# MULTI-LEVEL FISHERIES GOVERNANCE AND ITS IMPACT ON FISHERS' ADAPTATION STRATEGIES IN TAMIL NADU, INDIA

By

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# A THESIS

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# ABSTRACT

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Fishers, like other resource users, follow a range of adaptation strategies in response to environmental or economic stresses. This paper examines variation in fishers' adaptation strategies in the presence of local and regional institutions. In the context of marine socioecological systems in Tamil Nadu, India, I examine the effects of village and district level variation in governance structure on a common group of users (fishermen). I find that, in the absence of local or regional constraints, fishers adapt to changing conditions by changing effort. In situations of legal pluralism, where regional and local level fisheries management rules conflict, fishers defer to local level institutions first at the expense of state management regulations, as anticipated by previous studies. However, local institutions may avoid placing behavioral constraints on fishing, leading again to adaptation through the increase of effort instead of the promotion of rule-following behavior. Conversely, where local level institutions have weak claims over users' collective action (e.g., in the case of a heterogeneous village), district level regulations are successfully enforced, constraining fishers' adaptation responses. In this latter case, fishers resort to gear selectivity in the presence of district level regulations which place temporal restrictions on effort. This suggests that while village level heterogeneity may be detrimental to the establishment of successful local institutions governing commons management, it may actually enable the successful implementation of district level, resource management regulations.

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#### **1. INTRODUCTION**

Socio-ecological systems, or SESs, as the name suggests are comprised of both social and ecological variables (Ostrom, 2009) which are highly interconnected (Perry et.al. 2011). These systems are impacted by stresses derived from environmental and economic changes, in particular those associated with changing market conditions (which can result from globalization). Leichenko and O'Brien (2008) describe these dual stresses as 'double exposure'. This double exposure has ultimately led to negative outcomes for various components of marine systems like fish stock collapse and changes to social structures (Ommer & Team, 2007). Fisheries managers hope to keep the system in balance through the implementation of regulations, but fishermen still adapt in different ways to capacity and market changes. The goal of this research is to understand what types of rules and regulations are most effective in a context of changing market conditions and decline in fisheries ecosystem health.

We examine this question by looking at fishers' adaptation strategies with the aim of understanding what conditions constrain their adaptive capacity. We are particularly interested in understanding how adaptation strategies change in the presence of overlapping governance systems and how community characteristics may influence fishers' adaptive mechanisms.

The local level, marine socio-ecological systems in Tamil Nadu, India have been impacted by both stresses derived from environmental and economic change. Environmental stresses were stimulated by the 2004 Indian Ocean tsunami and the resultant aid response. Aid was commonly funneled into fishing villages along the Tamil Nadu coast both directly from NGOs and through the central and state governments. Tamil Nadu alone received over \$566 million USD from the Indian government in the immediate aftermath (Kruks-Wisner, 2011; Singh, 2005). Grants were provided by the government to purchase new gear and to repair boats

that were damaged (Mathew, 2005). This overwhelming response has had lasting effects through the addition of excess capacity to the fishery in Tamil Nadu, defined simply as 'too many fishers chasing too few fish' (Pomeroy et al., 2006; Silvestre et. al, 2003).

Economic stresses are exhibited by both domestic and international market changes in demand for certain seafood products as well as government subsidies focused on the marine product export industry. The government of Tamil Nadu has developed its fishery with an eye on the international market and increasing levels of globalization. The provision of various subsidies (as outlined later in the paper), can give fishermen a different type of adaptive capacity to respond to market changes. Access to information technology has also increased with globalization. With increased access, stresses on the system are able to diffuse more quickly across both markets and society, and due to the interlinked nature of socio-ecological systems, this rapid diffusion also impacts the coupled ecosystem components (Held, 2000; Young et. al., 2006) as exhibited through the schematic below where stresses ultimately affect fish catch (a measure of ecosystem health). Figure 1: Tamil Nadu marine socio-ecological system For interpretation of the references to color in this and all other figures, the reader is referred to the electronic version of this thesis



The above stresses impact local SESs (Ostrom, 2009; Perry, et.al, 2011) and to understand how, there are several key components that we must explore according to Ostrom (2009). All SESs are comprised of a resource system (in our case a coastal fishery), resource units (fish stocks), users (fishermen), and governance systems (rules that affect the adaptation strategies of fishermen). To begin to understand how this system works, it is important to explore the individual variables and how they are related (Ostrom, 2009). We therefore choose to focus on user adaptation decisions based on variation in governance systems. In all cases, fishermen are faced with similar stresses, but they adapt different strategies to cope. This variation is precisely what we aim to explain.

### 1.1 Current Literature

#### 1.1a Adaptation constraints: Dependent variable

Although research is limited, scholars have proposed a number of ways that resource users will adapt in the face of changing environmental conditions. Bavinck (1998) outlines that in fisheries, people tend to adapt by targeting specific species either because of their market price or because of species availability. Bavinck notes that changing environmental conditions, as seen through fishery ecosystem health is one of the key driving factors behind these adaptation decisions.

Coulthard (2008), in her study surrounding adaptation strategies to climate change within a South Indian lagoon fishery finds that those fishermen willing to diversify their fishing practices are better equipped to adapt to changing environmental conditions. She finds that traditional, caste fishermen are less willing to give up their ancestral methods of harvest and in fact it is the non-traditional, Dalit fishermen who are willing to diversify their harvest techniques based on changing species abundance and availability. She therefore concludes that tradition is a key factor in guiding and potentially constraining adaptation strategies.

Often intertwined with tradition, livelihood resilience has also been identified by scholars as a key factor in determining adaptive capacity (Moench and Dixit, 2004; Moench, 2005). Livelihood resilience is broadly defined as a resource user's willingness and ability to earn sufficient income for themselves outside of their "experienced coping range" (Coulthard, 2008). Adger et. al. (2003) in their study on adaptation strategies to climate change in developing countries outline that reducing dependence on resource systems or certain aspects of a resource system have been important adaptation strategies utilized to deal with changing environmental conditions. This adaptation strategy is of course mitigated by one's level of livelihood resilience

as in some cases resource users will not be able or willing to decrease or modify their dependence on a resource.

