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RESEARCH

Women's perspectives of small-scale fisheries and environmental change in Chilika lagoon, India

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Abstract

This article investigates the gendered implications of environmental change using case studies of two small-scale fishing communities in Chilika lagoon, India. We undertake an intersectional analysis that examines dynamics between groups of fisherwomen in relation to social-ecological change. We focus specifically on (1) fisherwomen's perspectives about the key drivers of change (e.g., natural disasters and aquaculture) within the social and ecological system of Chilika lagoon; (2) how environmental change is impacting the livelihoods and coping responses of fisherwomen; and (3) how fisherwomen communities are adapting to the ongoing process of change, highlighting in particular the gendered dimensions of out-migration. Our findings demonstrate that fisherwomen's roles and identities are not static and that the impacts of environmental change vary for different groups of fisherwomen. We find that gender intersects with caste, income, geographic location, age, and household membership to create heterogeneous experiences and knowledge that reflects the complexities associated with gender and environmental change. With specific regard to the increase in fisherwomen out-migrating, we show that responses and adaptations to environmental change have gender-differentiated impacts and challenges.

Keywords Small-scale fisheries · Environmental change · Chilika lagoon · Out-migration · Women

Introduction

Lagoons around the world have experienced environmental degradation resulting from various drivers of change (e.g., natural disasters and aquaculture). This has created adverse consequences for lagoon ecosystems (e.g., habitat and species loss) and human societies (e.g., loss of fishing livelihoods). Asia's largest lagoon, Chilika lagoon, situated along the eastern coastline of Odisha, India, is no exception. Recognized as a Ramsar Wetlands of International Importance in 1981 for its rich biodiversity, Chilika lagoon is a brackish-water lagoon which contributes to the livelihood and culture of approximately 150 fishing villages with over 400,000 fishers from various castes involved in the harvesting, processing, and/or marketing of fish and related fishery products (Ramsar 2012; Nayak 2014).

In the fisheries of Chilika lagoon, global- and local-level drivers have led to environmental changes, including resource depletion. Two key human-induced drivers of environmental change in Chilika are aquaculture which began in the 1980s, and the opening of a new sea mouth which occurred in 2001 (Nayak and Berkes 2012). Biophysical changes in this lagoon ecosystem associated with these drivers include fresh water- and salt water-level fluctuations, salinity issues, and the presence of invasive species. Social-economic changes include the loss of fishing livelihoods and income, leading to large-scale migration (Nayak and Berkes 2012).

This article addresses an important research gap in our understanding of environmental change in Chilika lagoon by highlighting the often-neglected perspectives of fisherwomen. Adopting a gender lens on environmental issues is crucial: women experience gender-differentiated risks as individuals, groups, community members, and in relation to men; possess specific knowledge and insights they have on processes of

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change, and themselves experience social changes as a result of interactions with a changing environment (Rocheleau et al. 1996). Moreover, as feminist scholars have emphasized, the specific, situated knowledge of women has long been overlooked in scholarship across various scientific fields, and can be used to better understand the positions of marginalized people and the political and social dynamics that exist (Harding 1992). In Chilika lagoon, our examination of fisherwomen's perspectives reveals the gender- and caste-differentiated impacts and challenges that fisher communities face during environmental change.

This study has three main objectives. First, we examine fisherwomen's views about key drivers of change, specifically the impacts of natural disasters and aquaculture. Second, we analyze how environmental change impacts the livelihoods of fisherwomen and how fisherwomen respond through coping strategies. Finally, we examine how fisherwomen are adapting to the ongoing process of environmental change, with a focus on resource depletion (i.e., fisheries) and the gendered implications of out-migration. Using an intersectional feminist lens enables us to consider fisherwomen's perspectives about changes in the fishery system in relation to social and ecological realities including caste, income, geographic location, age, and household membership. This paper thus offers an initial assessment of linkages to guide our understanding of the myriad experiences of fisherwomen and how structures of power interact and impact gender identities.

Theoretical framework and methods

There is a dynamic relationship between people and the fishery resources they depend upon. The process of defining this relationship is iterative and must account not only for changing natural resource conditions but also changing social conditions (Loomis and Paterson 2014). In the context of this research, environmental change and drivers of change are associated with both social and ecological factors and their relationships. A driver of change is any natural or human-induced factor that directly or indirectly causes a change in an ecosystem (MA 2003). Adaptation, in the context of environmental change, refers to an ongoing process of actions which assist a system to cope, manage, or adjust to a changing condition (Smit and Wandel 2006). Adger et al.'s (2007) research has shown that adaptation activities are impacted by multiple factors such as age, ethnicity, class, religion, and gender, which is supported in this paper through the use of an intersectional lens.

