



Understanding gender intersectionality for more robust ocean science

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ABSTRACT

The UN Decade of Ocean Science (UNDOS) aims to: “Generate knowledge, support innovation, and develop solutions for equitable and sustainable development of the ocean economy under changing environmental, social and climate conditions.” Changing conditions affect certain groups more than others, depending on exposure, sensitivity and adaptive capacity. Gendered differentiation has been studied in small scale coastal fisheries. However, this approach is often limited to male-female gender dichotomies. In contrast, the present analysis takes a more expansive approach centered around the concept of intersectionality, to demonstrate more nuanced differences in terms of individuals’ access to resources for adaptation. We build on multiple Earth System Governance contextual conditions and research lenses to demonstrate that an intersectional approach allows greater understanding of gendered adaptation options impacted by various other factors. This must include investigations beyond the traditional gender binary, which we have sought to achieve in this study by using broader local and individualistic context to observe different communities. We compare gender intersectionality in case studies from India and Tanzania. The evidence demonstrates that intersectional factors vary, impacting adaptiveness to changing Anthropocene conditions, depending upon cross-cutting context-specific systems of hierarchy and discrimination. However, despite variation, we demonstrate there are common factors to be investigated across all locations when identifying possible intersectional impacts of ocean policy interventions, particularly wealth, marriage and family roles, and social networks.

1. Introduction: UN Decade of Ocean Science and scientific gaps

The UN Decade of Ocean Science for Sustainable Development (UNDOS) highlights the need to “ensure ocean science can fully support countries in creating improved conditions for sustainable development of the Ocean (UNESCO, 2021).” UNDOS seeks to support science-informed policy, including policy directed towards stronger adaptation efforts (UNESCO 2021). One challenge highlighted by the UNDOS Implementation Plan is to: “Generate knowledge, support innovation, and develop solutions for *equitable* and sustainable development of the ocean economy under changing environmental, social and climate conditions (UNESCO-IOC, 2021: 22).” To achieve that goal, it is necessary to ensure availability of policy-relevant scientific knowledge, including social scientific evidence addressing how people are impacted

by – and respond to – these changing conditions.

However, these changing conditions affect certain groups more than others, depending on exposure, sensitivity, and adaptive capacity. That is, people may be exposed to changing conditions based on their livelihoods, locations, or social group identities. Resilience and adaptability to changes vary with the vulnerability of an individual, depending on given context and attributes. Power structures within systems of governance dictate who is more vulnerable to changes based on these attributes (May, 2021). For instance, communities living in less sturdy structures in less protected locations may face greater threats from storms or sea level rise (Adger et al., 2014; Leal Filho et al., 2018; Rabby et al., 2019). Even among people equally exposed to a common threat, some may be more sensitive than others in the sense that they can less afford to experience the harm. For example, while two different

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livelihood groups or social classes may both lose revenue for a period, those with more saved wealth assets may be able to more easily weather the storm (Novak Colwell and Axelrod, 2017). Revenue loss impacts individuals differently depending on their wealth because those with less assets or financial safety nets are more likely to sustain greater and longer lasting difficulties. Those with greater wealth, and access to more resources, are more likely to not only bounce back after a damaging event, but also to have the means to better protect themselves during the event. In contrast, short-term coping responses may be necessary for immediate survival but have long-term implications such as loss of productive assets (Heltberg et al., 2013). Finally, even among those who face equal exposure and are equally sensitive, some may have greater opportunities for adaptation than others. For example, some communities face cultural constraints on their adaptation options (Coulthard, 2008).

Gendered differentiation has been studied in small scale coastal fisheries, including in terms of adaptation constraints by gender. However, this analysis is often limited to male-female gender dichotomies. Intersectional approaches demonstrate differentiation within gender groups, driven primarily by other identity factors that increase or diminish individuals' decision-making power as a result of the discrimination they confront.

We build on multiple Earth System Governance contextual conditions and research lenses to demonstrate that an intersectional approach allows greater understanding of how gendered *adaptation* options are impacted by various other factors. For example, among women in Tamil Nadu and Puducherry, India, social networks and wealth can counteract the other constraints faced by women (Novak Colwell et al., 2017). Other research shows that women's fishing assets are influenced by marital or immigration status (Ferguson, 2021). These two examples show how different factors influence gendered experiences across different contexts. Intersectionality approaches highlight distributional *justice* resulting from *power* relationships that are *allocated* by multiple components of an individual's social identity, and result in simultaneous cross-cutting forms of discrimination and oppression. Stakeholders therefore have more or less *agency* depending on particular sets of demographic characteristics. In this case, injustice may be moderated by intentionally designed *architectures* that push decision-makers to consider important cross-cutting factors.

Science-informed Ocean policy requires the best scientific evidence, including nuanced analysis that demonstrates how changing physical conditions interact with stagnant social power structures. Remaining scientific gaps – particularly lacking knowledge of differentiated exposure, sensitivity, and adaptive capacity – may lead to policy that exacerbates existing injustices rather than promoting “equitable and sustainable” development.

Therefore, this study provides a roadmap for intersectional analysis that can inform equitable and sustainable ocean policy. We demonstrate the common experience of gender intersectionality across multiple case studies from India and Tanzania. At the same time, acknowledging the locational context of gender (Hawkins et al., 2011; Nightingale, 2011), we show how these case studies present different types of intersectional considerations across distinct cultural contexts that inform different systems of cross-cutting hierarchy and discrimination. Therefore, we demonstrate that future ocean science must investigate common factors across all locations to unpack context-specific intersectional power dynamics. These considerations include, in particular, impacts of wealth, family roles, and social networks.

The article proceeds by reviewing current literature on gendered outcomes in coastal small-scale fishing communities, followed by an introduction to the concept of gender intersectionality in coastal fisheries. We then present evidence from multiple case studies to demonstrate aspects that are universal and other factors that are more contextual in nature. Finally, these findings allow us to develop a framework for future intersectional ocean science research that can inform more robust policy decisions.