Fishermen (of mechanized and even motorized boats to some extent) have been known to use the above strategy to adapt to declining stock availability in a particular fishing ground. If fishermen have the ability to decrease their dependence on one fishing ground by diversifying the grounds they fish on, they will use this strategy to cope with poor conditions (Bavinck, 2001).

## 1.1b Rules

Scholars have suggested that mechanized boat fishermen exert a considerable amount of effort in devising adaptation strategies to circumvent regulations (Bavinck, 2001). We therefore turn to the literature on rule creation and enforcement. Extensive research has been conducted on community characteristics which enable the successful creation and implementation of local institutions (rules) to manage common pool resources such as fisheries (Ostrom, 1990, 2007; Agrawal, 2001). However, limited research has been carried out which looks at why certain resource users are less likely than others to follow rules (Madrigal-Ballestero et. al. 2012).

Some scholars have found a positive correlation between people's willingness to follow rules and the level of economic dependency they have on the resource (Madrigal-Ballestero et. al. 2012). Others have found that the content of the regulation (rule legitimacy) is particularly important. In a study of rule compliance within fisheries in Denmark, Nielson and Mathiesen (2003) outline that if regulations are imposed that are incompatible with traditional fishing practices or reasoning, fishermen will not follow them. Agrawal (2001) goes onto address that in situations where central authority (outside authority) attempts to regulate resource use, it can effectively cut the relationship of responsibility felt at the local level to the maintenance of the

resource, thereby affecting rule compliance. The imposition of outside rules is expected to have a negative relationship with the ability of those rules to impact fisher's adaptation strategies because it threatens their relationship of responsibility with the resource and outsider rule content may be seen as illegitimate. This point brings us to the role of relational pluralism and its impact on rule creation and enforcement.

#### 1.1c Heterogeneity and relational pluralism

We see through the literature on commons management that ease and effectiveness of enforcement are key contributing factors to the successful development and application of rules (Baland & Platteau, 1996; Ostrom, 1990). Bavinck (2001) outlines that village level organizations are the loci of rule-making and enforcement. These organizations can have different levels of efficacy though, dependent on the level of heterogeneity of the people which compose them, as outlined below.

In India, Cohn (1987) outlines that most individuals have a set of dual social relations: one which aligns them with a village community and another that aligns them with their caste or sub-caste. For each of these dual relationships there also exists a set of legal norms and a set of people that have the authority to enforce said norms. In multi-caste villages sometimes these dual relationships conflict and the community as a whole can "suffer from a lack of community identity and an inability to take collective action" (Bavinck, 2001, p. 51). In this case, the institutions formed within the village may only be able to exert minimal social pressure towards rule compliance (Bavinck, 2001). This village level heterogeneity will thereby negatively impact the ability of rules to effectively constrain adaptation behavior. These scholars therefore would expect adaptation strategies to be unconstrained in heterogeneous villages.

Alternatively, in villages where these dual relationships are intertwined given the homogeneity of religion and caste, Cohn states that caste norms and village norms operate within the same social boundaries. In these cases, Bavinck (2001) outlines that village authorities have the potential to form robust common interest strategies for collective action. Therefore, homogeneity is alternatively expected to lead to resource use situations where users' adaptation strategies are limited by village institutions. This is largely explained by Coulthard (2008) who outlines that an individual's adaptation decisions "are made within a wider social and cultural context of norms, values and rules, often determined by antecedent collective action" (p. 479). Following this logic then, it is expected that in homogenous villages, resource users will first defer and consult village norms and then adapt (in line with those) in their best interest.

# 1.1d Legal pluralism

What if there are discrepancies between village and district (or external) level laws with each staking a claim to fisheries management? This situation can lead to difficulties in rule enforcement. In Bavinck's (1998) study on legal pluralism within the fisheries sector in Tamil Nadu, he outlines that 'state law ends where fishermen law begins'. He finds that state level fisheries management bodies don't feel the need to intervene in situations where fishermen law is effective. Sometimes though, fishermen's law has different priorities than state level laws. Within the broader purview of village/state actors, this phenomenon is called legal pluralism and occurs when there are multiple rules present at various levels applicable to the same resource system. Bavinck (1998) outlines that "fishermen law generally has a greater legitimacy among fishermen; official law, however, which is backed by the power of the state, dominates the formal landscape" (p. 151).

In this study we have the opportunity to examine this key characteristic (legal pluralism) due to the complex governance hierarchy in India: where village organizations and their institutions are key players in local resource governance and district and state level (where in some case, fisheries management regulations have been enacted) must compete with those at the village level. Drawing from the literature on adaptation, legal pluralism, rule legitimacy and common-pool resource management, I constructed following hypothesis matrix:

District regulations present?		
Fishermen will follow village level rules		
Fishermen will	Fishermen will defer to village norms first then	
follow district	adapt their effort to market	
	District re Yes Fishermen will follow district regulations	

Figure 2: Hypothesis matrix

Young et. al. (2006) calls for research which takes into account institutional and demographic influences on socio-ecological systems. In order to examine the literature-derived hypotheses above we focus on marine socio-ecological systems in Tamil Nadu, India which are ideal cases to study given the variation in rules and social structure characteristic of each village studied. While focusing on common resource users, systems and units, we are able to concentrate on the effects of variation in governance systems on the adaptation strategies of fishermen.

# 2. THE FISHERIES IN TAMIL NADU: INCREASED CAPACITY AND CHANGING CATCH

# 2.1 Case selection

Tamil Nadu was chosen as our initial study site due to the variation in district level fisheries governance and state level management regulations. This state has a rich tradition of village governance organizations (*panchayats*) which in some cases stake claim to resource management within their territory. *Panchayats* are village councils largely comprised of elected male members of the dominant caste within the village. These groups are highly active in everyday village life and have traditionally taken responsibility for managing the village commons and for dispute settlement (Kruks-Wisner, 2010).

