adhere more to institutions to maintain fish stock

amongst the community, or whether neglect of institutions leads to more self-interested behaviour and thus greater gains that release from poverty.

In an attempt to delve further and determine if there is an interaction effect between poverty and institutional adherence acting upon commons sustenance, a two-way ANOVA was undertaken to examine this. To be able to undertake this reliably with sufficient sample size, the HPI was divided into two groups (“more poor” and “less poor”) at the median, as was the design principle adherence variable (“adhere” and “neglect”). The interaction plot of these variables upon fish scarcity can be seen in Figure 4 below.

Figure 4. Scarcity of fish as a function of design principle adherence (adhere vs neglect) and the household poverty index (more poor vs less poor).



In line with the previous correlations, poverty had a demonstrable effect on fish availability [F(1, 111)=5.06, p = 0.05] as did design principle adherence [F(1, 111)=3.90, p = 0.03]. However, there was no statistically significant interaction effect between poverty and institutions together upon fish stock [F(1, 111)=0.92, p = 0.34]. This indicates that design principle adherence has an effect upon commons preservation that is independent of poverty level.

Further, taking the finding of a positive correlation between poverty and design principle adherence in combination with the positive correlation between design principle adherence and fish stock, it then suggests that, in fact, more poverty leads to greater adherence to institutions to maintain and not overexploit the fishing commons. This, then, adds even more support against the poverty trap theory of

commons degradation, showing that the poor are able to organise to successfully govern CPRs.

5.3. Limitations of this study

There are of course limitations to the generalisability of these results, given they relate to the specific context of fishing commons governance in Puttalam, Sri Lanka. It is uncertain how they would relate to other CPRs and other locations because of the inherent complexity to institutions and the environment (Gowdy & Erickson, 2005), including the particular way design principles are implemented (Ostrom, 1990). However, this study offers a potential framework for quantitatively approaching design principles in different contexts.

Nevertheless, due to time and resource restrictions, the method chosen was principally a survey amongst respondents living in rural fishing communities. The sampling method, while kept as random as possible, followed a purposive sampling method to the extent that those relevant to the fishing sector were selected, and only a few villages in the area were sampled. While it is difficult to suggest then that this is a statistically representative sample of the local Puttalam community, it is still likely that respondents chosen are qualitatively representative of the population.

Moreover, since the survey of this study was centred on self-report, the indicators developed from it regarding environmental degradation and commons institutional governance practice were based on perceptions towards these aspects rather than being actual measures of them. Nevertheless, there is a value in gathering the perspectives of these rural communities, given that their views are likely to be

underrepresented despite them being more affected by environmental degradation (Dayananda, 2004; Jil et al. 2015; Primavera, 2006). Similarly, their perceptions are likely good proxies to the impacts from actual resource/environmental degradation and the governance involved overcoming it. Future research could seek to incorporate environmental data and compare these against local perceptions.

Further, because the survey incorporated a quantitative approach, much simplification was required, especially regarding the design principle descriptions and the subjective selection of HPI criteria. However, this was required given the nature of the methodology and survey items were carefully designed based on previously verified studies to limit bias and subjectivity (see Chapter 4). Nevertheless, with the study data grounded in self-reported survey answers, the analysis was restricted to descriptive statistics, correlations, and mean comparisons. While these can be suggestive, it is difficult to extrapolate implications for causation, and so the influence of third factors cannot be excluded.

6. Conclusion and future directions

This study explored the relationship between institutions and fishing commons governance in rural communities in Puttalam, and how poverty affects these. A quantitative survey was undertaken amongst locals involved in fishing, developing a novel dataset that provided the local perspective on their state of living (HPI), their use of institutional design principles to govern fishing commons, and their attitudes and perceptions of mangrove deforestation.

Our study has found that conserving mangroves is considered critical by all, regardless of poverty status. Additionally, the poor were more likely to adhere to institutions that better preserved the commons. This adds to the empirical evidence conflicting the EKC and its income-based explanations, as well as with the commons as poverty-trap and tragedy-by-default theories. Our findings suggest that Ostrom's design principles contribute to commons preservation, but some principles are more beneficial than others in this context - namely that of *monitoring*, followed by *conflict resolution mechanisms* and *well-defined boundaries*. Institutional adherence is found to be important for commons preservation independent of poverty status.