Allison and Ellis (2001) describe a range of strategies and responses at individual, household, and community levels, including livelihood diversification that fishing communities adopt as a response to fishery resource fluctuations. Livelihood diversification is one household strategy, where members of fishing households often become involved in different economic sectors to smooth the effects of fishery resource variations. Household-level responses include the allocation of family labor in time of need, or acceptance of income variation and modification of consumption patterns (Allison and Ellis 2001). McLeman and Smit (2006) highlight that among the many potential impacts of environmental change on human societies is the possibility of changes in human migration patterns. Adaptations, including out-migration, alter human relations with nature. These altered relationships with nature can have profound social, economic, and psychological effects on individuals, families, and communities. In Chilika lagoon, the social and ecological degradation of fisheries has played a major role in pressuring fishers to out-migrate (to urban centers) and leave their villages and fishery-based livelihoods behind (Nayak 2014). Certain adaptations can even exacerbate vulnerability and risks, resulting in maladaptation (Barnett and O'Neill 2010). In the context of environmental change and adaptation, this also includes determining whether out-migration in the face of environmental change is a viable option (Demetriades and Esplen 2008).

Gender is one of the primary social constructs that mediates relations between individuals and significantly determines individuals' relationships with resources and their engagement with nature (Meinzen-Dick et al. 2014). The tasks of social reproduction and care work have largely belonged to women, who not only play the role of wives and mothers, but who contribute substantially in many ways to the well-being of family members and the functioning of communities and economies (Elson 1991). With regard to fisheries, fisherwomen's tasks have become more difficult due to environmental change. Fisherwomen cope not only with uncertainties in the market due to economic changes and depletion in fish, but they suffer many consequences from out-migration as villagers leave their communities (Meinzen-Dick et al. 2014; Nayak and Vijayan 1996).

At the same time, caste and income levels also shape the experiences of fisherwomen. In Chilika lagoon, a caste-system is entrenched within a stratified society that greatly influences the status of fishing communities and establishes gender expectations (Sekhar 2004). In order to understand the range of options—and risks—that are available to fishers in Chilika lagoon as they adapt to environmental change, we use an intersectional analysis to understand the specific experiences of fisherwomen of two different castes in Chilika: the higher ranking Khatia caste and the lower ranking Khandra caste.

Intersectionality is "the interaction between gender, race, and other categories of difference in individual lives, social practices, institutional arrangements, and cultural ideologies and the outcomes of these interactions in terms of power" (Davis 2008: 68). Essentially, intersectionality allows us to understand the diversity of experiences among women and highlights that it is important to understand that gender relations are by no means

universal (Crenshaw 1991; Meinzen-Dick et al. 2014). Instead, we can examine more closely how the class- and caste-based biases that deprive the poorest and most marginalized in society compound gender inequity (Cronin et al. 2014). For instance, women of lower castes are sometimes further disadvantaged; they have limited access, control, and ownership of resources and are excluded from decision-making at the community level (Cronin et al. 2014).

Intersecting inequalities produce differing experiences of power and powerlessness between and among diverse groups of women and men, which in turn enable or deny them certain choices. This study of Chilika lagoon primarily focuses on how caste and gender influence fisherwomen's perspectives of change, impacts on livelihoods, and adaptation decisions. We consider how gender identity intersects with both higher and lower caste identities in the region. Although there are many other factors that might be considered in an intersectional analysis, our study of Chilika lagoon demonstrates that caste customs, norms, and gender expectations produce differentiated experiences as the lagoon undergoes environmental, social, and economic change. This analysis thus raises broader questions about how systems of oppression interact in the context of environmental change and opens new lines of inquiry for future research.

Research for this study was conducted in two fisher villages, Khatisahi and Biripadar. These villages were selected because they exhibit differences in village characteristics (see Table 2), and each village has a distinct fisher caste population. Fishers are generally considered lower on the Hindu caste hierarchy and historically the caste system defined the customary rules and norms of Chilika lagoon's community and contributed to fishing activities (Nayak and Berkes 2011; Nayak et al. 2014). As the following section explains, the caste system also shapes the experiences of both men and women, which results in gender-differentiated risks and vulnerabilities in adapting to environmental change.