Amongst villages, there is variation in community structure at the local level in terms of both caste and religion. This provides an opportunity to study the impacts of village level heterogeneity vs. homogeneity on the constraints posed on adaptation strategies. Again, in all cases I look at a particular user group (fishermen) working within a comparable resource system. I then ask how these variables effect their adaptation decisions.

Tamil Nadu accounts for roughly 15% of India's total marine fish catch (Bavinck et. al. 2008) with Chennai harbor contributing the most tonnage of fish landed and exported from the East coast of India (Salagrama, 2004). Its coastline measures roughly 1076 kilometers and has the largest continental shelf of the Eastern Indian coastal states (Salagrama, 2004), which has contributed to the success of the Tamil Nadu prawn (*Penaeus spp.*) fishery. The initial bulk of the exports was and continues to be prawns, but fishermen and exporters have since branched out to numerous other species as international demand is identified and continues to grow (Bavinck, 2001).

Tamil Nadu's fishery was heavily impacted by the Blue Revolution and pink gold rush (referring to the boom in the prawn fishery from 1965-1980 [Bavinck, 2001]), with large portions of the fishing fleet making the transition from man-powered or motorized boats to larger boats with mechanized gear (Kurien, 1985). The Blue Revolution in India was meant to be the marine equivalent of the Green Revolution in agriculture which vastly changed India's farming system in the 1960s. The central government of India promoted the industrialization and mechanization of fishing throughout the country and each state adopted different practices towards common goals. These goals included increasing overall catch, an increase in contribution from fishing to India's GDP as well as enhancing food security. The Tamil Nadu state government began incorporating fisheries targets into its five year plans in 1956 by launching a marine fisheries development program (Bavinck, 2001). These five year plans are economic development goals which set targets and priorities for each sector of the economy.

Bottom-trawling, a common method used for prawn harvest was advocated for widespread adoption during the Blue Revolution. This has been one of the key contributing factors to the current depressed state of the fishery in Tamil Nadu. Trawling is the most destructive form of fishing currently in use (Watson, 2006). In addition to destroying the trawled environment, shrimp trawlers also tend to discard up to 90% of the catch brought on deck (Venkataraman & Melkani, 2007). The provision of these types of boats was common as part of aid packages after the 2004 tsunami, with many NGOs adopting villages and indiscriminately distributing mechanized boats (Mathew, 2005; Beaumont, 2009).

The heavy promotion of trawling is currently observed in the composition of the fishing fleet. A full 61% of the mechanized fleet in Tamil Nadu depends on trawling as their primary harvest method, mainly for prawns. Due to the destructive nature of this harvest technique and

excess fishing capacity, catch has been steadily declining. As a result, a significant portion (roughly 39%) of the mechanized fleet has transitioned to other gear types such as hook and line or gill nets (Bavinck et. al. 2008).

Bavinck (2001) outlines that one consequence of the government of Tamil Nadu's fisheries development efforts was the establishment of a dual fishing economy. Tamil Nadu's robust artisanal, traditional fishing culture continued to fish in much the same way as they had historically. Alongside them was built a new, commercially oriented fleet that fished with foreign trawlers and other mechanized boats. This dichotomy in resource use and the resultant financial benefits built a new class of fishermen that was looked upon by policy makers as the success of their efforts. They were also considered to be the growing middle class of fishermen, a profession which was previously defined by its economic backwardness.

Many of these rising middle-class fishermen focused their efforts on prawns, given the lucrative price received on the export market. Before the Blue Revolution, fishermen mainly sold to the domestic market, with an exception being dried fish sold to Sri Lanka. The Blue Revolution and the embedded emphasis on export oriented development uncovered immense opportunities in terms of international demand, of which prawn was one of the most sought after commodities. In response to this demand, the Indian government founded the Marine Product Export Development Authority (MPEDA) in 1972 to promote the development of the fisheries export sector (Bavinck, 2001).

Tamil Nadu is the most productive region in India for prawn production. The state has focused its development initiatives through the provision of subsidies for boat refurbishment and trawl gear (Bavinck, 2001; Subramanian, 2009) to exploit this valuable marine resource, which is now significantly depleted. Interestingly, although fish landings have increased, the catch per

unit operation and per capita production of labor has been declining, in both the mechanized and non-mechanized sectors (Sathiadas et.al, 2007). This decline in production implies that the coastal resources of Tamil Nadu are becoming heavily depleted. Therefore, understanding the impact of various stresses, including market and environmental changes on this highly diverse fishery can be pivotal in understanding ecosystem implications and projecting impacts on other highly diverse social-ecological systems.

# 2.2 Fisheries management in Tamil Nadu: Current structure

There is a high degree of legal pluralism within fisheries management institutions along the Tamil Nadu coast. At the local level this range includes non-state actors such as the well developed and important village level institutions which claim exclusive authority over their adjacent waters (Bavinck, 2001). These non-state actors, depending on the village are either the village or caste *panchayat* or the Boat Owners Association (BOA) within that village, the latter of which is a dues-paying membership body of mechanized boat owners.

State actors operate within the purview of the Tamil Nadu State Fisheries Department and also act through district level offices. Bavinck (1998) outlines that the fishery officers within districts generally have a high degree of respect for the authority of non-state, village level fishermen councils and see state power as finite: ending where fishermen's law begins.

There is an annual 45-day closed season from 15April – 29May, locally known as the "monsoon ban" on mechanized boat fishing in effect in Tamil Nadu. This time zoning effort by the government began in 2001 in Tamil Nadu and is also observed, at a different time of the year in Kerala in congruence with their monsoon. It is meant to allow for the rejuvenation of fish stocks (Bavinck et.al, 2008). This regulation is generally followed by the majority of mechanized boat owners in Tamil Nadu (Sathyapalan et.al, 2008).