Future research could build on this study by using quantitative approaches that can deduce causality more directly, such as a randomised control trial (RCT) experiment, and could use an increased sample size to statistically represent the entire local population. In addition, qualitative approaches could be added for an overall mixed-methods approach where findings from both methods could be triangulated for a more nuanced picture. For example, qualitative approaches could help ground the HPI in the specific situation/values of the local community, as well as provide a more detailed understanding of the way design principles are implemented across various fishery commons.

In any case, by embracing complexity through an institutional and ecological economics approach, and by balancing economic growth with the needs of our environment, alleviating poverty and achieving a sustainable level of wellbeing for all (as Sri Lanka's 2030 vision strives to do) - without having to resign ourselves to the all too possible (but by no means inevitable) tragedy of degrading our only planetary

home - can become a feasible goal (GoSL, 2018; Gowdy & Erickson, 2005; Munasinghe, 2019; Raworth, 2017). We have a much greater capacity and motivation to solve social dilemmas than theories of rational choice have traditionally accepted (Ostrom, 2009). Policies and institutions should be redesigned with this in mind.

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Appendix

Survey questionnaire summary:

1. Introduction, informed consent, and screeners
2. Participatory poverty assessment
3. Design principles of fishery commons
4. Environmental degradation assessment

Part 1: Introduction, informed consent, and screeners

INTRODUCTION: We are conducting research into the use of mangrove forests and their relationship with life and fishing in and around the Puttalam Lagoon. This research is being conducted on behalf of SOAS, University of London. We hope that this research will help us understand the state of the environment in relation to the economic activity in the area.

As a long-term resident/worker in this area, we would like to ask you a few questions as part of a survey lasting approximately 15-20 minutes. All your responses will be completely anonymous and used only in combination with other people's answers so you will be in no way identifiable. You are welcome to end the survey at any point or not answer any question in particular.

S1. Would you be happy to take part in this survey?

1. Yes
2. No **[END SURVEY]**

S2. How long have you lived or worked in this area? ## **If less than 5 years, then [END SURVEY]** ##

S3. What is your age? ## **If less than 18, then [END SURVEY]** ##

S4. Village name. ## **WRITE, DO NOT ASK UNLESS UNSURE** ##

S5. Gender. ## **WRITE, DO NOT ASK UNLESS UNSURE** ##

1. Male
2. Female
3. Other

S6. Which best describes the sector of your main occupation(s)? ## **Multiple answers permitted. If NOT "(2) Fishing", then [END SURVEY] ##**

1. Agriculture (farming on land, e.g. crops / livestock)
2. Fishing
3. Aquaculture (farming on water, e.g. shrimp)
4. Tourism
5. Unemployed
6. Other **(Please specify)**

Part 2: Participatory poverty assessment (PPA)

Q1. Including yourself, how many people live in your household?

Q2. Including yourself, how many earners live in your household?

Q3. Who is the head of your household?

Q4. Do you own your house?
1. Yes
2. No

Q5. Do you own the land that your house is built on?
1. Yes
2. No

Q6A. What materials is your house mostly made from?
1. Wood
2. Brick
3. Concrete
4. Mud and thatch
5. Other **(Please specify)**

Q6B. How many bedrooms does your house have?

Q7. Does your house have toilet facilities?
1. Yes
2. No

Q8. Where do you get your drinking water from?
1. Tap
2. Shallow well
3. Deep well
4. Purchase containers

Q9. Where do you get your washing water from?
1. Tap
2. Shallow well
3. Deep well
4. Purchase containers

Q10. Which source of lighting do you use?
1. Kerosene
2. Electric

Q11. What do you use for cooking?
1. Fuel wood
2. Kerosene
3. LP gas

Q12. Has your household experienced a period of food shortage in the last year?
1. Yes – For longer than 2 months
2. Yes – For less than 2 months
3. No

Q13. Has someone in your household experienced health problems in the last year?

1. Yes
2. No

Q14. ## **IF Q13=1** ## Are you able to pay for a doctor with your own money?

Q15. Have you obtained any credit (borrowed any money as loans) in the last 5 years?

Q16. Which, and how many **(## write number ##)**, of the following livestock animals do you own?

1. Cattle
2. Chicken
3. Goats
4. Pigs
5. Other **(Please specify)**
6. No livestock

Q17. Which, and how many **(## write number ##)**, of the following vehicles do you own?

1. Pedal bicycle
2. Lorry/truck
3. Motorcycle
4. Three-wheeler
5. Tractor
6. Car
7. Other **(Please specify)**
8. No vehicle

Q18. Which of the following telecommunications facilities do you own?