A total of six family households—three in each research village—were involved in household case studies to contribute to the research analysis. The household case studies were largely ethnographic and a semi-structured interview format assisted in gathering key insights during visits. Additionally, these households were revisited to observe household members engaging in discussions and household activities. Within the two villages, semi-structured interviews and focus groups with additional village locals and key informants were conducted. Data collection methods including document reviews of past research on environmental changes and the history of Chilika lagoon, semi-structured interviews, focus groups, and participant observation were used and facilitated through participatory rural appraisal (PRA) techniques and tools (e.g., social maps, Venn diagrams) (Narayanasamy and Boraian 2005) (Table 1).

Village profiles: Khatisahi and Biripadar and gender roles

The fishers of Khatisahi are of the higher ranking Khatia caste and the fishers of Biripadar belong to the lower ranking Khandra caste. Both the Khatia and Khandra are capture fishers who rely on the production of fish, shrimp, and crab as their main source of income throughout the year. Over the last 10–15 years, there has been a drastic decrease in the number of men fishing and a higher rate of unemployment in both villages. In Khatisahi, approximately 117 (25%) Khatia men have experienced out-migration at some point in their lives with three women identified by villagers to have out-migrated. About 358 (45%) men in Biripadar have experienced out-migration at some point in their lives with approximately 10–15 women identified by villagers to have out-migrated as well. Khatisahi is relatively close to the new sea mouth (although the village is located deeper into the lagoon as compared to Biripadar) and villagers are experiencing the impact of the new sea mouth on their livelihoods (see Fig. 1). Aquaculture is not as prominent as it is in Biripadar but is increasing in practice with time.

Table 1 Summary of methods used in research

Method	Khatisahi				Biripadar				Total
–	Female (F)	Male (M)	Mixed (F/M)	Village total	Female (F)	Male (M)	Mixed (F/M)	Village total	–
Document review	–	–	–	–	–	–	–	–	–
Semi-structured interviews	21	18		39	26	14		40	79
Focus groups	1	1	1	3	1	1	1	3	6
Social map	1	1	–	2	1	1	–	2	4
Seasonal calendar	–	–	1	1	–	–	1	1	2
Activity profile	1	1	–	2	1	1	–	2	4
Venn diagram	–	–	1	1	–	–	1	1	2
Participant observation	–	–	–	–	–	–	–	–	–
Household case studies	–	–	–	3	–	–	–	3	6