# 2.3 Current conditions and adaptation responses

There are currently over 10,500 mechanized boats operating within the coastal waters of Tamil Nadu (CMFRI, 2010). The indiscriminate distribution of boats, post-tsunami, has contributed to overcapacity and overfishing in the coastal waters of Tamil Nadu. Over the decade prior to the tsunami, fish production in Tamil Nadu was already drastically declining (Mathew, 2005) and post-tsunami research and recommendations explicitly advised against recreating the problem of over capacity which existed pre-tsunami. Not only did the allocation of new and better boats reinstitute overcapacity but it also gave rise to an unsustainable, highly capitalized and fossil fuel dependent artisanal fishing base (Kurien et.al, 2005). The provision of various subsidies targeting fisheries development has helped maintain excess fishing capacity, to which declining ecosystem health is attributed (Salagrama, 2004; Sumaila & Pauly, 2006).

Increased capacity has led to an increase in resource use conflicts between artisanal and mechanized boat fishermen. In response to increasing levels of resource use conflicts between artisanal fishermen operating non-mechanized boats and the commercialized mechanized fleets targeting the same species within the same fishing grounds, fishermen in certain districts have negotiated a 3:4 day share regulation. This regulation states that mechanized trawlers are permitted to fish three out of the seven days of the week, whereas the other four days are reserved solely for artisanal, non-mechanized craft (Sathyapalan et.al, 2008).

Numerous fishermen along the Tamil Nadu coast have reported a significant decline in the quantity of many traditionally caught species (Sathyapalan et.al. 2008). In general, many of the fishermen interviewed blame this decline on the increased number of mechanized boats fishing in the coastal waters and particularly noted the influx post-tsunami. Fishermen have also reported changes in species availability. This is supported by a recent study done by Sathyapalan

et. al. (2008) showing shifts in species composition within the Palk Bay fishery. Fishermen related that certain species of *iral* (prawn), *ullam* (Hilsa shad; *Tenualosa ilisha*), and *kola* (flying fish; *Hirundichthys spp.*) are becoming rare (among others) while the prevalence of local varieties of *parai* (trevally; Carangidae), *sura* (shark; *Rhizoprionodon spp.*), and *naththili* (anchovy; Engraulidae) are increasing. Many attributed this change in species availability to over fishing and the environmental effects of the tsunami.

Fishermen have adapted different strategies given the above changes. One of these adaptation strategies is to fish outside of Tamil Nadu's territorial waters. Although district level regulations prohibit fishing outside their general jurisdiction, many fishermen, particularly in the Palk Bay region cross into Sri Lankan waters to fish (Bavinck et.al., 2008; Sathyapalan et.al., 2008). This particular adaptation strategy has led to increased conflict between Indian fishermen and the Sri Lankan Navy, resulting in injury, gear confiscation, disappearance and even death (Vivekanandan, 2005). Fishermen in all three districts also widely report crossing into the waters of Andhra Pradesh.

Due to the overexploitation of near shore fishing grounds (Bavinck, 2001), more fishermen are making near shore vs. deep sea fishing decisions. Fishermen in Nagapattinam reported that *maththi* (local variant of sardine) used to come very close to shore and now due to heavy fishing pressure, the fishermen must go farther and farther out to catch them. Additionally, other species normally caught closer to shore are also on the decline, forcing fishermen to fish farther out and deeper, which comes with an associated increase in risk and cost.

2.4 Sample characteristics

Three villages in three separate districts in Tamil Nadu were selected for this study (pinpointed in *Figure 3* below): one in which fishermen perceive no constraints to their adaptive capacity, one in which district level regulations effectively constrain adaptive capacity, and another where local level rules are the primary driving factor behind fishermen's adaptation decisions. Village names are not utilized due to the sensitive nature of certain pieces of information participants provided regarding illegal adaptation strategies.



*Table 1* denotes the sampling distribution between the three villages studied. There were no non-mechanized boat fishermen interviewed in Village R or Village C because the villages were almost completely composed of mechanized boat owners and fishermen.

District	Village	Mechanized fishermen	Non-mech. fishermen (motorized)	Total fishermen
Ramanathpuram	Village R	14	0	14
Nagapattinam	Village N	4	13	17
Cuddalore	Village C	6	0	6
Total		24	13	37

Table 1: Sampling distribution

There is variation in community structure and demographics within the three villages

studied, which is representative of general district-wise trends as seen in Figure 4 below.



Figure 4: Religion & community

Village R in Ramanathapuram is made up of a mix of castes and religions. In general, religion was reported to dictate gear specialty. Because of the high degree of heterogeneity among resource users in Village R, the primary local fisheries institutions were the BOAs, of which there were 7 with one overarching BOA authority. These BOAs were heavily divided on caste and gear lines. As a result of this fragmentation, there was a lack of village level rules in Village R that pertained to all fishermen. Another feature worth noting is that Ramanathapuram

district in general, due to its proximity to Sri Lanka has been at the nexus of the India-Sri Lanka fisheries conflict. This has led to a significant police presence in the coastal mechanized landing areas and the area itself has gained significant national attention due to the frequency of conflicts reported.

The other two villages studied, Villages N & C were much more homogenous in terms of caste and religion. All members of each village were from traditional Hindu fishing castes. In Village N there was some degree of heterogeneity in terms of gear used but that was reflected in the representatives chosen for the village *panchayat*, the primary local fisheries institution. Within the *panchayat*, the trawlers, gill netters and fiberglass boats owners were represented proportionally to the frequency with which they occurred in the village. In Village C, all residents were from the same traditional Hindu fishing caste and all utilized trawl gear. *Table 2* outlines the village level demographic differences.

District/Village	Caste	Religion	Primary	Primary local
			gear	fisheries inst.
Ramanathapuram	Mixed	Mixed	Mixed	BOA
Cuddalore	Traditional	Hindu	Trawl	BOA
	fishing caste			
Nagapattinam	Traditional	Hindu	Mixed	Panchayat
	fishing caste			

Table 2: Village-wise variables

In Village R (Ramanathapuram district) there are a few district level fisheries management regulations that are not present in the other two villages studied. In Ramanathapuram, non-mechanized and mechanized fishermen negotiated a 3:4 day share regulation such that trawlers are permitted to fish a designated three days out of a week where non-mechanized boats are permitted to fish the other four days. Additionally, trawlers are limited to trawling a maximum of three hours at a time before they must pull up their nets and they are limited to a maximum trip duration of 24 hours (Sathyapalan et. al., 2008). These regulations were largely followed within the fishing community studied in Village R, which allows an opportunity to compare how fishermen in other districts, without the presence of these types of temporal regulations adapt to external shocks.

