



VULNERABILITY ASSESSMENT OF LIFESTYLE AND LIVELIHOODS IN A HIGH RISK EROSION AREA OF INDIA BY USING TIME USE MICRO DATA IN TWO COASTAL FISHING COMMUNITIES



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ABSTRACT

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Coastal erosion is a universal problem. Coastal landforms are highly dynamic and modified by natural and man-made processes. To handle coastal erosion, many researchers put much greater emphasis on the assessment of spatial and temporal changes of shoreline using satellite data, but not much attention was focused on the socio-economic condition of those who live in the high risk eroded area. With this recognition, this article explores vulnerability assessment of lifestyle and livelihoods in the high risk eroded area of Odisha state of India, by comparing two coastal fishing communities (high risk eroded area and non-high risk one) and by applying time use approach to collect comprehensive information on human activities. The findings revealed that there were several major differences between the two communities in the time spent on paid work, unpaid work, and social, cultural, and recreational work. Easy access to the ocean was one of the influence factors determining their settlement in the high-risk one while the psychological response to reduce the fear of natural hazards was found. Besides, the wasting time and spending for house maintenance might influence their livelihood assets and reduce development setbacks related to an unprecedented crisis. The lessons learned from the case study imply that the time use research is used to investigate the vulnerability of natural hazards while identifying coping strategies to mitigate disaster risk in high risk erode area, and enhance livelihoods.

Contribution/ Originality: This article aims to evaluate people lifestyle and livelihoods in high risk eroded area in the State of Odisha in India, by applying time use approach. The research makes an enquiry into developing better understanding of socio-economic issues in high risk eroded area.

1. INTRODUCTION

Coastal ecosystems are found where the land meets the sea. Approximately one-third of human populations live in and around coastal areas (Brown *et al.*, 2006). All over the world, most big cities are crowded and becoming more so. People living in coastal areas are blessed with natural resources such as aquatic transportation and aquatic organisms, but coastal landforms are highly dynamic and modified by natural and man-made processes. Hydrodynamic, geomorphic, tectonic, and climate forces induce shoreline changes (Jangir *et al.*, 2016). In other words, the changes induced by erosion and accretion are dynamic in response to wind, waves, tides, currents, sea level fluctuation, sediment availability, seasonal and climatic variation, human alteration, and other factors that

influence the movement of sand and sediment within a shoreline system (Ramesh *et al.*, 2011; Williams, 2013). Recently, there has been growing concern about the impacts of rising sea levels induced by global climate change (Graham *et al.*, 2013; Kulpraneet, 2013; Martinich *et al.*, 2013; Williams, 2013; Zhang *et al.*, 2013). As a result of coastal changes, Bird (1985) estimates that 70% of the sandy beaches around the world are recessional.

In order to address coastal problems to either limit erosion or prevent deposition, many researchers have greatly emphasized assessing spatial and temporal changes to shorelines using satellite data (Esteves, 2004; Ramesh *et al.*, 2011; Jangir *et al.*, 2016; Nandi *et al.*, 2016). The satellite data enables us to identify coastal segments that are experiencing erosion or accretion, which can provide valuable information for coastal zone management (Jangir *et al.*, 2016). On the other hand, not much attention has been focused on the socio-economic conditions of those living in high-risk erosion areas. Continuous erosion along the shoreline affects the lifestyle and livelihoods of the local community. The magnitude of the coastal erosion problem can require a “planned retreat” or can force residents to “abandon the area.” Even before coastal erosion displaces them from their settlements and/or workplaces, it is important to address how difficult it is to co-exist with coastal changes and surrounding natural hazards and why they continue to stay in vulnerable areas, which are context-specific questions.

With this recognition, this article aims to evaluate people's lifestyle and livelihoods in a high-risk erosion area in the State of Odisha in India. To analyze the impacts of coastal erosion on lifestyle and livelihoods, this study applies a time use survey to collect comprehensive information on human activities by evaluating two coastal fishing communities: one in a high-risk erosion area (HREA) and the other in a non-high-risk erosion area (NHREA). Every person has 24 hours of time each day; thus, analyzing time-use microdata can help us understand the time use differences between the two coastal fishing communities. In the following sections, this article first profiles the field study site and then delineates the research method. Second, the research analyzes the similarity and difference of time use microdata between HREA and NHREA. Finally, the article highlights the vulnerability of people's lifestyle and livelihoods in HREA while identifying coping strategies to adapt to changes in the environment.