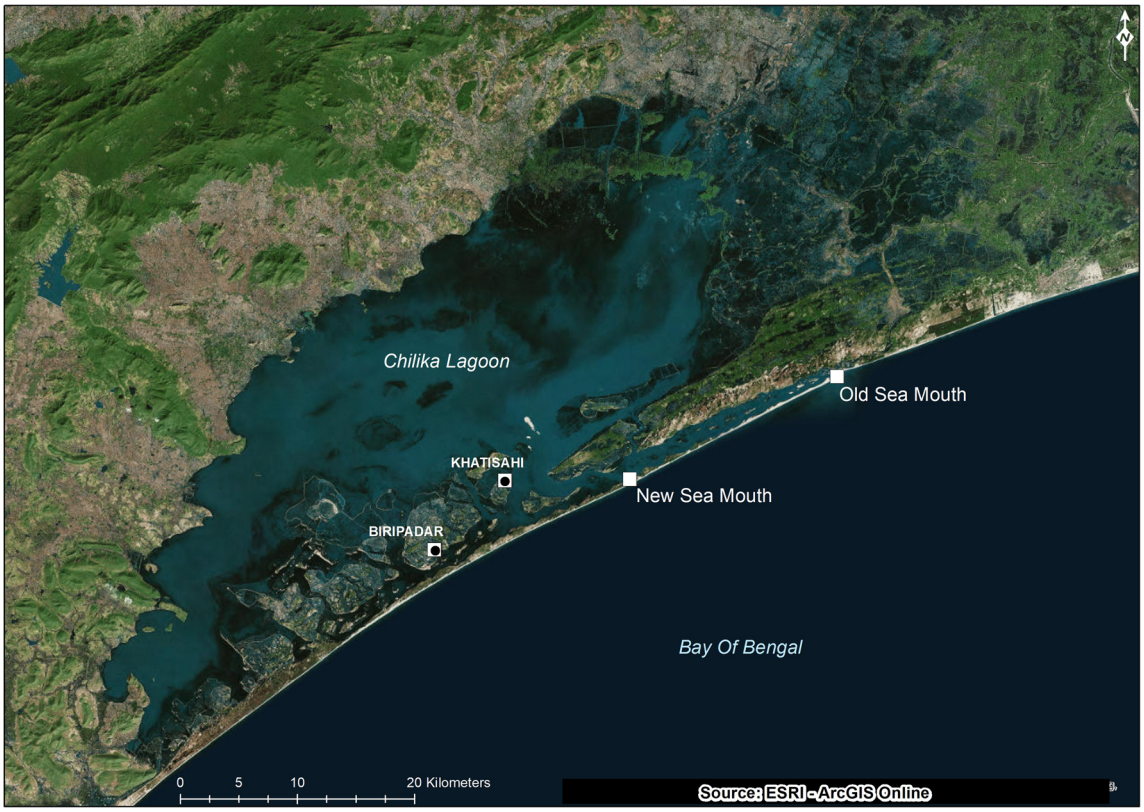

Fig. 1 Map of Chilika lagoon identifying the location of Khatisahi, Biripadar, and the new sea mouth

Khatia and Khandra men (both married and unmarried) traditionally engage in fishing activities and work in Chilika lagoon to provide for their families. The fisherwomen of these villages traditionally identify themselves as housewives (if married) and live in their homes engaging in household activities if unmarried. In the most basic form, Khatia women's household activities involve cooking and cleaning, along with taking care of children and the well-being of their family. Traditionally, the gendered division of labor is facilitated by caste customs, which restrict Khatia women from paid labor that requires them to leave their village. Khatia women's work processing fishery products (i.e., fish, shrimp, crab) is associated with domestic labor and is done primarily at home.

Khandra women have a significantly different social status than Khatia women. In addition to household activities such as cooking and cleaning, Khandra women take part in selling dry fish in marketplaces and also travel through different villages selling fish. Some Khandra women also participate in fishing activities in the lagoon. This includes handpicking shrimp from mud in shallow parts of the lagoon and setting fishnets. Over the last 10–15 years, Khandra women have increasingly become local wage laborers (i.e., construction workers) working in villages throughout Chilika. Khandra women participate in a more diverse set of income-earning activities and are mobile between different villages, whereas Khatia women's work remains largely within the home. Throughout this article, we highlight the similarities and differences between Khatia and Khandra women in terms of the type of work they undertake.

Results and discussion

In this section, Khatia and Khandra women's perspectives about environmental change and drivers of change set the foundation for a discussion about the changing nature of gender identities and focus on out-migration as a key adaptation strategy impacting fishers' livelihoods.

Fisherwomen's perspectives on key drivers of change

Interview results with both Khatia and Khandra women suggest that climate variability in relation to anomalies in seasonal and weather patterns, including extreme weather, were among the most concerning biophysical aspects observed and feared by fisherwomen. The coastal belt of Odisha is vulnerable to cyclones, storm surges, and floods which cause considerable damage to life and property (Mohanty et al. 2008). Fifty-three percent of interviewed fisherwomen (including both Khatia and Khandra women) expressed a fear of future cyclones hitting their village, of which 65% were Khatia. As noted above, Khatia women do not go to the lagoon to work but claimed that much of their fear comes from the fact that their houses are built close to

the lagoon as opposed to houses in Biripadar. However, this does not imply that Biripadar is less likely to suffer the consequences of disasters. Houses in both Khatisahi and Biripadar are poorly constructed, using materials such as mud bricks and palm leaves. These houses are unsuitable to withstand extreme weather or to offer safety in the event of a disaster.

With regard to direct anthropogenic stressors contributing to environmental change, two intricately co-related drivers of change in Chilika lagoon are the opening of the new sea mouth and aquaculture (see Fig. 2). Due to a combination of social and ecological pressures including climate-related changes, opening of the new sea mouth, and aquaculture, fishers are suffering the consequences of depleting fishery resources. Eighty-five percent of total fisherwomen interviewed recognize a direct connection between the ecological condition of the lagoon and the depletion of resources. Household roles contribute to varying levels of knowledge men and women have about the lagoon and its resources. Both Khatia and Khandra women work closely with fish that men generally bring home for the purpose of processing before it is sold, or cooked and consumed in the household. "Our husbands are fishermen and it is our duty to help them. We hope large amounts of fish come home every day. I help separate and categorize the fish and shrimp before it is sold for business or kept for cooking" (Vijaylaxmi Jally, 36 years old, married, interview, Khatisahi, September 18, 2015). Fisherwomen's engagement with fish processing provides them with significant knowledge about the condition of fishery resources. This is not only through observations and handling the fish, but through knowledge exchange with men in their households. Discussions about fishing and lagoon conditions were frequent in four of the six household case studies. Such conversations usually occurred over dinner when men had returned from fishing.