2. Gender divides and intersectionality

Justice relies on equitable access to, and allocation of, natural resources. Adaptation to changing conditions depends on people having access to sufficient resources for their adaptation response. Therefore, without adequate access to resources, people are left increasingly vulnerable to changing conditions, which threatens justice and security. Such access is determined by the degree to which individuals or groups have power to influence decision-making at multiple levels. As we demonstrate, this power stems from multiple group identities that can either expand or reduce access to resources needed for adaptation. Therefore, an adequate governance structure that addresses inequality and injustice will use intersectional considerations by observing people's intersecting group identities and applying these observations to better understand the degree to which people have the power to influence decisions that affect their lives.

Early research in gender vulnerability and fisheries livelihoods focuses on single characteristics (i.e., gender) that determine people's adaptation capabilities in context with the oppression and exclusion they face. More recent studies identify the need for nuanced understanding of intersecting factors. Therefore, our paper takes this extra step in order to understand how oppression, adaptation, and vulnerability vary based on local and individual context. After analyzing case studies conducted in small-scale fisheries, we show which factors are consistent across different contexts, and which are relevant only in some contexts. The following section reviews existing literature on gendered access to resources for adaptation purposes, then shows how intersectional analyses have strengthened gendered analysis. This leads us to the question of which factors are universal, and which are context specific, in their exacerbation or moderation of gendered oppression in coastal fishing communities.

2.1. Gender divides in fisheries and oceans

Scholars and practitioners have examined requirements for more equitable and sustainable coastal management systems. The Small-Scale Fisheries Guidelines (SSF Guidelines, FAO, 2015) highlight the need for attention to gendered impacts of natural and social conditions, suggesting that gender data should be analyzed by organizations as well as states. The relative numbers of women versus men in the management sector should be analyzed to see if hiring practices appear to be gendered. The guidelines also recommend that institutions should have systems that promote all deserving workers to higher positions in the organization, and those systems should specifically address and consider gender. While this goal is admirable and essential, and the need for sex-disaggregated ocean data is clear (see also Wabnitz et al., 2021; FAO and Biswas, 2017; Kleiber et al., 2015), the Guidelines do not confront power structures that keep such gender inequality in place, as intersectional approaches identify. Moreover, the Handbook for gender-equitable implementation of the Guidelines highlights the importance of intersectional analysis (p.3), but largely focuses on dichotomous gender divides in its assessment (FAO and Biswas, 2017). These approaches are crucial first steps for identifying necessary gender differentiated data for actionable ocean science. They mirror much existing scholarship in this area as well.

For instance, studies demonstrate that adaptation options may be differentiated by gender because of different access to resources and livelihood options. Fishing society tends to be more egalitarian than other urban or rural agricultural contexts (Rubinoff, 1999). However, differences within communities and between individuals of the same gender in terms of access and control over capital (financial, productive and social) have been shown to exacerbate gender divides in adapting to seasonal stresses (Novak Colwell et al., 2017).

Assigned roles are not unique to fishing communities: women tend to oversee household expenditures (food, education, healthcare) while men are in charge of productive assets. Similarly, Barclay et al. (2018)

highlight gendered roles in the market for shell money and jewelry in Langalanga's lagoons. Since the 1990s, women have been predominantly seen in the retail trading system, because when men dominated the shell money and fishery retail systems, the systems were inefficient due to their tendency to spend the money on "alcohol, gambling and extra-marital affairs, rather than bringing the money home to the family" (Barclay et al., 2018: 204). When tuna value chains in Indonesia are observed, men are usually seen either in positions that involve considerable physical labor and heavy lifting, or in higher positions of authority that accumulate greater sums of wealth. In contrast, women are seen with positions in markets of lower value trading. Women do not typically occupy higher-ranked authority positions, which can make them vulnerable to labor abuses (Barclay et al., 2020). This is a demonstration of gender intersecting with wealth and income assets. An interconnection between gender and positions in the fishery sector generate wealth differences that disparage women who are low income. In Maluku's fishery sector, women only comprise 30% of the retail trading management system. There is a common assumption among many small-scale fisheries that men's role is on the boats and in the water, and women's roles are on land within market endeavors. This distinction allows women to gain valuable knowledge within trading markets and create trading connections when they do manage to gain positions in the trading system.

Many of these role differentiations stem from women's presumed rightful role in the private sphere, converging with their difficulty obtaining positions of authority. These assumptive private roles may also disadvantage women who are in trading positions. For instance, women who work in the retail trading sector of their local fisheries are culturally constrained by a stigma placed on women traveling. Trading trips and markets away from home are primary potential sources of income, but societal restrictions make it difficult for women to profit from these experiences. First, women are discouraged to leave their domestic duties and families for extended periods of time, especially if they have young children under their care at home. Second, violence can ensue when women travel for the purpose of retail trading, because it is often wrongfully assumed that they are engaging in sexual encounters while on their excursions. In Langalanga, three women interviewees claimed that they were discouraged to travel for retail trips through means of violence, because of their fictitious assumed sexual relations with other men during their travels. (Barclay et al., 2018). Women who have more family duties at home are presumed to have less time for their duties in their place of employment, and the stigma surrounding supposed female promiscuity away from home decreases likely success for married women in the retail trading sector. These obstacles demonstrate how the intersection between gender and marriage/motherhood creates barriers for fisherwomen and female traders, particularly those who are married and/or have children, to travel and access more fruitful markets.

Gender roles may also result in differentiated bargaining power. de la Torre-Castro et al. (2017) show that management roles are often androcentric, primarily placing men in positions of hierarchical authority. Nightingale argues that by focusing on the allotment of authority and positional power, one can better observe that resource governance struggles often have little to do with the resources themselves, and more to do with attributive power structures (Nightingale, 2017). For instance, male-dominated livelihoods, specifically fishers, may also be prioritized in the policy sphere, which dictates the process and direction of resource allocation.

Many of the fishing allied sectors (which are dominated by women) have been less visible if not wholly absent in the decision-making process regarding fisheries management decisions. For example, in the aftermath of the 2004 Indian Ocean tsunami, relief and rehabilitation packages focused predominantly on rehabilitating the production sector with little resources devoted to rebuilding markets, transportation infrastructure, etc. that women vendors and other allied workers depend on (Novak Colwell, 2016).

