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Vulnerability to Viability: The Resilience of Marine Fishermen

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Abstract
Researchers in the fishing industry are increasingly intrigued by the stressors that fishermen encounter in their profession and how they manage to reduce the harmful effects on their livelihood. Numerous studies have revealed that fishermen who depend on fishing for a living are now more susceptible to the fishery's unexpected developments. Livelihood stressors could be the main root cause for many of the major issues affecting the socioeconomic progress of the fishing community. However, a knowledge vacuum exists in the vulnerability and viability of the fishing occupation. Hence, this paper aimed to study 1. the vulnerability context of the marine fishermen of different sociodemographic characteristics, 2. how they buffer the negative effects on their livelihood and 3. the correlation between marine fishermen's livelihood from fishing and its viability. A sample of 308 marine fishermen from the Kanyakumari region of Tamil Nadu, India, was chosen for conducting an empirical inquiry. The researchers found that the marine fishermen in the age group of 46-60 years (M = 199.51, SD = 14.756) faced lesser occupational stressors than the fishermen of other age groups (M = 206.75, SD = 11.527; 206.87, SD = 14.890). Fishermen with higher education, by buffering the negative effects of such stressors, could make the fishing occupation more viable than fishermen with lower educational backgrounds. It was confirmed that fishermen's resilience increased with the level of livelihood stressors and that the more resilient they were, the more viable their fishing occupation was.
Keywords: Vulnerability, Viability, Resilience, Marine, Fishermen, Fishing Occupation, Fisheries

Introduction

India's coastline extends over nine coastal states and four union territories. India is the second largest fish-producing country globally (Peter, 2017), and the total fish production with 700 species of fish (Jena & George, 2018) is around 13.42 million metric tons, of which 3.71 million metric tons are from marine fisheries (Kundu, Santhanam, & Srikanth, 2020). Thus, the marine fishing sector is a significant source of employment in India (Joseph, 2015), and around 16 million people are directly employed (Kundu et al., 2020). From 1993 to 2005, there was a significant increase of 70 per cent in the number of mechanized fishing units, along with a substantial expansion of 200 per cent in the motorized sector, which is known for its technical efficiency. In contrast, there was a decline of 43 per cent in the non-mechanized units, also known as the traditional sector (Sathiadas, 2009).

Kanyakumari district lies between $77^0.6$' and $77^0.34$' of the eastern longitude and $8^0.5$' and $8^0.21$' of the northern longitude. It is situated in the southern extreme of the Indian Peninsula and has a coastline of 67.59 kilometres extending from Cape Comorin to Arockiapuram on the east coast and Cape Comorin to Neerodi on the west coast (Lazarus & Joel, 1979). The marine fishermen population in Kanyakumari district is distributed in 43 fishing villages (Catholic Parishes). The district ranks second in the State, next to Ramanathapuram, in terms of the number of active marine fishermen living in Tamil Nadu. It holds over 22 per cent of the working age group of the State's fishermen (Department of GoI & CMFRI, 2016).

Table No. 1: Active Marine Fishermen in Kanyakumari District – 2016

Activity	Full-Timers	Part-Timers	Total	State Total
Fishing	39616 (18.14)	3861 (1.77)	43477 (19.91)	**218351**

Source: Marine Fisheries Census 2016, Tamil Nadu, Department of Fisheries, GoI, Central Marine Fisheries Research Institute (CMFRI).

Note: Figures in parentheses represent percentages to the state total

Due to its high nutritional value, even tiny quantities of fish can enhance individuals' diets. These foods can supply essential nutrients that are lacking in the common starchy staples that make up the majority of impoverished people's diets(Ruby P & Ahilan B, 2018). Fish accounts for around 20% of the total animal protein consumed in 127 developing nations, and this percentage can rise to as high as 90% in Small Island Developing States (SIDS) or coastal regions (Thorpe, Reid, Anrooy, & Brugere, 2006). SIDS or coastal areas possess a significant degree of inherent susceptibility due to external variables, such as their small size, distant location, exposure to natural adversities, and limited resource availability. However, they possess higher levels of income compared to other countries that are classified as least developed and are not located on the coast. SIDS is considered to be among the global regions that face significant challenges in achieving sustainable development, according to many indicators (FAO, 2014).