Fisherwomen perceive and interpret environmental changes (e.g., depletion of fishery resources) as pushing fishers out of fishing, increasing fisherwomen's household burden, and posing difficulties to find viable sources of livelihood to support their families. In the following sections, we discuss how the process of environmental change poses specific challenges for fisherwomen regarding changes in the division of labor and the diversification of gender roles.

Impacts of environmental change on women's livelihoods

Increased frequency and intensity of extreme weather is reinforcing fisherwomen's fear and vulnerability to environmental risks, and disproportionally impacting fisherwomen as compared to fishermen. Habtezion (2013) argues that women are often disadvantaged in dealing with environmental risks because socio-cultural norms often limit women from acquiring the skills and information necessary to avoid particular hazards. "Every year I fear a cyclone will wash me and my children into the lagoon. I don't know what I would do on my own to save my children, especially if my husband wasn't with me. I can't even swim to save my own life" (Anita Das, 31 year old, married, interview, Biripadar, October 25, 2015). In our study, we find that 75% of total fisherwomen participants believe that they lack necessary skills (i.e., swimming, climbing) to survive a natural disaster. Fishers in both villages also communicated that women in Chilika are seldom involved in meetings with government representatives that offer disaster warnings and pre-disaster training in villages. Fishermen attend these meetings and are traditionally primarily responsible for the physical protection and well-being of their families at the time of a natural disaster.

Although fishermen may be recognized more than fisherwomen as being "responsible" for protecting their families, fisherwomen inevitably bear the burden of protecting children and elders in the household, which can also undermine their preparedness for a disaster. For example, traditionally, the diets of fishers consisted of fish and shellfish, but food insecurity within villages is growing and fisherwomen are among the highest experiencing malnutrition. "Sometimes our families have little or nothing to eat. There are times when I can only offer one meal to my children and I remain hungry not knowing when our next meal will come" (Mandi Behera, 28 year old, married, interview, Biripadar, October 20, 2015). Ajibade et al. (2013) state that the caregiving roles and responsibilities that women are generally responsible for often increases their pre-disaster vulnerability and places additional burdens on them during disaster recovery. Fisherwomen's vulnerability to disasters is

Fig. 2 Sand bunds created for aquaculture purposes in the lagoon area of Biripadar (Photo: Fatima Noor Khan)

more likely to increase with the growing absence of fishermen in villages as they out-migrate. Some interviewed fisherwomen described their struggle working as wage laborers to feed their children and to pay for costly damages to their homes from cyclones until their husbands returned after having out-migrated. This illustrates that fisherwomen are active agents who negotiate and strategize through change.

In Biripadar, higher levels of non-fisher encroachment through aquaculture as compared to Khatisahi have pushed many fishermen out of the lagoon, resulting in a greater loss of livelihoods, higher rates of unemployment among fishermen, and higher rates of fishermen out-migrating. Khatisahi is surrounded by six non-fisher villages and Biripadar by nine non-fisher villages with approximately twenty-six other non-fisher villages in the interior lands. As is often the case, resources attract multiple users, creating greater complexity in the management of resources (Feeny et al. 1990). Thus, although non-fishers have traditionally engaged in activities such as land cultivation and earned their livelihoods from sources other than fishing, new encroachment in the lagoon is having an impact. Traditions have shifted with an influx of non-fishers harvesting the lagoon. Presently, the majority of these non-fisher villages are engaged in some form of fishing in Chilika, which is contributing to the heterogeneity of resource users and privatization of the lagoon, mostly through aquaculture.

This out-migration has pressured many Khandra women to find employment as wage laborers, which has become a growing trend than ever before. This is noteworthy in Chilika, as local wage labor contractors are generally non-fishers and the majority of labor is based in non-fisher villages. "20 years ago when I was a child, Khandra women didn't have to leave their village and engage in wage labour. Women mostly took part in fish processing at home. Now days, for Khandra women, income generation involves activities such as road construction, masonry, and rice cultivation in villages throughout Chilika" (Chanchala Das, 30 year old, married, interview, Biripadar, October 5, 2015). During women's focus group in Biripadar, participants shared that there is an increasing number of Khandra women working as local wage laborers because of fishermen's conflict with non-fishermen over the lagoon. This change ultimately reduces fisher communities' livelihood dependence on the lagoon. Many Khandra men refuse to work for non-fishers because of this issue and some Khandra men are denied employment by contractors because they are fishermen who have had conflicts and confrontations with other non-fishers when fishing in the lagoon (personal communications, men's focus group, Biripadar, October 11, 2015). Fisherwomen's involvement in wage labor relative to men exemplifies the gender-based caste politics of labor and how some fisherwomen are bearing the brunt of change in Chilika by needing to take on paid labor.