In devising fisheries management regulations, such as the annual 45-day fishing ban, implemented in Tamil Nadu, India and similarly implemented (though the schedule and duration differs) throughout coastal India, the stakeholder engagement process was completely dominated by men fishers, while women and other allied workers were not consulted (Novak Colwell et al., 2017).

In addition to livelihood-based participation that discriminates against professions largely populated by women, other governing processes explicitly exclude women, often in the name of tradition. They may be prohibited from holding elected positions or even to serve as family representatives in community meetings.

Where there is evidence of women participating in such governance arrangements, it may be through established women's groups, such as self-help groups (SHGs) in southeastern Indian villages. This avenue allows some women's perspectives to be loosely represented through their social network affiliations.

These constraints on resources, livelihood choices, and policy influence typically add up to fewer adaptation options for women, on average. However, as with the Small-Scale Fisheries Guidelines approach, this "gender divide" analysis does not fully confront power dynamics that reinforce such divides or uncover different experiences within each gender group. For example, the Guidelines do not particularly confront the social stigma of women being employed in more demanding roles in the fisheries sector despite having family duties. Recent studies also show that the stigma of traveling for working women severely hinders their abilities to gain prominent positions in the market and elevate their own status. The negative managerial and social attitudes that hinder women from traveling for work, as men do, is not explicitly mentioned in the SSF Guidelines outside of a brief mention of "leaving family duties". Nothing is mentioned of the promiscuity stereotype of traveling working women, which is a common source of vulnerability to violence for these people. In reference to gendered spaces, these Guidelines only discuss promoting the land and coast sector (women-dominated) to be economically equivalent to the deep-sea sector. While this is important, nothing is mentioned about merging access to gendered spaces. Instead, a separate but equal doctrine is insinuated.

2.2. Intersectionality – beyond mere gender divides

FAO and Nilanjana Biswas (2017) note the importance of considering relationships between power and gender, particularly intersections with "other sources of power, such as class, race, religion, or sexuality (3)." Such consideration is essential for disaggregating impacts on different individuals rather than lumping together all women as vulnerable (Arora-Jonsson, 2011), identifying how these other factors further establish barriers for women and men of particular identities (Nightingale, 2011). This section further defines the concept of intersectionality and applies it to identify necessary ocean science information for management decisions.

Intersectionality is a component of power relations that combines different factors to determine what sort of individual dominates a system and which individuals are forced into an inferior position. In short, intersectionality is the acknowledgement that humans are multi-faceted and have various characteristics that contribute to determining their position in society (Garry, 2011: 827), particularly in terms of how they must confront overlapping systems of discrimination. For instance, the division of women's private sphere intersects with forced subordination in the workplace to lock in disadvantages for women in the retail trading sector. Men tend not to experience these intersecting obstacles, and therefore find it easier to succeed in the retail and trading sector of their markets, while comfortably holding positions of leadership, though their experiences may also vary based on different identity factors. Adaptation options are often constrained by these limits to individuals' limited choices and influence (Thompson-Hall et al., 2016).

Early intersectional approaches, originating in large part from Black

feminist scholarship, focus particularly on racist and patriarchal systems of domination that compound each other's effects on individuals (Crenshaw, 1991). Although this scholarship emerged in the context of understanding racism and patriarchy in the United States, many of its lessons may be applicable in other contexts even though the specific patterns of discrimination differ (Detraz, 2017).

In the realm of environmental justice and access to high quality resources, these intersecting systems may mutually reinforce domination. They do so by exposing vulnerable individuals identifying with multiple marginalized groups to additional risk (Ryder, 2017), and then downplaying their concerns (Kojola, 2019). Intersecting group identities may also constrain or enable opportunities to respond to these risks by organizing against oppression (Taylor, 1997). These systems may further harm individuals by limiting their choices, and thereby constraining options available for individual adaptation to changing conditions (Thompson-Hall et al., 2016).

Intersectional policy aims at applying individual variation to public policy and adapting and accommodating to promote an equitable system of governance. American lawyer Kimberlé Crenshaw argues that using a "single axis" approach to public policy does not account for human complexity, and only represents a portion of an individual's relation to the hierarchical power system (Crenshaw, 1991). Without fully understanding and addressing the resulting power disconnects (Webster, 2015), governance systems fail to overcome existing forms of discrimination and oppression. Therefore, it is argued that locally contextualized intersectional governance systems are more appropriate and effective than globally framed, generic policy mechanisms in combatting vulnerability (Ojha et al., 2016).

The intricacies of intersectionality can make it difficult to comprehend and form a political consensus. One of these difficulties is that there are not only diversities among individual women and men, but there is also diversity from community to community in terms of how these power dynamics are constructed and implemented (Nightingale, 2011). International system-level gender inequalities, which are consistent across multiple locations, intersect with smaller-scale community expectations. Therefore, every individual in any place on earth can be intersectionally analyzed differently than everyone else. For this reason and others, there is no current consensus on how to carry out intersectional analysis. Despite its complexity and nuance, intersectional policy has proven effective when enacted properly. In 2020, IIED conducted a structured analysis to examine the effectiveness of intersectional policy. One of the project's greatest successes was in Zanzibar and Northern Tanzania, where IIED and Stronger Voice's research helped to create an intersectional "tool-kit" that allowed marginalized groups to gain traction in their climate crisis movement for a more sustainable environmental policy (Sverdlik, 2021). By including local people in regional gender analysis, intersectionality can become slightly less daunting. Case studies are vital to intersectional work because location is a primary factor in determining someone's "inherent" societal role. As we demonstrate below, comparative case studies also provide better knowledge about which intersectional factors are held in common, and which vary across different contexts and places.