In their study, Daw, Adger, Brown, and Badjeck (2009) predicted that a significant number of small-scale fishermen experience poverty, which is commonly attributed to the depletion of resources and/or the reliance on fisheries as a safety net for the most impoverished individuals in society. Hence, this broad comprehension of the impoverished economic conditions in which small-scale fishermen from developing nations reside captures some of the challenges they encounter. Climate change could have a detrimental impact on fishery resources (Daw, Adger, Brown, & Badjeck, 2009). Additionally, the UN Framework Convention on Climate Change explains that climate change is causing substantial effects on biodiversity, terrestrial ecosystems and coastal zones. The UNFCCC has also warned that during the past few decades, more than 20 percent of the world's fish species have faced extinction, threats, or endangerment(CBD, 2007) while the World Bank, in the nature-based solutions for its portfolio, in one of its books named ‘Biodiversity, Climate Change and Adaptation’ stated that the fisheries and fishermen's livelihood are increasingly under threat from pollution, invasive alien species, habitat loss and fragmentation, and climate change.

With the unprecedented changes in the fishery, fishermen making livelihoods out of fishing are becoming more vulnerable. Many experts have disclosed the fact that fishing livelihoods are affected by human practices such as issues include the presence of too many fleets, fishing limits that are too high, illegal fishing activities, and consistently inadequate management of nearly all fisheries (Rebufat, 2007) and by the natural aspects such as coastal erosion and unanticipated disasters (Jamwal, 2019). India has lost around 234 square kilometres of coastal land due to erosion, and the Kanyakumari district is one of the coastal districts with the highest risk of sea-level rise and erosion of the coast (Jamwal, 2019). Besides, fish stocks are susceptible to exogenous influences such as overcapacity, damaging fishing techniques, and conflict among different groups of fishermen (Bavinck & Johnson, 2008), the rigidity of fish value chains (Bino, 2015), occupational dangers (Suresh et al., 2018), ocean pollution (Vikas & Dwarakish, 2015), climate change and unpredictable variations in weather (Roxy, et al., 2018).

Nevertheless, fishermen endeavour to identify alternatives in order to mitigate the impact of the stressors. To deal with periodic hurricanes, tides, and a variety of social, political, and economic difficulties, both proactive and reactive strategies are employed (Salas, Bjorkan, Bobadilla, &Cabrera, 2011). Additionally, fishermen adopt psychological defence systems to limit their subjective experience of threats, enabling them to endure the high-stress occupation, adversities, and bad consequences associated with fishing (Pollnac & Poggie, 2008)

The existing available data have not comprehensively covered the essential indicators of the cause-effect relationship between the livelihood stressors and coping strategies of fishermen in Kanyakumari district and their influences on fishing viability. Riordan, Johnson and

Thomas (1991) and Pickett and Joeri (2019) argued that fishermen may not encounter stressors to the same degree as persons in other occupations because of their high-stress occupations and high-risk settings. Aldwin and Revenson (1987) perceived that coping mechanisms with minimal effort can deal with stressors (Riordan , Johnson, & Thomas, 1991), (Pickett & Joeri, 2019), (Aldwin & Revenson, 1987).

This article intends to measure if the vulnerable situations that the marine fishermen of Kanyakumari district experience and manage can be demonstrated by livelihood-related stressors and their resilience, respectively. Therefore, the purpose of this study is to find out the livelihood vulnerability the fishermen of Kanyakumari district encounter and how they are resilient to deal with such vulnerabilities. Eventually, this study will analyze the cause-effect relationship between factors such as livelihood stressors, resilience, and fishing viability.