Additionally, Khatia and Khandra women are coping with financial pressures associated with household savings and difficulties paying ongoing expenses. Coping refers to short-term, immediate, and reactive responses motivated by a situation or crisis, and due to necessity, before any long-term strategies are considered (Nelson et al. 2007). Forty-eight percent of Khatia women and 62% of Khandra women participants have used coping strategies including taking monetary loans and mortgages to pay for costs related to food, clothing, health care, wedding events, religious festivities, and children's education. Some fisherwomen have also taken loans to pay outstanding debts which are compounded with interest. Fisherwomen also explained that some coping strategies (i.e., loans) are also becoming unavailable which is instigating adaptation responses including occupational diversification. In addition to further explaining fisherwomen's wage labor activities, fisherwomen are also dealing with financial burdens through self-help groups such as thrift and credit groups and coconut coir groups established through NGOs, further discussed below.

In addition to financial pressures and exposure to natural disasters, qualitative interpretations of fisherwomen's responses from interviews and focus groups suggest that fisherwomen, especially Khandra women, are becoming increasingly susceptible to public threats and domestic violence in villages due to the higher number of non-fisher villages surrounding Biripadar (see Table 2). An intersectional analysis highlights the significance of the geographic location of Biripadar and the social circumstances of the village for the overall safety of fisherwomen. Ninety percent of Khandra women spoke feeling unsafe traveling through Biripadar and surrounding areas because they fear violence from non-fishermen. Fifty percent of Khandra women participants reported having experienced some form of violence and harassment by non-fishers on Biripadar property. This includes physical abuse (i.e., being pushed, spat on) and verbal assault (i.e., receiving death threats, name-calling) while undertaking daily activities that require women to travel throughout the village. Khandra women also need to travel a few kilometers away from their homes to ponds and open fields in order to bathe or find space to defecate where many of these women state to have been attacked by non-fishermen. Indeed, many women living in poor rural and urban settlements in India do not have access to basic facilities such as toilets; often have to walk long distances in search of private places to defecate; and experience a higher risk of harassment, rape, and loss of the most basic levels of dignity (Cronin et al. 2014). Comparatively, the infrastructure of Khatisahi is more developed, with facilities such as pit latrines/toilets, showers, and ponds available within the village. Therefore, Khatia women do not have to travel to distant territories where safety may be of greater concern.

Table 2 Village profile chart for Khatisahi and Biripadar

Village comparison	Khatisahi	Biripadar
Population	1000	1500
Percentage of females	53%	47%
Percentage of males	47%	53%
Households	230	200
Caste rank	High ranking fishers (Khatia)	Low ranking fishers (Khandra)
Married women	Housewives	Housewives/paid laborers
Married men	Fishers by tradition	Fishers by tradition
Unemployment of men	Low	High
Unemployment of women	High	Low
Out-migration	Relatively low/increasing	Relatively high/increasing
Education/literacy	High	Low
Aquaculture	Prominence low/increasing	Prominence high/increasing
Fishery resources	Fish, shrimp, and crab	Fish, shrimp, crab, and dry shrimp
Area leased for fishing	900 ha	567 ha
Agricultural/cultivation land	Very little	Little/used to have more land
Fisher businessmen	12	2
Women's thrift and credit groups	12	5
Cyclone centers	1	0
NGO support	None	Various organizations
Surrounding non-fisher villages	6	9 +
Language	Odiya	Odiya

Additionally, 46% of Khandra women participants and 25% of Khatia women participants associated the lagoon crisis with increased alcohol and drug abuse and domestic abuse targeting women. There was also a general consensus between Khatia and Khandra men participants that drug and alcohol abuse and domestic violence towards fisherwomen has increased in the last 15–20 years alongside growing issues with non-fishers and degradation of the lagoon. Although the increase in alcohol and drug abuse and violence may not be completely attributed to environmental change, such issues are clearly perceived as systemic problems by residents and are viewed as problems that are amplified by the livelihood crises and fishers' detachment from the lagoon.

Growing heterogeneity of fisherwomen

Khatia and Khandra women's identities are diversifying and reflect a growing heterogeneity of experiences among fisherwomen as a consequence of environmental change. For example, 70% of total fisherwomen participants believe that their roles are changing as they shift away from traditional caste-based roles towards alternative vocations, and a diverse range of household and community activities. In both research villages, women's primary roles and responsibilities have traditionally been domestic, and there is a cultural preference for women to attend to these responsibilities while men perform the role of primary breadwinners. Khatia and Khandra women are still observing their customary caste duties (i.e., processing fish, household tasks) but their traditional activities are becoming increasingly difficult to manage and in some cases are fading. This change is accompanied by adjustments in the division of labor between fisherwomen and fishermen.