2.3. Applying intersectionality through the ESG Science Plan to ocean science

To produce "the science we need for the ocean we want," it is essential to address nuances of ocean impacts for different groups of people. Much existing research highlights geographical differences related to range of ocean species, cultural uses of ocean resources, or production capacity to exploit resources. However, the Earth System Governance Science Plan (Burch et al., 2019) directs scholars towards different approaches for identifying some of these nuances. Its *Justice & Allocation* research lens requires an identification of how groups are differently impacted by access to various natural resources. Coupled with intersecting contextual conditions of *Diversity* and *Inequality*, the

Plan highlights the need to understand these differential experiences, particularly diminished access for some groups to decision-making processes (i.e., through *Democracy & Power*, another ESG research lens). Oppressed and/or marginalized groups often face unequal barriers to influencing policy, and therefore confront increasing injustice amid decreasing allocation of resources. Existing research highlights gendered dimensions of decision-making participation, geographical advantages, and economic power (e.g., de la Torre-Castro, 2019). We extend this understanding to demonstrate how these factors – differentiated among individuals who share a gender identity – may also mitigate or exacerbate gender-based oppression.

In the context of ocean science that prepares people to adapt to the *Anthropocene's* changing conditions, these considerations are crucial because different groups face different threats and opportunities for *adaptation*. First, it is important to disaggregate who faces increased exposure to ocean system changes, depending on their location, livelihoods and/or household responsibilities. Second, some may be more sensitive than others to these threats, less able to survive while experiencing the harm. And finally, capacity to adapt is similarly unequal due to some groups' limited capitals (particularly human, natural, social, and financial) (Allison and Ellis, 2001), as well as cultural constraints on changing livelihoods or other choices (Coulthard, 2008).

Intersectionality approaches are necessary for fully applying the Earth System Governance Science Plan to ocean science. To tackle the above unequal conditions and adaptation options, it is essential to understand how people are or are not empowered to respond. Intersectionality approaches highlight distributional *injustice* resulting from *power* relationships that are *allocated* by group. These complementary systems of discrimination force us to consider how each individual's multiple identities potentially result in overlapping forms of oppression that constrain their adaptation options. We present case studies from India and Tanzania to highlight the impact of intersecting identities on adaptation choices in coastal communities. That is, we demonstrate that individual stakeholders have more or less *agency* depending on particular combinations of demographic characteristics that influence their overall position in society. Our goal of conducting research in this fashion was to answer the question of what factors intersect with gender across multiple case studies to increase vulnerability of certain individual identities, and how can this knowledge be used to advocate for contextualized local governance. By observing both case studies as unique contexts, we sought to observe which factors were universal and which were more contextualized to a certain region, ultimately applying the results to policy-relevant approaches.

3. Research methods

Our research draws on evidence from small-scale fisheries case studies in two countries: Zanzibar, Tanzania and both Southeastern (Tamil Nadu/Puducherry) and Southwestern (Kerala) India. These cases were chosen to demonstrate gender divides that occur as a result of various systems of discrimination – based on gender, wealth, social networks, and geographic location – that impact adaptation opportunities. Although they rely on different types of evidence, all three case studies explicitly set out to identify and describe gendered systems of hierarchy that impact individuals' adaptation options.

The coupling of these case studies allows us to compare the implications of intersecting social identity categories (e.g., caste, gender, and class) for adaptation constraints in each region. In other words, it allows us to explore patterns that differ in terms of how overlapping "*context-specific ... social categorizations*", related to broader power relations, affect adaptation choices (Kaijser and Kronsell, 2014). Data was collected prior to the intent of making this cross-case comparison, so our observations and analyses were compared retrospectively. A retrospective analysis of these cases is relevant and appropriate because it allows us to observe commonalities between the two cases that were not originally intended. The comparison and contrast allows us to better

understand broader implications of results from each location, thereby identifying how an intersectional governance framework could help communities facing gender injustices. Data was collected independently for each of the study regions, but nonetheless provides opportunity for comparison across contexts. In particular, the case studies all address individuals' different abilities to adapt to situations that limit their access to natural resources for livelihood and food security. Through each case, we are able to identify "which social categories are represented in, but also which are absent from, the case(s) under study (Kajiser and Kronsell, 2014: 422)." In particular, we sought evidence regarding how gendered oppression was moderated by wealth, social networks, participation, religion, geography/location, education, and family roles in each region. We also looked for evidence of other intersectional factors in each case study, to ensure that our hypothesized list did not limit findings.

Research in Zanzibar took place from 2000 to 2020, which included ethnography, interviews and diaries of participant observation, and collection of fish catch data from Zanzibar's East coast. Additional details about data collection are available in published scholarship (de la Torre-Castro and Lindström, 2010; de la Torre-Castro et al., 2014, 2017, 2019; Fröcklin et al., 2013, 2014, 2018). The India case study was replicated on both coasts to see if the gender divide was consistent within India. These surveys (N = 282 in Tamil Nadu and Puducherry in 2015; N = 1800 in Kerala in 2016) were intended to show how fisheries policy (i.e., a seasonal trawl ban) affects individuals' adaptation options based on their specific socio-economic situations. Surveys were conducted to observe whether there was a gender divide in adaptation responses or coping strategies, in response to stresses faced by resource use constraints, and whether any emerging gender divide is conditioned on other factors as well. Additional details about Tamil Nadu data collection are available in Novak Colwell et al. (2017) and its online appendix. The Kerala study replicated the same survey approach, but surveyed a broader sample rather than relying on household random selection within each community. Both survey instruments are available from the authors.

4. Findings from comparative case studies: India and Tanzania

4.1. Adapting to fishing policy in southern India

Adaptation may be required for people confronting all manners of change. While much research highlights adaptation behavior related to physical changes in the natural environment (e.g., Smit and Wandel, 2006), humans must also adapt to changing social or policy contexts that respond to those physical changes. In coastal India, all fishing communities observe a seasonal trawl ban. States implement the ban at different times of year, and the length of the period has varied over time (and continues to vary across states), ranging from 45 to 61 days in recent years. While trawl fishers are entitled to compensation for their compliance during this period, allied sector workers do not receive compensation for losses, leading many to confront stark declines in income during this time (Novak Colwell and Axelrod, 2017).