2. PROFILE OF THE FIELD STUDY SITE AND METHODOLOGY

Odisha, the 9th largest state in India by area and the 11th largest by population, is located on the country's southeastern coast (Chandramouli, 2011). Ramesh *et al.* (2011) assessed long-term changes over a period of 38 years from 1972 to 2010 in Odisha State. The research revealed that 8.2% (39.3 km) of the coast is undergoing high erosion, though a major stretch of Odisha's coastline (>61%) is either accreting or stable. Furthermore, district-based statistics indicate that erosion is dominant in the coastal districts of Puri where the present case study site is located as well as in Jagatsinghpur (Ramesh *et al.*, 2011).

It is important to note that the agricultural sector is dependent on the monsoon cycle. A tropical monsoon climate has distinct seasonal patterns of rainfall and its seasons can be classified as a rainy season and a dry season in the coastal districts of Odisha State. The rainy season is when the southwest monsoon brings significant rainfall from June to September. Subsequently, the northeast monsoon brings some rain in October and November. Tropical cyclones from the Bay of Bengal occur primarily during these months. When the south wind begins to blow, the climate becomes dry and it shifts to the dry season. It is winter by March and then temperatures start to increase through June before the southwest monsoon arrives. In April, which is one of the hottest months, heavy ocean waves become active, though wave heights fluctuate wildly (Islam *et al.*, 2014). Those who are dependent on aquatic resources must adjust themselves to the migratory nature and strong restrictions of the water environment on the basis of seasonality, the nature of fish ecology, and tidal fluctuation, resulting in different time use values for their activities according to the seasons.

To investigate these issues using a time use survey, two fishing communities were selected in the Chilika Lagoon of Puri District in the State of Odisha in India. Both communities are traditional fisher sub-caste groups

from the Chilika Lagoon (Iwasaki and Shaw, 2010): Nolia and Keuta. The Nolia originally came from the State of Andhra Pradesh. This migrating fisher sub-caste group with over one thousand years of coastal fishing traditions settled near the mouth of the Chilika Lagoon nearly 200 years ago (Mohanty *et al.*, 2010). Some of them further migrated and settled their coastal fisheries on the sandbar area along the Bay of Bengal, which is located in an HREA. Those living in HREAs are faced with severe coastal erosion issues, requiring them to relocate their settlements to other sites when the shoreline encroaches.

This study chose the fishing community on the sandbar of Chilika Lagoon as its HREA and the neighboring fishing community situated in a closed-off section of the mouth of the Chilika Lagoon as the NHREA. This area belongs to the Keuta fisher sub-caste group. Then, five subject couples (fishermen and fisher-wives) in each respective community were selected, totaling 20 participants for the time use survey.

It is important to note that there are several constraints facing developing countries in regards to conducting a time use survey. Hirway (2010) pointed out three major challenges of conducting this type of survey in developing countries. First, the low level of literacy, which is common in many developing countries, makes it difficult for researchers to use 24 hour, self-reporting time diaries with 10-15 minute time slots. Thus, this type of survey requires alternative methods including observations or face-to-face interviews. Second, local people view time on a scale of minutes or even hours to be insignificant. Their attitudes may not allow for detailed reporting of their time use. Hence, this type of survey requires linking self-reporting to major common events such as the time when school is in session or the time during which TV/radio programs are aired to help recall time use in larger time slots. Third, the time use patterns of the people who are largely dependent on the agricultural sector in many developing countries differ seasonally. In spite of this characteristic, many countries have conducted single day or specific period time use surveys, failing to provide for seasonal variations in the data.