1. Land phone
2. Mobile phone
3. No telephone

Q19. Which of the electronic devices do you own?

1. Radio
2. TV
3. Computer
4. None of these

Q20. How many years of school have you attended? **(## 0-13 ##)**

Q21. Approximately which of the following is closest to your household income (**Rs.**) last month?

1. Below 10,000
2. 10-19,000
3. 20-29,000
4. 30-39,000
5. 40-49,000
6. Over 50,000

Q22. Please imagine a ladder, with steps numbered from 0 at the bottom to 10 at the top. The top of the ladder represents the best possible life for you and the bottom of the ladder represents the worst possible life for you. On which step of the ladder would you say you personally feel you stand at this time? **(## 0-10 ##)**

Q23. Which, and how many **(## write number ##)**, of the following fishing vessels do you own?

1. Motor boat
2. Theppam
3. Vallam
4. Other **(Please specify)**
5. No ownership of boats

Q24. Which, and how many **(## write number ##)**, of the following fishing gear do you own?

1. Crab catching gear
2. Thallu nets
3. Sangili nets
4. Fishing hooks
5. Gill nets
6. Prawn catching gear
7. Other **(Please specify)**
8. No ownership of fishing equipment

Q25. Does your household have any sources of income outside of fishing?

1. Household store
2. Sale of agricultural grown produce
3. Sale of livestock
4. Sale of materials, e.g. wood
5. Other **(Please specify)**
6. No other source of income

Part 3: Design principles of fishery commons

[Metric A (Q26-Q33)]: How much do you agree, on a scale of 1 to 7, with the following statements? 1 being "Not at all" to 7 being "Agree completely" (or "Don't know" if required).

Q26. ## **WELL DEFINED RULES** ## There are well defined boundaries and rules on *who* can fish, *where*, and using *what* equipment.

Q27. ## **CONGRUENCE WITH LOCAL CONDITIONS** ## These boundaries prevent overfishing and are suitable to the situation of our local fishing community. While they do involve some costs, these are ultimately outweighed by the benefits I receive.

Q28. ## **COLLECTIVE CHOICE ARRANGEMENTS** ## I have the opportunity to participate in discussions on how fishing should be managed and am able to influence the rules that are put in.

Q29. ## **MONITORING** ## Overall there are adequate systems in place to monitor fishing to make sure it is undertaken in line with the rules.

Q30. ## **SANCTIONS** ## Penalties are enforced for failing to abide by the fishing regulations.

Q31. ## **CONFLICT RESOLUTION** ## If conflicts arise between different fishing groups these can easily be resolved.

Q32. ## **SELF-DETERMINATION** ## Fishing rules are organised and governed largely by local fishers, and generally supported by the district and government without much interference.

Q33. ## **NESTED ENTERPRISE** ## National laws on the whole help us manage fisheries.

Part 4: Environmental degradation assessment

Q34. Do you think there is more or less fish available to catch than five years ago?

1. A lot more
2. Somewhat more
3. About the same
4. Somewhat less
5. A lot less
6. Don’t know

Q35. To what extent do you agree or disagree that the amount of fishing needs to be controlled to prevent overfishing?

1. Strongly agree
2. Somewhat agree
3. Neither agree nor disagree
4. Somewhat disagree
5. Strongly disagree
6. Don’t know

Q36. What resources do you utilise from the sea?

1. Fish
2. Shrimp/prawn
3. Crab
4. Squid
5. Seaweed
6. Oyster/clam
7. Other **(Please specify)**

Q37. To what extent would you say you use mangrove trees for the following purposes? Please answer either “1. A lot”, “2. A little”, or “3. Not at all” for each of the following options.

1. As fuel wood/charcoal
2. As building materials for construction, housing, furniture, etc.
3. To make space for agricultural farming
4. Other (Please specify)

Q38. How important do you think it is to preserve the mangrove trees?

1. Very important
2. Somewhat important
3. A little important
4. Not at all important
5. Don’t know

Q39. On the whole, what impact do you think aquaculture (shrimp farming) has had on your fishing activity? Please also specify the impacts.

1. Very positive
2. Somewhat positive
3. Neither positive nor negative
4. Somewhat negative
5. Very negative
6. Don’t know

Q40. On the whole, what impact do you think tourism has had on the local area? Please also specify the impacts.

1. Very positive
2. Somewhat positive
3. Neither positive nor negative
4. Somewhat negative
5. Very negative
6. Don’t know

END SURVEY: Thank you for taking part in our survey!