Methods

In the present study, we adopted an ontological approach, and by employing multistage cluster and systematic random sampling techniques, we obtained primary data from a sample of 308 active marine fishermen based in the district of Kanyakumari, which located in the southern tip of Tamil Nadu state, India. We used an interview schedule and interviewed the respondents one at a time. We preferred one of the active marine fishermen who could provide data from their real-time occupational experiences. An itemized Rating Scale was used to measure vulnerability, Viability and Resilience, which were the major subjects of this study. The information was gathered between 2019 and 2020. By employing an explanatory research design, we formulated research questions such as: can marine fishermen respond and become adaptive to those uncertainties caused by the livelihood stressors (vulnerability) while attempting to fulfil their diverse consumption and financial requirements (viability)? Can the degree of livelihood stressors be reduced for marine fishermen when they use coping strategies (resilience)? Therefore, our focus was on the number of possible cause-effect links between vulnerability, viability, and resilience, as well as identifying disparities among marine fishermen based on various sociodemographic parameters in relation to the mentioned variables.

Data Processing

We used the variable map below to show how they interact. In this study, the fishermen's socioeconomic status is taken into account as an independent variable. At the same time, vulnerability and resilience are reflected as intervening variables that affect the dependent variable, namely, viability.

The variables were further grouped into qualitative and quantitative variables with four levels of measurement, namely Nominal, Ordinal, Interval and Ratio variables. Thus, we identified 22 nominal variables, 8 ordinal variables, 110 interval variables, and 13 ratio variables, which were identified and considered for data analysis. The variables that were in ratio form were computed for the purpose of applying inferential Statistics.

Data Analysis

We used the IBM SPSS (version 22) for coding, classification, editing, computing and analysis of the data. Inferential statistics, namely the Independent Sample T-test and One-way ANOVA, were applied to determine the differences in vulnerability and viability between the different categories of fishermen.

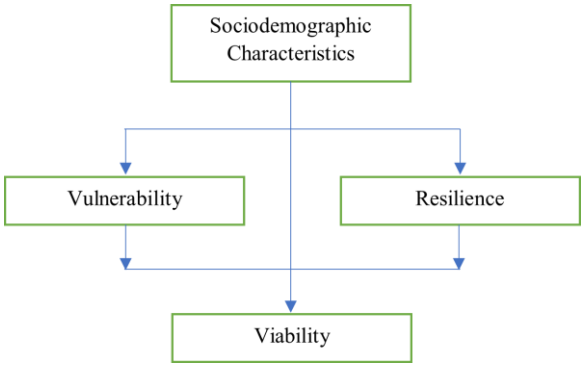

Figure 1: Diagram showing the interrelatedness of variables

Pearson's Correlation and Stepwise Multiple Regression Analysis were employed to find the collinearity between vulnerability, resilience and viability of the fishing occupation and to measure the level of influence that the vulnerability and resilience made upon the occupational viability (dependent variable).

Ethical Consideration

We sought permission from the village parish councils of the selected fishing villages and ensured that all the respondents provided informed consent, comprehending the study's objectives and their potential involvements. We ensured measures to protect the privacy and confidentiality of the respondents' personal information and responses. Data had been anonymized wherever possible to prevent the disclosure of sensitive information.

Results

The number of marine fishermen across different backgrounds is listed in Table 1, along with the respective mean differences, Standard Deviations, independent sample t-tests, one-way ANOVA and Post-hoc tests.