To address these challenges, this study applies the face-to-face interview method for a monthly time use survey conducted over one year from April 2015 to March 2016. Approximately seven days per month per person of time use microdata was collected, amounting to 1666 samples in total. A predetermined list of human activities on the basis of four-time use classifications, as proposed by Nakayama (2014) is applied, taking into account greater efforts for subsistence economic activities as compared to industrialized countries. The classifications include (i) "paid work" such as fishing, general labor, retail, fish commission businesses, (ii) "unpaid work" such as cooking, collecting water, house cleaning, care for children/elderly, (iii) "personal care" such as sleeping and eating, and (iv) "social, cultural, and recreational work" such as talking with others (friends, relatives, etc.), access to media (television, newspaper, etc.), and participation in community functions. In conducting the time use survey, two interviewers, who had already been trained and were engaged in the preliminary survey with the same 20 participants in March 2015, asked how each respondent spent his or her time the previous day. The interviewers were well-educated and lived in the targeted communities so that their local experience and knowledge could help narrow the gap between actual time use and reported time use, to some extent.

In addition to the time use survey, this study conducted interviews with all 20 participants to complement the information provided in the results of the time use survey.

3. RESULTS

3.1. Property of Participants and Their Living Conditions

For males, the average age of all respondents engaged in fishery activities was 39 (ranging from 34 to 46 years old) in the HREA and 45 (ranging from 29 to 59 years old) in the NHREA. Similar to the male fishers, the average age of all fisher-wives who were engaged in paid work including fish processing, fish commission businesses, and general labor was 32 (ranging from 26 to 38 years old) in the HREA and 36 (ranging from 22 to 50 years old) in the NHREA. The number of family members (4.8 and 5.0) in each household was nearly the same for both sample communities.

Compared to the NHREA, people living in the HREA experience poor housing conditions, as homes are typically made of mud and wood materials. Apart from the NHREA, there are no public facilities such as schools, hospitals, or marketplaces. Boat navigation is the only method of transportation from the sandbar to the inland area to access vital facilities.

3.2. Year-Based Daily Time Use

During the period April 2015 to March 2016, this study analyzed the year-based daily time use of human activities categorized by area and gender (Table 1). The findings revealed little difference between the two communities in the time spent on the four-time use classifications with the exception of the category "other" (move such as walking, bike move, and boat navigation). Due to difficult transportation conditions, the people living in the HREA require more time for travelling (62 min per day) than those living in the NHREA (8 min per day). On the other hand, significant differences between genders were found in the time spent on paid and unpaid work. Fishermen spent an average of 314 min per day for paid work while fisher-wives spent an average of 126 min per day. In contrast to paid work, fishermen spent an average of 57 min per day for unpaid work while fisher-wives spent an average of 350 min per day. The findings are largely in line with the results of the national time use survey conducted by the government from 1998-99 (Nakayama, 2014) as shown in Table 1.

Table-1. Four-time use classifications by area and gender

Unit (min. per day)	Ave.	High-risk Eroded Area			Non-high-risk Eroded Area			India* (Nakayama, 2014)	
		Male	Female	Avg.	Male	Female	Avg.	Male	Female
Paid Work	220	313	121	217	315	132	224	221	61
Unpaid Work	203	57	352	204	57	348	202	39	295
Personal Care	648	632	625	629	671	665	668	857	834
Social, Cultural, and Recreational Work	333	369	286	328	383	293	338	269	227
Other (Move)	35	68	56	62	15	2	8	53	23

* The data was collected through a government survey conducted from 1998-99, amounting to 18,591 samples in eight states.

Apart from the time to move, there were several major differences in the activities by area (Table 2). These include the following: "talking with others," "fishing," "access to media," "house maintenance," "general labor," and "house cleaning." In the HREA, people spend more time fishing and on fishing-related activities, talking with others, and on house maintenance. On the other hand, diverse livelihood strategies combining fishing and other jobs, particularly general labor, were found in the NHREA. Based on the availability of an electrical power supply and better communication networks in the community, people tend to have more access to media such as television and newspapers. A substantial amount of time spent on media might reduce the time for talking with others and vice versa. It is important to note that there is a gap between house cleaning and house maintenance by area. The fisher-wives living in the NHREA, where many homes are made of concrete blocks, spent an average of 67 min per a day on cleaning, compared to the average of 22 min per a day in the HREA because the dust or the like are prevented from being accumulated in the shed-like homes. Rather house cleaning, a long time spent on house maintenance especially for fisher-wives (108 min per day) was found in the HREA. Additionally, those living in the HREA spent more time praying (29 min per day) than them in the NHREA (16 min per day).