In confronting stressors, not everyone has the same options for adapting to new conditions. As a result, some individuals are forced to pursue more reactive coping strategies that respond to the short-term threat while leaving them worse off (Heltberg et al., 2013). For example, foregoing a meal may allow someone to stretch their family's food supply, but it also results in detrimental health effects to the individual. Some individuals have more adaptation options than others, leading some to take more reactive behaviors. These adaptation constraints often result from intersecting forms of structural discrimination, including lack of particular livelihood options for certain groups (e.g., women in Tamil Nadu participate in fishing-related work, but are not permitted to fish themselves; access to wealth is often passed down through generations). In the case of the seasonal trawl ban, while some are able to save money earned during other parts of the year, or to rely

on relatives, others do forego a meal when they lack other options.

4.1.1. Overarching gender divide

Within two fishing villages in South-eastern India (one in Tamil Nadu, one in Puducherry), a gender divide did emerge in the 2015 survey (Novak Colwell et al., 2017) (see Table 1 for a comparison of factors impacting adaptive capacity in each of the case studies). Women were more likely, on average, to engage in reactive behaviors such as reduced food consumption (16% vs 4% for men, $p < 0.01$).¹

In Kerala, all adaptation and coping strategies were more prevalent than among the respondents to the earlier survey. However, the overarching gender divide persisted among these respondents as well, with 68% of women and 42% of men answering that they had reduced food intake in response to the fishing ban's seasonal hardships (difference is statistically significant at $p < 0.01$).

4.1.2. Other factors intersecting with gender

However, this divide was conditioned on other factors on both coasts. In Tamil Nadu/Puducherry (East coast), it was found that household wealth was linked to increased adaptive capacity of women but not men. In these villages, women who were classified as having medium to high levels of wealth (measured through access to a variety of household assets) were found to have a greater ability to adapt in the face of seasonal stresses and were less likely to turn to harmful *ex ante* coping strategies (such as selling off assets or decreasing food consumption) ($b = -0.50$, $p < 0.05$). Within these same villages, it was

Table 1
Patterns of hierarchy and oppression affecting adaptive capacity in fisherfolk.

	Tamil Nadu, India	Kerala, India	Zanzibar, Tanzania
Women's roles in resource harvesting	Not culturally allowed, but other fishing industry roles	Not culturally allowed, but other fishing industry roles	Near shore, specifically algae
Overall gender divide	Yes	Yes	Yes
Impact of wealth or social class on gender divide?	Yes – household wealth	Yes – household wealth and fishing assets	Yes – poverty exacerbates gender divide
Impact of social networks or governance participation on gender divide	Yes – social networks, but not other forms of participation	No reported variation	Yes, but mostly for men; individual agency in decision-making benefits women, participation has weak benefit for women
Impact of religion on gender divide	No variation among respondents	Yes, but only for men	Not analyzed
Impact of spatial or geographical factors on gender divide	No	No	Yes – impacts which species to harvest, and women's ability to access while conducting family care responsibilities
Impact of education on gender divide	No	No	Yes
Impact of family roles/marital status on gender divide	Not analyzed	Not analyzed	Influences spatial factors; husbands' occupations also impact options

¹ All statistical findings for Tamil Nadu and Puducherry case studies are reported in further detail in Novak Colwell et al. (2017). Kerala findings are included as a separate table in the online appendix to this article.

shown that women who had strong social networks were able to draw on those networks as an additional means of support to manage difficult times ($b = -1.03$, $p < 0.05$). However, networked connections only offered an additional safety net for those women who also had medium-high levels of wealth ($b = -1.69$, $p < 0.05$), likely by increasing the pool of economic support for them and their families. Women with low levels of wealth did not receive the same benefits from their networked connections, and their social networks (combined with low levels of wealth) did not make a significant impact in preventing them from turning to potentially harmful, *ex ante* coping responses ($b = -0.19$, $p > 0.1$). In other words, adaptive capacity for people within these communities was driven by an interaction between gender, access to wealth (i.e., social class) and network connections (i.e., access to social resources).

All fisherpeople interviewed in the Tamil Nadu case study were Hindu and members of a hereditary fishing caste. Fishing castes are classified as “Other Backward Castes” by the Tamil Nadu government. This reflects their relatively low position in India’s caste hierarchy and entitles them to certain rations and subsidies from the government. While lower caste women do have relatively greater freedoms of movement and speech than upper caste women (Agarwal, 2001), the intersection between gender, caste and class is an important determinant of power relations within and outside fishing areas in Tamil Nadu and Puducherry territory. Our data shows that higher class women (of the same caste) have enhanced adaptive capacity versus their lower class counterparts.

Other factors were examined and found not to influence adaptation choices for women or men (e.g., women: experience with community governance by reporting problems, $b = 0.52$, $p > 0.3$; possession of fishing-specific assets, $b = 0.02$, $p > 0.9$).

Unlike in Tamil Nadu and Puducherry, there was almost no variation in terms of Kerala respondents’ reported access to social networks or forms of empowerment such as participation in governance. 98.7% of respondents (and even more frequently among women) said they participate in community decision-making and have access to social networks. For men, the likelihood of reduced food consumption is correlated with lower fishing assets ($b = -0.19$, $p < 0.01$), lower household assets ($b = -0.57$, $p < 0.001$), and Christian or Muslim (vs. Hindu) religion ($b = -0.99$, $p < 0.001$), but not with education at standard levels of statistical significance ($b = -0.03$, $p > 0.19$). In contrast, women’s reduced consumption is mitigated by fishing assets ($b = -0.56$, $p < 0.005$) and household assets ($b = -0.28$, $p < 0.1$), but not education: $b = -0.07$, $p > 0.12$ or religion ($b = -0.34$, $p > 0.24$) (see Appendix Table). Impacts of participation and networks could not be assessed due to their lack of variation among respondents, and caste status does not vary for many of the participants who are members of the Christian community. As such, the gender divide is once again present, and once again women and men are impacted by different additional factors, with lower wealth/class exacerbating difficulties for both men and women, and Hindu religion mitigating constraints only for male respondents. However, the context also clearly matters, with different forms of power and participation mitigating social harms, and different community experiences with caste and religion, in Kerala and Tamil Nadu/Puducherry.