Table: 2

Mean Difference in the Scores of Livelihood Vulnerability among Marine Fishermen with Different Sociodemographic Characteristics

S. No.	Group	Factors	N	Mean	S.D.	Statistical Test	Post-hoc Test
1	**Age**						
	1	18 – 25 years	53	206.75	11.527	F = 8.842 ***P = 0.000*** **Sig**	*Group3 Vs Group1 & Group2*
	2	26 – 45 years	155	206.87	14.890		
	3	46 – 60 years	100	199.51	14.756		
	Total		308	204.46	14.689		
2	**Education**						
	1	No Education	22	201.23	16.169	F = 2.458 *P = 0.056* Not Sig	*Nil*
	2	Primary	87	201.61	16.245		
	3	High	140	205.46	14.999		
	4	Higher	59	207.51	9.469		
	Total		308	204.46	14.689		
3	**Marital Status**						
	1	Unmarried	68	206.69	11.708	F = 1.088 *P = 0.338* Not Sig	*Nil*
	2	Married	231	203.90	15.654		
	3	Divorced / Widower /	9	201.89	5.278		

S. No.	Group	Factors	N	Mean	S.D.	Statistical Test	Post-hoc Test
		Remarried					
	Total		308	204.46	14.689		
	Family Type						
4	1	Nuclear	290	204.09	14.548	t = -1.771 *P = 0.078* Not Sig	*NA*
	2	Joint	18	210.39	16.099		
	Family Size						
5	1	≤ 4 Members	134	203.77	15.154	t = -0.725 *P = 0.469* Not Sig	*NA*
	2	> 4 Members	174	204.99	14.342		

While applying the Analysis of Variance, particularly one-way ANOVA, to test the differences in livelihood vulnerability among marine fishermen of different age groups, we observed evidence of significant differences. We found that the marine fishermen in the age group of 46-60 years (199.51±14.756) experienced lower vulnerability than the younger fishermen (206.75±11.572, 206.87±14.890). The post-hoc test also confirmed significant differences in the occupational risk faced by the fishermen in the age group of 46-60 years versus 18-25 years and 26-45 years of age. Hence, it could be concluded that younger fishermen and middle-aged fishermen are more vulnerable to various types of occupational stressors than older fishermen.

Regarding the educational backgrounds of the marine fishermen, no difference was observed. They were discovered to be just as susceptible to the pressures of their livelihood. This was also the same in the case of fishermen with different marital status, their family types and family size.

Table: 3

Mean Difference in the Scores of Fishing Occupational Viability among Marine Fishermen with Different Sociodemographic Characteristics

S. No.	Group	Factors	N	Mean	S.D.	Statistical Test	Post-hoc Test
	Age						
1	1	18 – 25 years	53	56.36	7.079	F = 7.477 ***P = 0.001*** **Sig**	*Group1 Vs Group2 & Group3*
	2	26 – 45 years	155	52.46	8.103		
	3	46 – 60 years	100	51.05	8.689		
	Total		308	52.68	8.306		
	Education						
2	1	No Education	22	51.45	8.245	F = 4.546 ***P = 0.004*** **Sig**	*Group4 Vs Group2 & Group3*
	2	Primary	87	51.56	8.037		
	3	High	140	52.09	8.509		
	4	Higher	59	56.17	7.456		
	Total		308	52.68	8.306		
3	**Marital Status**						
	1	Unmarried	68	55.74	7.386	F = 8.154	*Group1*

S. No.	Group	Factors	N	Mean	S.D.	Statistical Test	Post-hoc Test
	2	Married	231	52.01	8.391	***P = 0.000*** **Sig**	*Vs Group2 & Group3*
	3	Divorced / Widower / Remarried	9	46.56	5.659		
	Total		308	52.68	8.306		
	Family Type						
4	1	Nuclear	290	52.67	8.286	t = -0.083 *P = 0.934* Not Sig	*NA*
	2	Joint	18	52.83	8.873		
	Family Size						
5	1	≤ 4 Members	134	53.05	8.695	t = -0.698 *P = 0.486* Not Sig	*NA*
	2	> 4 Members	174	52.39	8.008		

We identified evidence of differences in fishing viability among marine fishermen with different age groups. It was observed that the marine fishermen in the age group of 18-25 years (56.36±7.079) could make their fishing occupation more viable than the fishermen in the age groups of 26-45 years (52.46±8.103) and 46-60 years (51.05±8.689). The post-hoc test also confirmed significant differences in the viability aspect of fishing occupation between the fishermen in the age group one and the other two groups. Therefore, it could be concluded that the early adult fishermen could convert their fishing occupation into something more viable and feasible than the older fishermen.