In many instances, fisherwomen, especially Khandra women, are becoming de facto head of households and primary earners of household incomes. In addition to their household burdens, fisherwomen are engaging in local wage labor to earn incomes. Generally, Khandra women report that they do not feel satisfied working for non-fishers, but are working because of the decrease in Khandra men's fishing incomes, men's unemployment, or increased out-migration of men. Forty percent of Khandra women participants say they are working as laborers out of desperation to either supplement household incomes or because they have solely become responsible for household income. In comparison, 30% of Khatia women are inclined to work as wage laborers to supplement their household income, but do not work because their caste restricts women from doing so. The financial risks for Khatia women are in part linked to their unemployable status and reflect a gender bias that is caste related. These findings support Datta and Gailey's (2012) claim that women's access to resources, particularly jobs, can be limited due to cultural conditions that subordinate the role of women and their decision-making power. However, Khandra women's employment through wage labor is only one way environmental change has diversified women's income generation activities. Fisherwomen are also engaging in self-help groups to generate income. In Khatisahi, these groups function as thrift and credit groups, and in Biripadar they also include coconut coir work groups (see Fig. 3). These activities reflect ways in which fisherwomen are responding to environmental change within the scope of their traditional gender roles, but also beyond these roles as well.

Fisherwomen's changing household and community activities demonstrate that gender roles and identities are not static;

Fig. 3 Biripadar woman demonstrating how coconut coir is spun and pulled to later be woven into final products such as mats (Photo: Fatima Noor Khan)

rather, they are constantly in flux with the changing environment. Furthermore, gendered impacts of environmental change are not only differentiated between genders (i.e., men and women), they vary within gender groups. Seventy-six percent of Khatia women participants are members of thrift and credit groups in order to alleviate financial pressures in households related to fishermen's fluctuating incomes. Compared to Khatia women, only 42% of Khandra women participants are involved in these groups. During focus group discussions, Khandra women mentioned that a few thrift and credit groups have become inactive in Biripadar as women prioritize time towards wage labor and coconut coir work.

These differences demonstrate that the gender differentiated impacts of environmental change and the livelihood strategies that result are not the same for all fisherwomen. Khatia and Khandra women's involvement in local wage labor, as a response to an environmental crisis, varies due to caste customs that permit Khandra women to engage in wage labor, but traditionally condemns Khatia women when they do. Yet, these norms are also gradually changing. Priri Balia Jena, a Khatia woman, explains: "As a Khatia woman, traditionally I would never be allowed to work and earn an income outside of my home. But since my husband is no longer making money from fishing, both of us may be forced to work as laborers to survive" (40 years old, married, personal communication, mixed focus group, Khatisahi, October 6, 2015). This example shows that there are intersections of gender roles with social, cultural, and political factors such as caste, income, geographic location, age, and household membership that increase heterogeneity between different fisherwomen. This includes intra-group differences between fisherwomen of the same caste and village depending on income and employment status.

Lastly, although more women undertaking wage labor may increase women's labor burdens, women's involvement in self-help groups may also be empowering women. These self-help groups offer a common platform for fisherwomen to share and discuss problems and issues and overcome their social limitations including financial dependency on men, and lack of access to local decision-making. Some fisherwomen are thus redefining gender assumptions and expectations in significant ways. We also see this through fisherwomen's increased involvement in out-migration, explored below.

Out-migration as a key adaptation strategy

In many cases, out-migration has become the only livelihood option for fishers in Chilika. A summary of Khatia and Khandra men and women's migration details is presented in Table 3. Out-migration, in the context of this research, refers to villagers temporarily relocating to cities in India to avail employment opportunities. Villagers migrate to cities throughout India to work as wage laborers in the construction, textile, culinary, and electrical industries. During men's focus group in Biripadar, participants communicated that out-migration began in their village approximately 15 years ago, around the time the new sea mouth opened and aquaculture intensified. Although fishermen would generally migrate for 4–6 months at a time, out-migration gradually intensified in fisher villages with greater numbers of fishermen abandoning their fishing practices all together, higher populations of fishermen pursuing migration, and increased frequency of migration throughout the year.