Table-2. Major differences in activities by area and gender

Unit (min. per day)	Avg.	High-risk Erosion Area			Non-high-risk Erosion Area		
		Male	Female	Avg.	Male	Female	Avg.
Talking with Others	179	244	204	224	161	107	134
Fishing	122	257	44	151	183	0	92
Access to Media	101	53	29	41	170	153	162
House Maintenance	42	36	108	72	11	11	10
General Labor	28	1	2	2	98	11	55
House Cleaning	23	1	22	11	4	67	36
Personal Religious Activities	23	33	26	29	14	18	16
Fish Commission Business	16	7	43	25	0	15	7

3.3. Seasonal Time Use

According to the four-time use classifications, seasonal time use according to people's lifestyle and livelihoods by area and gender is shown in Figures 1 through 4. The findings reveal that there was little seasonal difference between the two communities in the time spent on the category "personal care" as shown in Figure 3. However, wide gaps for the other three categories are identified as follows.

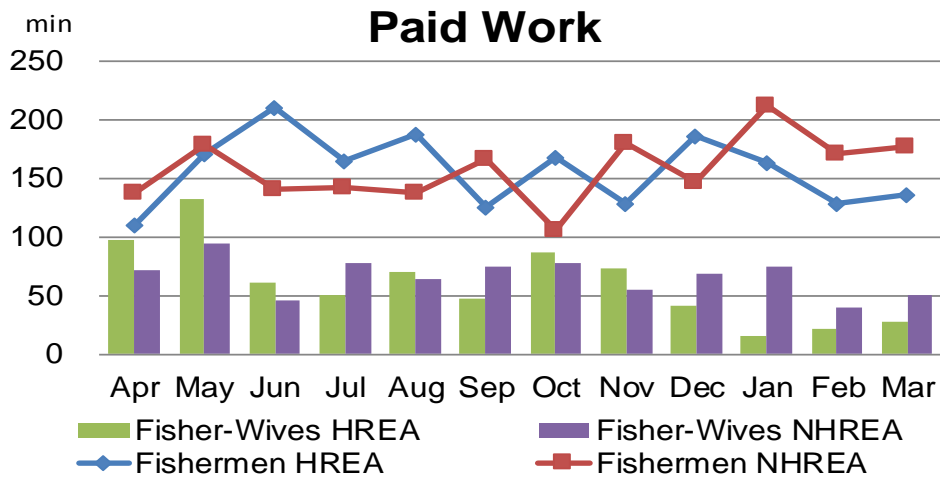