Fishermen with higher educational background (56.17±7.456) could find more yields out of fishing occupation than the fishermen with no education (51.45±8.245), primary education (51.56±8.037) and high school education (52.09±8.509). The post-hoc test established significant differences among fishermen with higher education versus fishermen with primary and high school education.

Table: 4
Correlation between Vulnerability, Coping Strategies and Fishing Viability

Variables	1. Livelihood Vulnerability	2. Coping Strategies	3. Fishing Viability
1. Livelihood Vulnerability	1		
2. Coping Strategies	0.349** 0.000	1	
3. Fishing Viability	0.119* 0.036	0.450** 0.000	1

* Correlation is significant at 0.05 level

** Correlation is significant at 0.01 level

When we recorded the findings about the correlation between the variables, namely livelihood vulnerability, coping strategies and fishing viability, we discovered that there was a positive relationship between each of the three variables when they interacted with one

another. Coping strategies and fishing viability had a positive relationship between them with medium effect (r=0.450, P<0.000) when compared to the relationship of other variables. Further, it was also observed that livelihood vulnerability had a positive relationship with coping strategies with a medium effect (r=0.349, P<0.000). However, the livelihood stressors did not have a similar amount of relationship with fishing viability. It could be, therefore, concluded that greater livelihood stress leads to greater coping, and greater coping enhances fishing viability.

Table: 5
Multiple Regression Analysis for the Fishing Viability (DV) subject to Livelihood Vulnerability and Coping Strategies (Predictors / INV)

Model	Factors	R	R^2	R^2 Change	B	t	Sig.
1	Resilience	0.450	0.203	0.200	0.450	8.807	P = 0.000

Only the coping strategies employed by the artisanal marine fishermen were found to have a better effect on the fishing viability, with a 20.2 per cent variance. The regression equation was determined to be the most optimal according to the significant F-ratio (F = 77.564, P<0.000). Additionally, the effect of coping strategies on fishing viability was found to be positive (t = 8.807, P = 0.000), whi
le the regression analysis excluded the livelihood vulnerability as it did not have any effect on the fishing livelihood. The results were insignificant (t = -0.789, P = 0.430).

Table: 6
Multiple Regression Analysis for the Fishing Viability (DV) subject to the subdimensions of Coping Strategies (Predictors / INV)

Model	Factors	R	R^2	R^2 Change	B	t	Sig.
1	Management Skills	0.395	0.156	0.153	0.242	3.451	P = 0.001
2	Technology Adoption	0.429	0.184	0.179	0.227	3.245	P = 0.001

Additional analysis has been employed to determine the extent to which the sub-dimensions of coping mechanisms have affected the viability of the fishing occupation. We once again applied stepwise multiple linear regression analysis to determine which of the five established sub-dimensional coping strategies, namely fishing efforts, management skills, technology adoption, human capital, and fishermen collective, contribute to the fishing occupation and make it a sustainable livelihood alternative for fishermen.

Our observation revealed that out of the five aforementioned coping techniques, management skills and technology adoption emerged as significant contributing factors for the dependent variable known as 'fishing viability.' In order to ensure the financial, economic, and social sustainability of their occupation, the fishermen needed to prioritize improved management techniques and the adoption of advanced technology. We observed that the deployment of technology and management skills had the potential to add 18.4 percent and 15.6 percent, respectively, to the viability of the fishing occupation.

The regression analysis yielded statistically significant F-ratios (F=34.408 and F=56.523, P<0.000 and P<0.000, respectively), indicating that this regression model is comparatively superior. Furthermore, it is worth mentioning that the fishing viability was not affected by fishing efforts, the collective of fishermen, or human capital. The regression analysis has omitted these variables as they were insignificant (t = 1.340, 1.061 & 1.886 and P = 0.181, 0.289 & 0.060, respectively).