In addition to these temporal restrictions (which applied to Ramanathapuram only), there is also a spatial restriction that pertains to mechanized boats in all three villages studied (a Tamil Nadu state fisheries regulation). This regulation states that the area within three nautical miles of the coast is reserved for the operation of country craft, such as *kattumarams*. Mechanized boats are not permitted to trawl within this three nautical mile zone (Sathyapalan et. al., 2008). While this regulation was mentioned in interviews in Village R, it was not in Villages N and C though it pertains to the entire coast.

In Village N (Nagapattinam district), central management regulations have been attempted through the district fisheries department. These regulations are in the form of gear restrictions, such as bans on trawl nets and juvenile fish catch as well as minimum net mesh size but have been largely unsuccessful. In Village C (Cuddalore district), the district fisheries department focuses largely on welfare schemes and no fisheries management regulations were identified.

# 3. METHODS

# 3.1 Qualitative methods

Semi-structured interviews at landing sites in three villages in three separate districts were carried out between June and late August 2012 (please reference Appendix A for interview instrument). As Tamil is not my native language, I anticipated the need for a research assistant and/or native speaker to assist in carrying out the data collections. A local translator was identified with the help of our local partners, and the translator delivered the questions to the fishermen and translated their answers into English.

When it was apparent that the English speaking skills of each translator varied, I attempted to mitigate this by translating the interview questions into Tamil with the help of a native Tamil speaker and teacher. Furthermore, when difficulty was expressed by the translator in translating fishermen's answers into English, the translator wrote the fishermen's answers in Tamil and it was later translated with the help of a Tamil fisheries professional in Tamil Nadu and in some cases a native Tamil speaker and teacher in the US after data collection was complete.

During the data analysis stage, each sample (fisherman interview) was examined, emergent themes and concepts were identified and a list of concepts was compiled based on a corpus-based coding system, which allowed for the detection of patterns amongst samples (please reference Appendix B for coding table).

Participant observation was carried out at both beach landing sites within the villages in Ramanathapuram and Nagapattinam and established docking sites for trawlers in Cuddalore and Nagapattinam. Special note was taken as to the roles of people working at the site, the landing process including how the fish were sold (e.g.: auction, transfer to middleman, etc.), quantity and species landed.

# 3.2 Unit of analysis

In qualitative data collection, it is important to specify a unit of analysis because "each unit of analysis implies a different kind of data collection, a different focus for the analysis of data, and a different level at which statements about findings and conclusions" can be made (Patton, 2002, p. 228). Therefore, although participants in this study were fishermen, and my sample size is the total number of fishermen interviewed, my unit of analysis is the village since all proposed explanations for variation in adaptation strategies are at the village level. This is further justified because it is actually the authorities at the village level that enforce the rules (or choose not to)(Bavinck, 2001). This is the appropriate unit of analysis because it is the variation in adaptation strategies between villages that I aim to explain.

# 3.3 Sampling techniques

Purposeful sampling, a method aimed at selecting information-rich cases for study was chosen as it promotes in-depth understanding of a particular research question. This allowed for in-depth inquiry focused at understanding under what conditions fishermen are able to adapt and which rules are most effective in curbing effects on fish catch. While this in-depth understanding comes at the expense of empirical generalizations (Patton, 2002); it can highlight the conditions which lead to certain outcomes, which is an important goal of this research. As the purpose of the study was to examine and understand different adaptation strategies used by fishermen in the face of external shocks, it was important to investigate village situations where different types of rules were applied. In the future, random sampling techniques in addition to a larger sample size will be necessary to make empirical generalizations.

Within the broader purview of purposeful sampling techniques, two sub-strategies were used: maximum variation sampling as well as snowball sampling. Maximum variation sampling

was used to select our study villages. This is a technique used to identify common themes which may be present across villages that otherwise have a high degree of variation between them (Patton, 2002). A small sample size, which is characteristic of this study, can be problematic as a high degree of heterogeneity between and amongst samples can complicate the analysis and generalizability of the data. This strategy actually "turns that apparent weakness into a strength by applying the following logic: Any common patterns that emerge from great variation are of particular interest and value in capturing the core experiences and central, shared dimensions of a setting or phenomenon" (Patton, 2002, p.235). In this way I have attempted to mitigate for the weakness of a small sample by identifying and maximizing on the shared experience information obtained from the analysis. This technique also allows one to identify village level variables which seem to have the greatest impact on the shared experience. Because Indian society is extremely heterogeneous this technique is particularly useful in an applied context. As a result, a great deal can be learned from the shared outcomes discovered.

In order to separate the possible demographic effects of a heterogeneous sample on decision making from the effects of the rules on fishermen's decision making process, a technique called process tracing was employed. Semi-structured interview questions were delivered and participants were asked to specifically outline their reasons for choosing a particular adaptation strategy versus alternative options (Ranyard & Svenson, 2010). By asking these targeted *why* questions, I was able to "focus participants on information relevant to their motives and reasons for a decision" (Ranyard & Svenson, 2010, p.126). These reasons in turn help in understanding the decision making process fishermen went through in response to external shocks and which variables played a significant role in their adaptation decisions.

Snowball sampling was used to identify fishermen within villages to interview. This technique was utilized because it focused time and effort on information-rich cases and allowed for maximum interview efficiency in obtaining information from key-informants. In each village visited, we began our interviews at the local landing center and carried out the interview with an identified fisherman or boat owner. That particular person would then suggest further people who could answer our questions, in effect snowballing the sample to a wider range of knowledgeable participants (Patton, 2002).