In addition to social networks beyond villages, the East coast research also qualitatively explored women’s Self-Help Groups (SHG) as a means of empowerment. Membership creates local social network ties, and also facilitates access to and promotion of savings schemes and rotating loan availability. This gives members a potential additional safety net to access in times of need. However, the rotating loans cannot be accessed at will or on demand – given the rotating nature of the opportunity, a member can only take advantage of the rotating loan when it is their turn in the cycle. Although direct SHG membership was not statistically significant in reducing individuals’ need to select reactive coping, it is possible that SHG membership connected women to others outside their home villages in similar groups, thereby strengthening their broader social networks discussed above.

Spatial dimensions were not found to be particularly important determinants of the gendered experience in either location. For example, the two east coast villages had different access to the sea as a result of post-tsunami reconstruction placement (0.5 km vs 2.5 km from the coast), but results between the two villages did not differ significantly. However, women and men do have access to different livelihoods on land and at sea.

Neither survey differentiated experiences on the basis of nationality or marital/family status, though more recent research has demonstrated the importance of those factors for intersectional discrimination (Ferguson, 2021).

4.1.3. India case summary

Incorporating an intersectional lens in our analysis of adaptation and coping responses to a seasonal fishing ban highlights major social factors that condition how individuals experience the resource closure.

We find that an individual’s class and gender (as two intersecting social categories of identity) interact with an individual’s social capital (exhibited through outside village networks) to condition adaptation and coping responses to a seasonal fishing closure in Tamil Nadu & Puducherry, India. Lower class women have greater limitations on their ability to adapt in non-destructive ways and as a result are more likely to turn to harmful, short term coping responses. These coping responses, like cutting down on food intake, can serve to reinforce and perpetuate their marginalization by affecting their own human capital. Conversely, higher class women who have access to outside social networks have additional adaptation options not available to lower class, non-networked women. This in turn may serve to maintain their relative social power and ability to adapt to other seasonal stresses. Given the high degree of importance of informal, reciprocal exchange networks – a woman’s ability (or perceived ability) to reciprocate (as measured through her level of household assets) appears to be an important mechanism that mediates the relationship between networks and enhanced adaptive capacity, thereby empowering certain women, while simultaneously serving as a disadvantage to others.

In contrast, in Kerala, only reduced wealth and fishing assets further limited women’s adaptation options. Men, on the other hand, were affected by both lower wealth and religious identity outside of the Hindu community. However, the biggest contrast between Kerala on the one hand, and Tamil Nadu and Puducherry on the other, is that social networks and civic participation were almost universally available to Kerala respondents, thereby supporting their adaptation opportunities across the board. This key difference is crucial to understanding possible policy responses that would limit gender divides in adaptation responses, while also acknowledging that the social context of the two areas is quite different.

4.2. Adapting to new fishing practices in Zanzibar, Tanzania

In Zanzibar, coastal livelihoods revolve around diverse rural and maritime activities, with marine-based options at the forefront. Traditional marine management systems have confronted new conditions and ideas in recent decades, including new fishing technology, aquaculture, and management strategies such as Marine Protected Areas. Cultural traditions, including gender roles, moderate peoples’ experiences with these changing situations.

4.2.1. Overarching gender divide

One example of these changes is seaweed farming of red algae *Euchema* species, originally introduced in the 1980s to alleviate pressure on fisheries and to provide men with better income opportunities (Bryceson, 2002). However, profits have been diminished by international competition and the leverage exerted by companies purchasing the raw product to extract carrageenan (Rönnbäck et al., 2002). In response, men have largely exited the industry and left these lower income livelihoods to women. Higher temperatures, driven by global

climate change, have further harmed this industry by limiting algal growth and increasing disease susceptibility. Nonetheless, many women remain trapped in this livelihood option that keeps many in poverty (de la Torre-Castro et al., 2017), in part because of international policies that continue to support aquaculture development with anecdotes from the very few people – including some women (Msuya and Hurtado, 2017) – who have been enriched by the industry (Forss, 2010; Eklöf et al., 2012).

Though Zanzibar has not always been a patriarchal society, current conditions have substantial limits for women. Much of the divide is driven by a gendered division of labor that also has clear spatial components. Mapping seascapes showed that from coastal forest to the open sea, all ecosystems' uses are structured by gender. Closer to land (shallower waters), women dominate, while men dominate livelihood activities further out to sea (deeper waters), where they have a much wider range of spatial and livelihood options (de la Torre-Castro et al., 2017). Women are not allowed to be boat captains, and only few women own a boat (and even these women do not participate directly in the activities emerging from their vessels). Only men fish in corals or the deep sea, where species of highest economic value (though not necessarily as much ecosystem service provision) are found (de la Torre-Castro et al., 2017). Moreover, men are free to move wherever they want, including to fishing grounds in other villages, countries and between the countryside and urban areas in Stone Town (Fröcklin et al., 2013). Seagrass meadows (situated in the intertidal/mid area between coast and the open sea) are used by both men and women, and are important for food security and steady supply of goods and services (seasonality independent). Despite this overlapping use in seagrass meadows, the primary activity is still highly gendered (de la Torre-Castro et al., 2017). Men fish fin-fish and invertebrates (e.g., octopus and lobsters) with harpoon, while women collect small invertebrates (e.g., gastropods and bivalves) or farm red algae as discussed above (de la Torre-Castro et al., 2014; Fröcklin et al., 2012). As such, gendered spaces influence women's opportunities to shift livelihoods in the face of changing conditions.

4.2.2. Other factors intersecting with gender

As in the India examples, wealth and social class exacerbate gender divides in Zanzibar's fishing communities. These intersecting forms of discrimination limit livelihood options available to community members who face changing conditions in the marine sector (Fröcklin et al., 2013, 2018). For women, poverty is an important factor that conditions their ability to invest in new opportunities. As a result, many women are forced to focus on subsistence activities in the short term rather than planning for future livelihoods (de la Torre-Castro, 2019). For men, opportunities may also be constrained by wealth, particularly as measured by their ability to invest in housing materials (evident in roof types) and fishing implements (gear/vessels). These resources enable men – but not necessarily women – to shift livelihoods in response to changing conditions. The resulting higher incomes and increased status (particularly for those purchasing more modern fishing gear, working in the public sector or as auctioneers) creates a feedback loop where well-resourced individuals continue to take most advantage of changing situations.