Figure-1. Seasonal time use for paid work

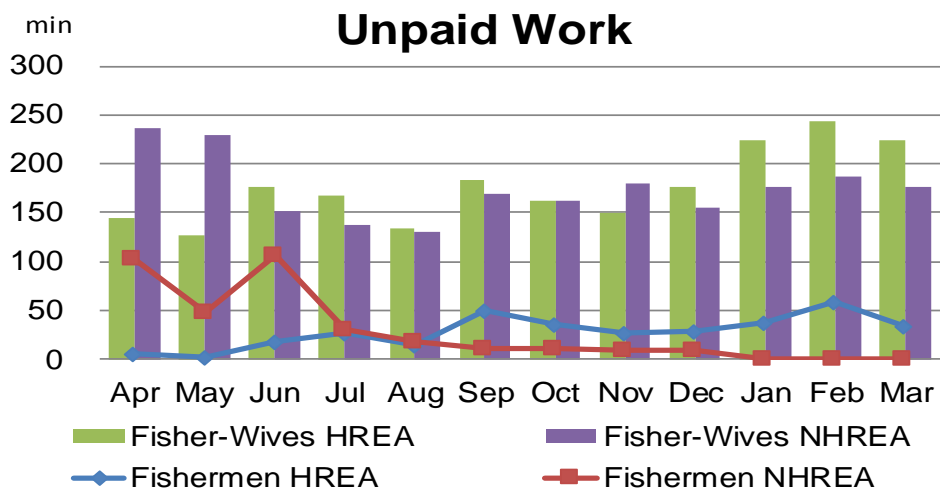


Figure-2. Seasonal time use for unpaid work

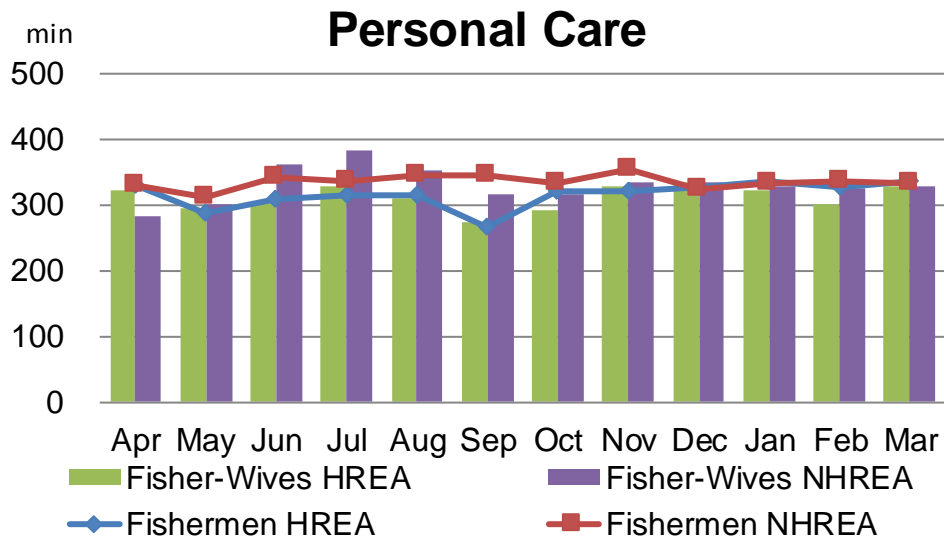


Figure-3. Seasonal time use for personal care

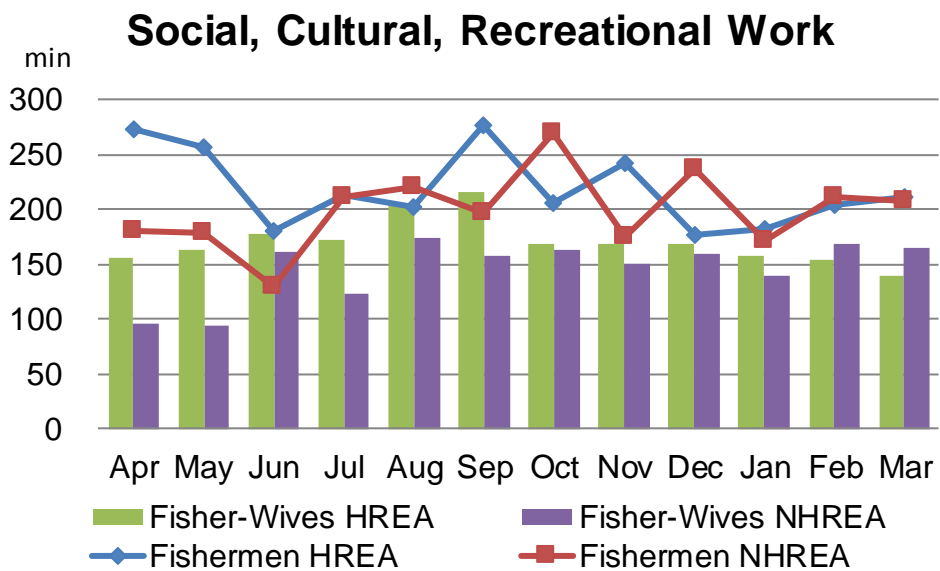


Figure-4. Seasonal time use for social, cultural, and recreational work

Fishermen spent a significant amount of time in fisheries throughout the year in the HREA, while those from the NHREA spent the most time in fisheries during the period January to March. Fishing and general labor were dominant in specific months (May to June and November), which corresponded, more or less, with the rainy season (see Figure 5 and Figure 6). It can be said that the fishermen living in the NHREA adopt a seasonal livelihood strategy, combining fishing in the winter and general labor in the summer. They also made greater efforts toward house maintenance in April and May to adjust to the extremely hot climate (see Figure 7). Findings