Therefore, it may be argued that fishermen used larger boats, more investments, a variety of fishing techniques, and a wide range of gear to mitigate the risk to their livelihood and

maintain the viability of the fishing occupation. They constantly altered their fishing equipment and craft to suit the needs of the fishing technique, location, and time. Owners could ensure the long-term viability of their activity by collaborating with a select group of fellow fishermen to eliminate certain risk components related to the financial side. They established connections with fishermen of other crafts by sharing profits and losses. Ultimately, competitive dividends from both owners and crews enabled them to sustain their occupation. The fishermen were able to thrive in their occupation and become resilient by employing the coping mechanisms mentioned above.

Discussion

Based on our analysis, this study is one of the most significant attempts to measure the vulnerability, viability, and marine fishermen's resiliency in the study region, considering the importance of fisheries research. Additionally, we assessed the relationship between these variables and differences among the various groups of marine fishermen. When we measure the vulnerability context, occupational viability, and resilience of marine fishermen, we found that when livelihood vulnerability increases, the resilience of the fishermen increases, and so does the occupational viability (r = 0.349, 0.119 & 0.450). All three variables recorded a positive correlation between them. Evidence showed that the resilience of the fishermen determined occupational viability (R2 = 0.202, t = 8.807, P=0.000), not vulnerability. Additionally, among the subdimensions of resilience, we found that the adaptive abilities of the fishermen, namely fishing management (R^2 = 0.156, t = 3.451, P=0.001) and adoption of technology into fishing occupation (R^2 = 0.184, t = 3.245, P=0.001). Salas et al. (2011) confirm that fishermen employ proactive and reactive strategies to face natural, coastal, political, financial, and artificial stressors. Researchers Pollnac & Poggie (2008) found that by using psychological defense mechanisms to reduce their subjective experience of dangers, fishermen are able to endure the high levels of stress associated with their work as well as obstacles and unfavorable outcomes.

This study confirms the theory of stress and coping propounded by Walinga (2014) that the fishermen have considered the livelihood stressors as threats and have had livelihood resources and their capabilities to change or control those stressors (Walinga, 2014). By far, this study has found that the fishermen had options of livelihood resources and capabilities to remove or reduce the threats created by various livelihood stressors (vulnerability). Subsequently, they were able to make their occupation viable.

Limitations

The study was limited to only 308 active marine fishermen from the 11 fishing villages of Kanyakumari district of Tamil Nadu, India. Hence, the observed information collected from them cannot give a generalized picture of the fishermen across the universe. As the respondents were selected on the basis of some prescribed criteria, other fishermen and women who engaged as part-timers in a mixed business-farming-fishing-livestock livelihood or as a seasonal fall-back were missed out and whose views were not taken into account. The psychological well-being of the fishermen and fish marketing concerning livelihoods were missed. Besides, standardized constructs were not employed.

Conclusion

Concerns about food security and the effects of global warming are growing. The fishery sector is particularly susceptible to the adverse consequences of global warming. The global warming phenomenon poses a significant threat to the livelihoods of over 36 million fisherfolk worldwide and nearly 1.5 billion consumers who depend on fish as a primary source of animal protein, constituting more than 20 percent of their diet. The fisheries industry and the means of subsistence for fishermen are being seriously affected by this environmental issue. In addition to various stressors from multiple dimensions that impact the lifestyles of fishermen and significantly influence the sustainability of their activity, the

coping techniques employed by the fishermen play a crucial role in ensuring the viability of the fishing occupation. According to this study, the younger fishermen are more susceptible to livelihood stressors despite their ability to cope better than the older fishermen. Hence, it is necessary to address their physical, social, and emotional wellness.

Declaration of Conflicting Interests

The author(s) have stated that they have no potential conflicts of interest with this study, the authorship, and/or the publication of this article.

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Statement on the Availability of Data

The data that substantiate the findings of this paper are available upon request from the corresponding author.

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