In addition, women's opportunities are further constrained by their education level and their husbands' occupations, as well as their individual agency in decision-making (Fröcklin et al., 2018).

As in southeastern India, social position also translates into social network access that has different implications for women and men. However, in Zanzibar, networks are stronger and more organized for men, helping men to increase opportunities. Women, in contrast to the Indian experience, have little opportunity to benefit from social networks due to their disorganization particularly among seaweed farmers. Women's networks are to some extent developed by externally-driven microcredit opportunities, but these networks do not have the same widespread impact as men's networks (Fröcklin et al., 2013). As such,

social position (and thus social network access) is not a factor that can moderate gender discrimination to the same degree in this context.

As noted above, spatial access to marine livelihoods is highly gendered in Zanzibar. In addition to the limited opportunities for work further from shore, women are generally constrained to activities in the nearest areas to their households so they can take care of household chores and children while bringing some limited additional income to the household. Along with the opportunity to switch to household activity when seaweed is less accessible during high tides, these household responsibilities also confine some women to continue working with seaweed despite the low income it provides. As a result, unlike men, women are further constrained by their level of household responsibilities and the proximity of their homes to valuable resources. These spatial and family dynamics may therefore exacerbate some women's oppression.

Access to governance participation also has gendered impacts in this fishery (de la Torre-Castro and Lindström, 2010). For men, political affiliations may impact social networks and/or work opportunities, though more research is needed to identify how these relationships evolve, and their implications for adaptation choices. For women, participation opportunities are another key factor influencing adaptation options. Despite vocalizing concerns, women were not sufficiently influential in the process of developing fishing and coastal policies. Certain guidelines such as the Marine and Coastal Environmental Management Project (MACEMP) did target women specifically with some added components, but overall it was not technically written for the benefit of women (de la Torre-Castro et al., 2017). It is clear that intentionally designed governance systems, with opportunities for influence from marginalized voices, can reduce some of the gender divide in adaptive capacity.

Other factors have not yet been studied in terms of their gendered intersectional impacts, but would be valuable topics for future investigation. For example, ethnic hierarchies have important impacts in Zanzibar society, but have not been fully assessed in coastal villages. Religion also plays a role in resource use and management, though there is not a great deal of religious diversity within fishing villages to allow analysis. Nationality is also an important factor in Zanzibar, with priority often given to foreign workers in the tourism industry. However, the intersectional implications of that hierarchy are also not well-studied in the fishing sector. Additional factors would also be valuable to study, such as the role of gendered influences in arts, traditional culture, popular culture, religion and spirituality.

4.2.3. Zanzibar case summary

As with the Indian case studies, evidence from Zanzibar demonstrates more adaptation limitations for women than for men on the whole. Again, this divide is conditioned on other intersecting factors that further exacerbate harm to women in fishing communities, particularly wealth or social class. These cross-cutting forms of discrimination further harm certain individuals by denying them opportunities for adaptation. In other areas, the same factors are present in Zanzibar as southern India, but play out differently. For example, social position enables access to beneficial social networks in both countries, but these networks are not as available to support women in the Zanzibar context.

Collective action, organization and agency may also have important benefits for mitigating gendered oppression in Zanzibar. However, whereas such participation varies by person in Tamil Nadu and Puducherry, it is widespread in Kerala but very low for local women in Zanzibar. Women in other coastal areas in the Western Indian Ocean (e.g., Kenya) and Latin-America have greater agency and influence, possibly as a result of aid agencies' non-critical assessments (e.g., accepting myths of success without longitudinal evidence of sustained success) and the need for women to focus on short-term subsistence activities, as well as household burdens, more than in other regions (Fröcklin et al., 2018).

Finally, some intersecting power influences are present in Zanzibar

that are not found in our other study locations, but do require further analysis elsewhere. For example, spatial divides (i.e., physical access to resources) play a more central role in limiting options in Zanzibar than they do in the Indian sites.

5. Discussion

Location, and local context, determine intersectional effects on an individual's position in society and the resulting opportunities they may access in the face of overlapping forms of discrimination, domination, and oppression. As these case studies demonstrate, despite that local context, there are universal lessons to be learned about intersectionality and the type of information necessary to take it seriously. Cho, Crenshaw and McCall (2013: 788–89) argue that “some of what circulates as critical debate about what intersectionality is or does reflects a lack of engagement with both originating and contemporary literatures on intersectionality.” In light of this statement, we aimed to properly connect the arguments made in each case study to foundational intersectionality literature. For example, a fundamental component of properly implementing intersectional management is to achieve greater unity across the diverse social spectrum and diverse fields that constitute the study of intersectionality (Cho et al., 2013).

First, any intersectional analysis must be grounded in an understanding of local power dynamics and governing architecture, starting with who is empowered to participate in decision-making. Lack of attention to women's – or other – voices may cause gendered impacts of policy choices. As such, governing processes need to consider whether the full range of stakeholder voices is present, particularly when gender divides impact livelihood, education, spatial access or other individual characteristics. In these situations, consultation based on particular livelihoods or geographic spaces may unintentionally exclude on the basis of gender. While the dynamics are highly context-specific, the need to assess these dynamics is likely consistent across all communities when considering individuals' adaptive capacity.

Second, one commonality among our case studies is the economic inequality of different livelihoods. In each study location, shoreline work, which is dominated by women, has less economic value than deep sea fishing, which is dominated by men. The cultural norm that women work closer to the land and men work in the deep sea reinforces the gendered spaces concept that keeps women in an economically inferior position. In other words, “manly” work is of higher economic value. This is a missed opportunity, since women have broad and untapped knowledge of the fishery trading and processing system. Women have also proven to place high value on the overall interconnectedness of their community's ecological resources and systems in some situations, though Arora-Jonsson (2011) cautions against generalizing this narrative of virtue.