In Khatisahi and Biripadar, men, including husbands, fathers, sons, and brothers, constitute the majority of the population migrating. Yet, it is imperative to recognize that with the progression of time, there are more reports of women out-migrating: "Women's roles tended to generally be in the home. Now more and more women are out-migrating for work. Women are being pressured to out-migrate because they have to make money and out-migration is the only way they can make money" (Mandi Behera, 28 years old, married, interview, Biripadar, October 20, 2015). This signifies how out-migration is intensifying as an adaptation strategy in Chilika lagoon and further disconnecting fisher communities from their traditions. In Khatisahi, the first cases of fisherwomen out-migrating began approximately 5 years ago, and in Biripadar approximately 8 years ago. Similar to men, women migrate for periods ranging from 3 to 12 months before returning to their village in Chilika. Women mostly migrate to states in South India for paid labor, predominately in the textiles industry or construction. Of the Khandra women that migrate, they may do so as individuals but also with family members to augment the potential benefits in terms of work opportunities and income. In contrast, the majority of Khatia women who move out of state do so with their husbands, and they are less likely to earn an income. In these cases, Khatia women out-migrated with their husbands and children in order to continue living together as a family. This is largely because of caste customs, which allow Khandra women to engage in

Table 3 Summary of Khatia and Khandra men and women's migration details

Out-migration details	Men	Women
# of migrants from Khatisahi	117	3
# of migrants from Biripadar	358	10–15
Average age	18–40	18–45
Locations	Throughout India, mostly southern states (Tamil Nadu, Karnataka, Kerala)	Throughout India, mostly southern states (Tamil Nadu, Karnataka, Kerala)
Time periods	Migrate for periods ranging from 3 to 12 months	Migrate for periods ranging from 3 to 12 months
Employment industry	Construction, textiles, culinary, electrical	Construction, textiles
Salary	Rs. 5000–8000 per month depending on type of work and hours worked	Rs. 5000–7000 per month depending on type of work and hours worked
Migration groups	• Unmarried men (increase in youth migrating) • Married men	• Unmarried women • Married women who migrate with their husbands • Widows

paid labor while Khatia women are traditionally restricted from doing so.

All fisherwomen participants communicated that the main reason women are migrating is to generate income especially in cases where women become primary earners (e.g., Khandra women), or to support household income generation opportunities (i.e., Khatia women). This increase in fisherwomen out-migrating suggests that social and cultural values along with caste norms in Chilika are changing. Sixty-five percent of total fisherwomen participants believe that out-migration is contributing to fisherwomen's detachment and alienation from traditional roles and customs. "My husband is not fishing the lagoon at all anymore since he started out-migrating. My fourteen-year-old son has not learned fishing from his father which has been a tradition for generations. Slowly, fishermen and fisherwomen are losing their fishing skills and knowledge" (Urmila Jally, 41 years old, married, interview, Biripadar, September 25, 2015). Seventy-five percent of participants, fishermen and fisherwomen, believe that fisher communities will continue to suffer the loss of fishing as a source of livelihood, and predict growing trends of fisherwomen out-migrating as fishers' search for alternative occupations to support their households.

Due to the increasing rate of out-migration in villages, many people, especially Khandra women and men, are self-identifying as laborers and out-migrants as opposed to fishers. Fishers' detachment from the lagoon and absence from fishing has simultaneously increased the prominence of non-fishers occupying the lagoon. This demonstrates how adaptation strategies not only function as a response to the environmental crisis, but also contribute to a cycle of ongoing change. This suggests that some adaptation strategies are in fact "maladaptive" and are amplifying the crisis instead of alleviating it.

Conclusion

Our research findings show that environmental change in Chilika lagoon is mediated through complex social and ecological processes, including drivers of change that are contributing to the continuous re-shaping of gender identities. The intersectional lens used in this study reveals that fisherwomen interpret, experience, and live through environmental change in different ways and face unique challenges connected to their gender identity, particularly where gender and caste identities intersect. This article addresses a research gap by paying attention to the narratives of fisherwomen, which highlights their unique experiences and insights about environmental change. Although we focus specifically on the intersection of gender and caste identity, and what this means for adaptation to environmental change, these findings raise further questions about the intersections of identity, interlocking

systems of oppression, and our relations to changing environments. Further research should take on these challenges.

Importantly, the impacts of environmental change and the livelihood strategies that result are not identical among fishers or fisherwomen. Our analysis of fishers' adaptation strategies in Chilika lagoon finds that more fisherwomen out-migrating is a response to the growing environmental crisis, but one that is shaped by fisherwomen's caste identity. This trend shows that environmental change has had profound consequences on fishers' caste-based culture, specifically gender roles and the division of labor. Fisherwomen's experiences and perspectives convey messages of great uncertainty about environmental change in Chilika lagoon and what the future holds for fishers' livelihoods.

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