Snowball sampling, while appropriate for this study, does have a number of limitations. Snowball sampling is a nonprobability sampling technique which prevents the generalizability of the data to the larger fisherman population (Johnson, 2001). This technique was employed because I was targeting a specific subset of the fishermen population which was ill-defined: those who had been fishing for at least ten years or more. These fishermen were purposefully targeted for their knowledge of how changes in conditions (both economic and environmental) over time have affected adaptation responses.

# 4. EXPECTED OBSERVATIONS

Scholars have shown that village level heterogeneity complicates the establishment of successful village level institutions (Agrawal, 2001). Based on this, I expect that adaptation will be unconstrained in Village R due to the heterogeneous nature of the village. Villages N and C are characterized by a homogeneity of identities and interests. I therefore would expect to observe the establishment of strong village level, resource management institutions and adaptation therefore to be constrained.

If district level regulations affect fishermen's ability to devise adaptation strategies, I would expect to see different adaptation strategies adopted in Village R (Ramanathpuram district) and Villages N (Nagapattinam district) because those districts have attempted to regulate fishing. In contrast, I would expect that fishermen in Villages C (Cuddalore district) would increase their fishing effort, as seen through hours spent fishing when the market price for certain species is high in the hopes of increasing catch and the resultant on-shore pay-off.

If village level institutions affect fishermen's adaptation strategies, I expect to observe fishermen deferring to and consulting the local village level institution regarding any changes in effort or decisions regarding gear usage and/or fishing holidays. In the case of strong village level institutions that stake a claim to resource management, it is expected that fishermen's adaptation strategies will be constrained in line with those local rules. If the local rules are lax, but the village organization strong, it is expected that fishermen's adaptation strategies will be unconstrained. In this way, if village level institutions affect fishermen's willingness to follow rules, I expect to observe unconstrained fishing in all three villages because none of the three studied villages employ strict village-level rules.

Finally, in regards to legal pluralism, I expect to observe that in specific cases where district and local level rule conflict, fishermen will follow local rules and disregard district/state level regulations. In other words, district management regulations would be relevant only where the village does not stake a claim to management. As a result, district regulations should be influential where the village is not involved in management (Village R) because the district regulations are backed by the power of the state. Village level rules (or lack thereof) should then be consequential in other locations (Villages N & C). Based on the aforementioned village characteristics combined with the literature-derived hypotheses, the following expectation matrix was constructed.

Variable	Village C	Village N	Village R
Heterogeneity	Constrained	Constrained	Unconstrained
District regulations	Unconstrained	Constrained	Constrained
Strict village rules	Unconstrained	Unconstrained	Unconstrained
Village & district rules	Unconstrained	Unconstrained	Constrained

 Table 3: Expectations matrix

# 5. RESULTS

# 5.1 Adaptation strategies and constraints

In **Village C**, 5 out of 6 fishermen reported changing their net to adapt: 3 out of those 5 reported changing their net in accordance with market prices of certain key species. When the price for prawns is high, they use a prawn trawl net which has a smaller mesh size. When the price for prawns is low, they switch to a fish trawl net with a larger mesh size. Two out of those five fishermen reported that the quantity of certain species caught has a greater impact on their choice to change nets. In this case, whichever species they are catching more of, they will select a net accordingly and focus their effort there. Additionally, if they continue catching, they will continue fishing. One fisherman in this group (C3) stated that price doesn't matter only quantity matters. If they've been catching more of something they will keep fishing for that. This implies that given the absence of temporal effort restrictions, continuing to fish is an option employed by some fishermen in Village C.

In **Village N**, 8 out of 17 fishermen reported changing their nets to adapt: 6 of those fishermen reported changing their net in response to changes in market prices while 2 reported that they change their net primarily based on quantity caught. Additionally, 9 out of 17 fishermen reported that they will either increase or decrease their effort (in terms of hours spent fishing) based on price or quantity caught. 5 out of the 9 reported price as the driving factor behind effort decisions. These fishermen reported that, for example, if the price for prawns is high, they will increase their effort for prawn fishing. Four out of the nine reported that quantity determines their level of effort. These fishermen stated if they are catching a large quantity of a particular species, they will focus their effort on that species and continue to fish. Fisherman N8 reported that price does not affect the amount he fishes. He will go early to a place at 6am and if

there is prawn there, he will stay until 6pm. If he doesn't catch any, the price doesn't matter, he will still come home. Fishermen N6 and N7 reported that it didn't matter if the price is high or low. If there is quantity, they will keep fishing. If there isn't, they will stop.

In **Village R**, two out of the fourteen fishermen expressed they did not change their fishing practices in order to adapt to the changing market. These fishermen stated that regardless of market price they exert the same amount of effort. One of these fishermen (Fisherman R6) outlined that he doesn't change anything about the way he fishes, because to change something costs money.

The remaining 12 out of 14 fishermen interviewed in **Village R** reported changing their net as a common adaptation strategy in response to shifting market prices. If the market price for prawn decreases past a certain point, the fishermen will change their prawn trawl net to a fish trawl net, which has a larger mesh size. In this way, they report adapting to the market. A group of four fishermen (Fishermen R4-R7), after outlining the district level regulations that apply to them stated that they cannot increase their effort if prawn price increases because of the timezoning regulations.

Lastly, one fisherman (R11) reported that a number of fishermen were adapting to the effort regulations and the perceived negative impact they have on catch and therefore profit, by turning to a new black market for sea cucumbers. He reported the sale of sea cucumbers is banned in India, but because they fetch high prices in Japan and China, they are sent through Sri Lanka and exported to these countries. This strategy supplements the trawler's income considerably since at the time of the interviews, the price for prawns was very low. Fisherman R11 reported that the fishermen were "forced" into doing this because their current profit was very low if non-existent.

# 5.2 Rules and legal pluralism

In **Village C**, 3 out of the 6 fishermen referenced the presence of the BOA within their village, but primarily as a dispute settlement body between fishermen. This village organization does not act in a resource management capacity and stakes no claim to fisheries governance. Additionally, there are no district fisheries regulations to contend with as the district fisheries department works mainly in a welfare capacity.