Third, these economic inequalities determine who has resources that allow them to adapt by exiting the situation. In each case study, we see that wealth can mitigate other disadvantages for women and men. Even though wealth has different effects in each location, access to financial resources is an important overarching factor impacting *how* gender divides impact adaptation choices.

Fourth, culturally-determined gender roles also affect adaptation opportunities – particularly livelihood options – available to individuals. In Tanzania, some of the barriers to spatial and livelihood integration seem to revolve around perceived household responsibilities for women, particularly married women with children. Interestingly, Ferguson (2021) shows that married women in Palau actually have more access to fishing assets through their husbands' boat ownership. The impact of marriage and family roles clearly depends upon local norms and practices, and is once again a factor to consider for developing disaggregated data collection plans for all ocean policy decisions.

Fifth, access to social networks may also reduce gendered disadvantages in some locations. In South-eastern India, networks created a buffer against harmful coping options, but only for women who had

more wealth. In South-western India (Kerala state), however, networks may play a different role, with analysis complicated by the pervasiveness of these linkages. In Zanzibar, women were generally excluded from such networks. Vulnerability may also be determined by individuals' connection to the community, with some evidence that immigration status may limit fishing opportunities as well (Ferguson, 2021).

Finally, religion, education, and geographic location also had effects on gendered oppression in some, but not all, contexts.

6. Conclusions and lessons for management

In order to properly use an intersectional framework to create public policy, there are some implications that must be considered. As Nightingale (2011) shows, location is a main component of intersectionality because community norms can vary heavily from region to region. Therefore, intersectional policy frameworks must include locals, specifically local women, in the discussion. In order to understand the best method of facilitating inclusion and equity, those who are most marginalized must be directly addressed. Secondly, economic inequalities are at the center of gender studies in small-scale fisheries. In many coastal fisheries, women are viewed as caretakers and men are viewed as breadwinners. Women's contributions to local economic systems are highly valuable but underpaid. For example, in Langelanga's lagoons, women have a significant role in the retail side of shell money and jewelry, which are highly valued commodities in this region. Even though women facilitate most of the market for these items, men are traditionally in roles of higher authority and do more of the physical labor for finding the shells, therefore reaping a vast sum of the profits (Barclay et al., 2018). In order to promote gender equality in small-scale fisheries, women's participation in the fishery markets must be properly financially compensated. Many coastal fisheries have created designated spaces separated by gender, the common theme being that women take an inferior role. For instance, physical, deep-sea labor is dominated by men, while women are traditionally in land-locked roles. Another intersectional policy implication would be to merge these spaces into one collaborative system, where people of all genders are represented at each stage of the market. By creating designated gender spaces, women are excluded from the use of many natural resources that the ocean has to offer.

Drawing on common findings from the case studies here, we identify a series of social factors that should be reviewed by decision-makers in order to ensure intersectional hierarchy is taken seriously. This effort is essential for collecting the information necessary for “equitable and sustainable development of the ocean economy under changing ... conditions.” Without these types of intersectional evidence, ocean science is insufficient for tackling inequalities and power divides that limit adaptive capacity.

What follows is a brief checklist encompassing some of the main components that intersect with gender to discriminate and oppress women in small-scale fisheries. It is not an all-encompassing list of factors, but provides a starting point for information that needs to be gathered in order to enable gender-informed ocean policy.

1. Wealth and Income

Poverty intersects with gender to decrease power for women in small-scale fisheries. Individual wealth cannot be inherently changed by the government, but intersectional social welfare programs can mitigate the effects of poverty. More equitable management and market systems that merge gendered spaces would strengthen women's position in their coastal communities. Often amplified by family duties and obligations, women struggle to achieve higher positions of authority in the workplace and subsequently escape the poverty trap. Affirmative action policies are a potential solution, but they must be analyzed and created in an intersectional framework that analyzes more factors about

applicants than just their gender.

2. Marriage and Family Roles

When women are married, the stigma around leaving their household or community duties for work-related activities greatly increases. The stereotype of married woman as homemaker limits livelihood options. Straying from this stereotype may lead to social isolation.

Motherhood for women in coastal fisheries is parallel to their marital status. Once women have children, they are even less likely to achieve high level or physical labor positions in some studied communities. Community expectations of mothers are incredibly high, and with the expectation of fathers to be the family breadwinners, the women are left with most of the responsibilities of childcare, further limiting the ability to work further from home. This expectation can trap SSF mothers in dangerous or hostile relationships, especially when they depend upon husbands for access to fishing resources. Inclusionary employment policies for married women and mothers should prevent them from being barred from SSF work in general, and should also promote women, married or child-rearing women in specific, to higher positions in the market.

3. Hierarchy and Coercion

Clear attention also must be paid to local factors that increase vulnerability. For instance, an individual's dependence on employment may limit their options and also reduce their willingness to report problematic behavior. This situation, in turn, also makes the individual more vulnerable to physical violence and financial harm due to fears of appearing in the public sphere (Finkbeiner et al., 2021). Policies must take this vulnerability seriously, and limit its impact, first by understanding how it is experienced in particular contexts.

4. Social Networks

Conversely, gendered vulnerability may be reduced by access to social networks. These connections may offer livelihood alternatives and possibilities for migration. In some cases, they may also result in opportunities for participation in resource management decisions by offering a counter-weight to male-dominated community organizations. The establishment and recognition of such organizations may allow greater leverage and therefore expanded adaptation choices.

Finally, as the India case study demonstrates, it may be important to consider the interaction of multiple factors simultaneously. For instance, in Tamil Nadu and Puducherry, social networks only mitigated gender divides among individuals with greater wealth.

By understanding these intersecting processes at a community level, ocean science will be positioned to empower stakeholders, particularly those who have been marginalized in the past. The resulting model enacts ESG Science Plan principles to inform policy-relevant interdisciplinary ocean research. By integrating social and natural scientific knowledge in an intersectional framework, scholars and practitioners will be best positioned to achieve ocean sustainability goals. In particular, these more nuanced knowledge inputs to governing architectures can increase individuals' abilities to adapt to changing Anthropocene conditions.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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