from the interviews reveal that all male participants in the community engaged in making green leaf roofs for shade in the front of their houses. The green leaf roof was then used as a vegetable garden by planting creeper plants such as cucumber and pumpkin, leading to increased time available for paid work in the rainy season as mentioned above.

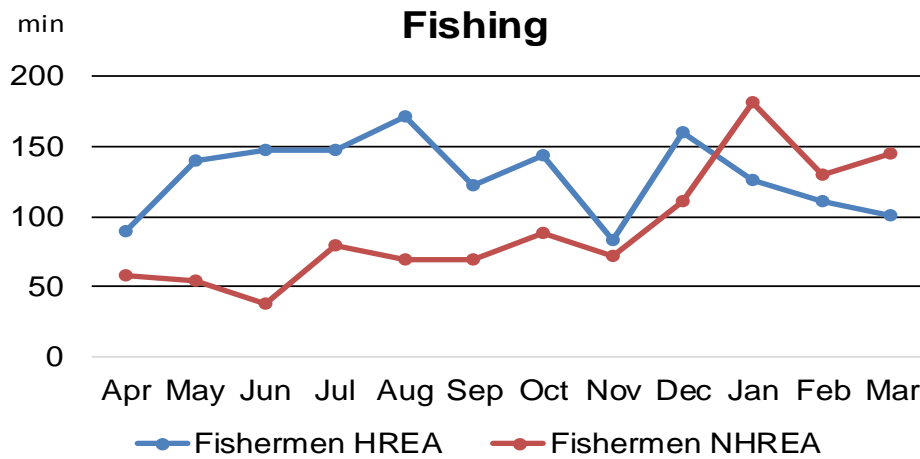


Figure-5. Seasonal time use for fishing

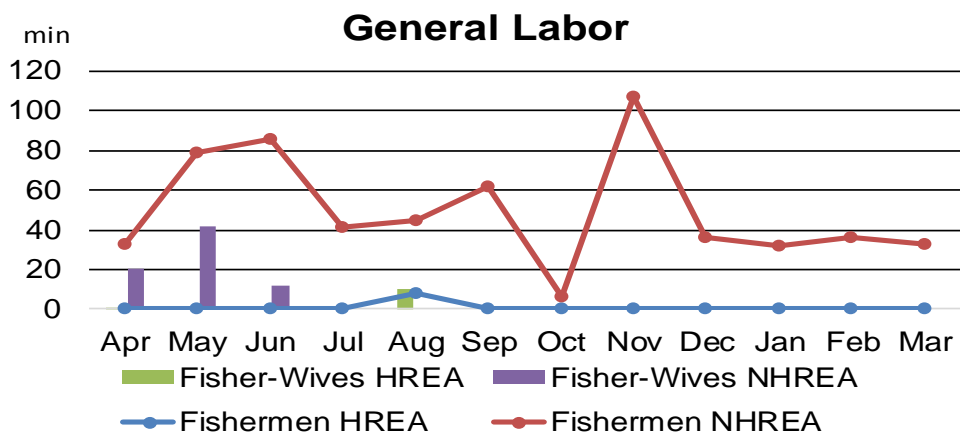


Figure-6. Seasonal time use for general labor

On the other hand, the fishermen from the HREA arranged the green leaf roofs at the initial stage of constructing their houses, which were different from the inland housing structures. They needed to spend more time on unpaid work, particularly house maintenance, during the period September to March (see Figure 2 and Figure 7). During and after the rainy season, those living in the HREA, especially fisher-wives, spent time repairing their houses.