In **Village C**, all fishermen reported following the government's monsoon ban but when it came to other regulations governing how they fish one fisherman (C4) reported they will go to the government as a group of 10-15 villages for a meeting to negotiate (if there is a regulation they don't agree with), but if the government doesn't budge, they will do what they think is best anyways. Another fisherman (C3) stated it is the people who choose the rules which govern them.

In **Village N**, 12 out of the 17 fishermen interviewed referred to their local *panchayat* as the primary fisheries governance institution whose rules they do follow. Fisher N13 stated, after discussing the district's ban on trawl nets stated that the *panchayat* also upheld the ban on trawl nets for about two days, but then agreed that it was O.K. for fishermen to use trawl nets. After this decision, the entire village went back to using them regardless of the government regulation. Fishermen N11 & N12 stated that it's the *panchayat* that makes the rules. Of note though is the common remark that the *panchayat* doesn't give any restrictions to the fishermen except to not fish on festival days. Fisherman N3 reported that the *panchayat* advocates for the fishermen to catch what they can.

In **Village N**, 13 out of the 17 fishermen interviewed reported that they know of district/state level regulations that apply to them, but choose not to follow them. Most fishermen who provided a reason for this outlined that the government makes regulations that they cannot follow and regulations that aren't enforced. Therefore due to the fishermen's depressed economic situation, they are compelled, or "forced", to disregard them. Fisherman N2 reported that he doesn't follow the regulations of the government except the 45 day ban, and doesn't recognize them either. He stated that the government makes regulations they can't afford to follow because their income is so low. Fishermen N4 reported that the government first introduced the net, he bought it at a subsidized rate but it was still very expensive. He felt he couldn't afford not to use it. Fisherman N5 stated that the government regulations are there but he doesn't follow them. The Fisheries Department makes them. He stated that the government banned trawl nets but since so many big fishers use them they just paid the fisheries department some money and now they can use them again.

In **Village R**, only one fisherman out of 14 interviewed mentioned the presence of the Boat Owners' Association (Fisher R7) and stated that the association advocates on behalf of fishermen. Fisher R7 also happened to be the president of the BOA. These village organizations are highly fragmented, and due to their fragmentation, have been unsuccessful at establishing local level institutions governing fisheries management. Therefore, in Village R, district regulations do not have to contend with village level rules governing fisheries resources.

In **Village R**, of the 14 fishermen interviewed, nine fishermen answered the questions regarding rules they follow. All nine of the fishermen referenced the district level regulations that apply to them. These include the 3:4 day share regulation, 3 hr. max trawl time and the

monsoon ban. Two of the nine fishermen specifically noted that before these temporal effort restrictions were put into place (i.e, 1994) in Ramanathapuram district, they exerted more fishing effort. Fisher R14 stated that before the 3 day trawl maximum, he fished his boat 6 days/wk. Another fisherman (R13) reported that before the three day trawl regulation was set in 1994 they would go out daily either from 5am-4pm in the rainy season and do overnight trips in the normal season.

# 6. DISCUSSION

#### 6.1 Adaptation constraints

The data suggests that while price is a contributing factor leading to adaptation decisions (Bavinck, 1998), fishermen are also adapting to overall fish catch quantity. In some cases, as seen in Village C fish catch quantity is much more important in determining adaptation strategies than price. This particularly comes into play after the monsoon ban is lifted. The monsoon ban is the only state level regulation fishermen consistently reported following. Prior to the ban, the market supply is low because fish catch is low. During the ban, there is no mechanized fishing which helps fish populations recover, but it also drives up the price of seafood since there is still demand but no supply. After the ban lifts, however, all fishermen return to sea, catching larger quantities than pre-ban (Kurup, 2009). Fishermen and export agents reported that post-ban, heavy fishing pressure effectively swamps the market with seafood which drives the price down because there is so much supply. At this point, exporters actually stop buying from fishermen until they are able to empty their freezers.

In Village C, which is not governed by district level regulations, fishermen opt to increase their effort in response to rising prices or quantity caught, in addition to employing gear selectivity options. In Village N, despite district efforts to regulate, fishermen follow similar strategies to Village C. In Village R, where fishermen are governed by district level regulations limiting fishing effort, the data suggests that fishermen respond to these same stresses through gear selectivity only instead of effort changes.

Additionally, in the presence of the effort restrictions, some fishermen in Village R reported turning to black market opportunities in sea cucumber harvest to make up for their perceived economic losses from legal fishing activities. This suggests that while temporal effort restrictions are successful at constraining adaptation strategies, particularly by limiting fishers'

ability to increase effort, there are also potentially negative and unanticipated consequences to these regulations if fishermen feel they are put at a disadvantage.

# 6.2 Rules

The data suggests that rule legitimacy is positively correlated with enforcement, as suggested by the literature. In contrast with Village R, it became apparent through interviews with all fishermen in Village N that the state and district level fisheries regulatory bodies have a serious problem with enforceability and applicability of regulations at the local level. There is a significant disconnect between the village level *panchayat* and the Fisheries Department within the village studied and this has the potential to have serious implications for sustainable harvest and ecosystem health, given that all state and district level management regulations are disregarded except the monsoon ban.

While all fishermen in all villages observe the monsoon ban, it is in fact the time post-ban where there is opportunity for continued management of harvest. The regulations that are enforced at the district level in Ramanathapuram, at least in Village R, appear to effectively promote the continued management of harvest by putting temporal limits on effort. In Villages N and C, without the presence of temporal restrictions on effort, the post monsoon opportunity for continued harvest management appears to be lost and fishermen continue to exert heavy pressure well into the lean season, when production is low (Bavinck et. al. 2008). During this time many fishermen report an inability to catch enough to offset their trip costs. This fishing strategy depresses the market price for all fishermen and to a certain extent (the exact extent is beyond the scope of this paper), reverses some of the ban's progress in terms of stock regeneration.

6.3 Heterogeneity vs. homogeneity: Conditions behind legal pluralism

Village N, characterized by homogeneity of identities and interests exhibited a strong village *panchayat* whose interests and rules conflicted with those of the state/district. Our data supports the hypothesis that in situations of legal pluralism, where there are inconsistencies between district and village level rules, the ability of district level regulations to constrain fishermen's adaptation strategies will be limited. This is clearly exhibited by the fact that in Village N, 13 out of the 17 fishermen interviewed reported disregarding all district/state regulations (with the exception of the monsoon ban), supporting their village *panchayat's* decisions in terms of fisheries management.

In contrast, the evidence in this study suggests that the regional fisheries regulations were better enforced in a heterogeneous atmosphere (Village R) where there was a large degree of variation in resource users. This seemingly contradicts some of the theory behind successful commons management (Agrawal, 2001) in that rules (albeit district regulations) were successfully enforced in Village R versus Village N which was homogenous. As scholars anticipate, our data shows that within a heterogeneous village, local institutions were unsuccessful in building strong common interest strategies for fisheries management. However, this absence of village rules opened up the possibility of greater district influence, and fishers instead deferred to district regulations. This supports the hypothesis that fishers will defer to state/district law in the absence of a strong village law because it's backed by the power of the state. This leads us to hypothesize further that in situations where heterogeneity may be a disadvantage to the successful implementation of local level institutions, it may actually be an advantage for state level institutions, allowing them greater opportunity to exert management authority: an issue which merits further study.

# 7. CONCLUSION

Fishermen already report changes in catch and species availability as well as stock shifts as presented earlier in the paper. The system is adapting by evolving new markets, such as the market for crab and cuttlefish. Fishermen are adapting by modifying their nets to catch different species and the demand is only increasing both internationally and domestically. The implementation of regulations and enforceability thereof appear to be the component of the system that continues to lag behind the rest. Without this pivotal filter, the resultant negative impacts on fish catch will continue to be seen.

Other factors may also condition adaptation strategies devised by fishermen. One of these confounding factors may be the wealth of individual fishermen, a variable that was not addressed in this study. Higher levels of wealth may increase a fisherman's adaptive capacity to changing conditions. Wealth also may impact livelihood resilience by increasing an individual's opportunity to earn income outside fishing if necessary. Addressing inter-village differences in economic status and its potential influence on resource users' perceived adaptation constraints would be an important component in a follow-up study to this research.

Limited data was gathered in this study on information access and the role of cell phones in devising adaptation strategies. Initial reports were mixed: some fishermen stated that they utilize cell phones to communicate among boats if schools of fish are seen. Fishermen can use this information to coordinate their effort to maximize the returns. Another group of fishermen stated that they may use their cell phones to check the market price at a number of nearby landing centers and then land their catch accordingly. Still another group reported that even if they are able to get market information on their phones at sea, landing in other places usually means an increased cost in fuel and time, which is not worth what small increase in profit they

would get upon landing. Future research is needed to clarify the potential relationship between information access and adaptation responses.

Additionally, examining the village level variables that enable effective rule enforcement will be important in future fisheries management attempts. An examination of demographic variables and their impact on local versus regional institutional efficacy seems warranted. Given the sample size of this study it is difficult to separate the heterogeneity of resource users and the high level of state government presence in the case of Village R in Ramanathapuram where district level regulations were effectively enforced and followed. Incorporating other villages that are not located in politically sensitive zones but are also heterogeneous in nature will be important in understanding potential variables that lead to successful resource governance. A larger sample size consisting of heterogeneous villages in politically sensitive zones in addition to a control set of heterogeneous villages which are unassociated with politically sensitive zones, but whose districts also exert management authority, would allow us to better separate the effects of these two variables. This additional information will be important in developing policy suggestions.

This analysis has shown that fishers will continue to adapt to changes in markets and species availability. District regulations and robust village level institutions have the potential to constrain adaptation strategies. The reality of legal pluralism that exists in many coastal villages in Tamil Nadu, and largely throughout India needs to be accepted (over just acknowledged) but also utilized to successfully build sustainable harvest strategies. Therefore, fisheries development at the state level may benefit from increasing their efforts in building credibility with village organizations. This could potentially be fostered through mentorship programs of younger fishermen initiated by marine colleges and the Fisheries Department. Additionally, a

key motive for successful resource management is the provision of adequate incentives for resource conservation (Agrawal, 2001). Therefore, increasing the incentives for fishermen to follow district level regulations is also worth exploring.

APPENDICES

# APPENDIX A

# Interview questionnaire:

Position:

1	.)	Before you started in this job, what did you do for work? -Why/when did you switch?
2	2)	Has the species you've caught changed over the past 10 years?
3	3)	Has the amount of fish and prawn you've caught changed over the past 10 years? -Why?
4	I)	Who do you sell your catch to -Why?
		-Do you negotiate the price?
5	5)	What is the typical price per kg prawns you receive upon landing -How has the price changed over the past 10 years?

Location:

-Why has it changed?

Name:

- 6) Where does your catch go from the beach?
- 7) If the price of shrimp rises or falls, does it change the way you fish? -(ex: different net, how often you go out, etc.)
- 8) What type of rules govern how you fish?

-who makes those rules?

-do you have a say in them?

# APPENDIX B

# Coding table:

**Questions:** What causes fishermen to choose different adaptation strategies in the face of changing market conditions and species availability? Which rules are most effective in constraining adaptation strategies?

Concept/Theme	Code	Summary
Changing price	ΔΡ	Fisherman: The price of
		prawn is decreasing and the
		price of fish is increasing
Changing catch	ΔC	Fisherman: Catch is
		decreasing for all species
		due to the increased number
		of boats fishing
Adaptation strategy	Adapt	Fisherman: I can't increase
		my effort if the price rises
		for prawns but I can invest
		in a new net in the hopes of
		catching more
Rules applicable	Rule	Fisherman: The government
		banned small mesh-size
		nets, but I use them
		anyways.
Presence and function of	Inst	Fisherman: There is a 15
community-level		member panchayat, all
governance organization		members are men and all
_		members fish.

Table 4:	Coding	matrix
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