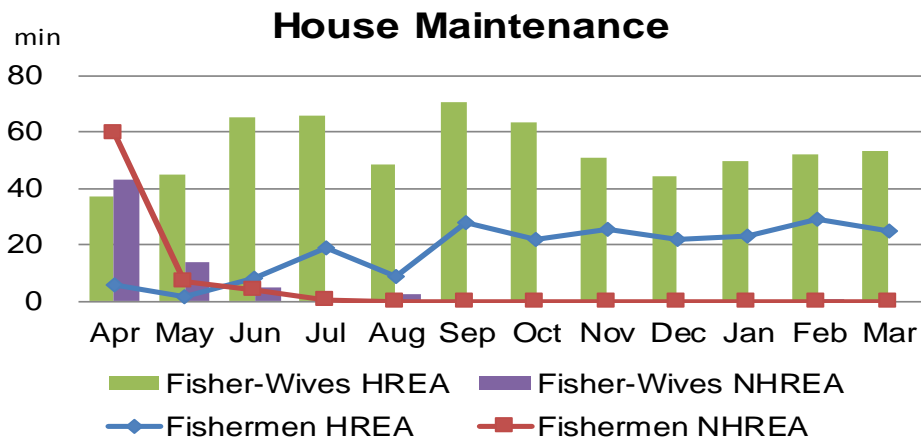


Figure-7. Seasonal time use for house maintenance

In the winter season, the fisher-wives from the HREA spent less time on paid work. It is likely that because less fish was caught, the opportunity for them to engage in the fish-related business was reduced. Related to this, an evident increase in the time spent collecting water was found in the area. After the rainy season, they spent more time collecting water as seen in Figure 8, resulting in a higher ratio of unpaid work in the winter season. There are no ponds or tanks on the sandbar of the Chilika Lagoon so the local people collect groundwater for daily consumption such as bathing, cooking, and washing by digging in the sand. Due to the salt concentration of the groundwater, however, there was no choice for them but to bring drinking water from inland coastal areas by boat. Even in the NHREA, there was a scarcity of drinking water and water collection was largely associated with a twofold increase in the winter compared to the rainy season. During the period from winter to the summer season, more time was spent praying among fishermen living in the HREA (see Figure 9). In March, they spent 39 min per a day for personal religious activities while fishermen living in the NHREA spent only 4 min per day on it. The difference of time use for personal religious activities is largely linked to a fear of natural hazards as discussed in the next section.

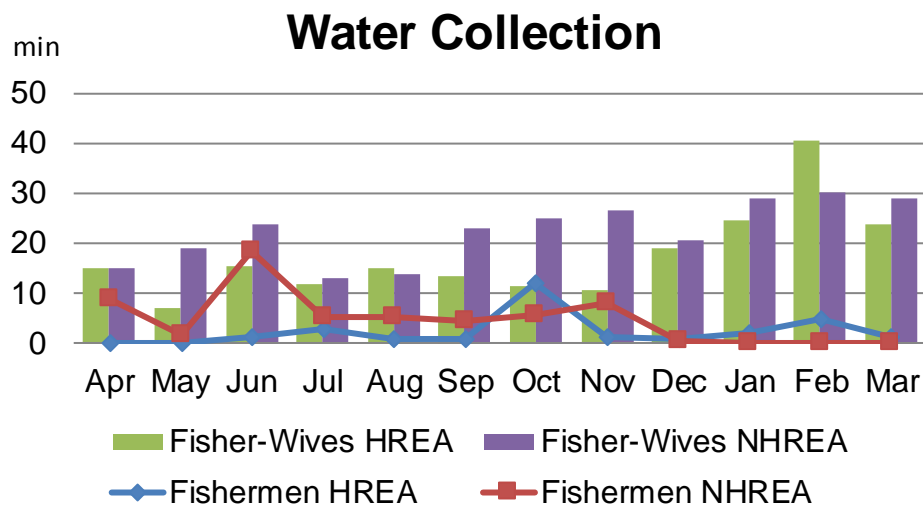


Figure-8. Seasonal time use for water collection

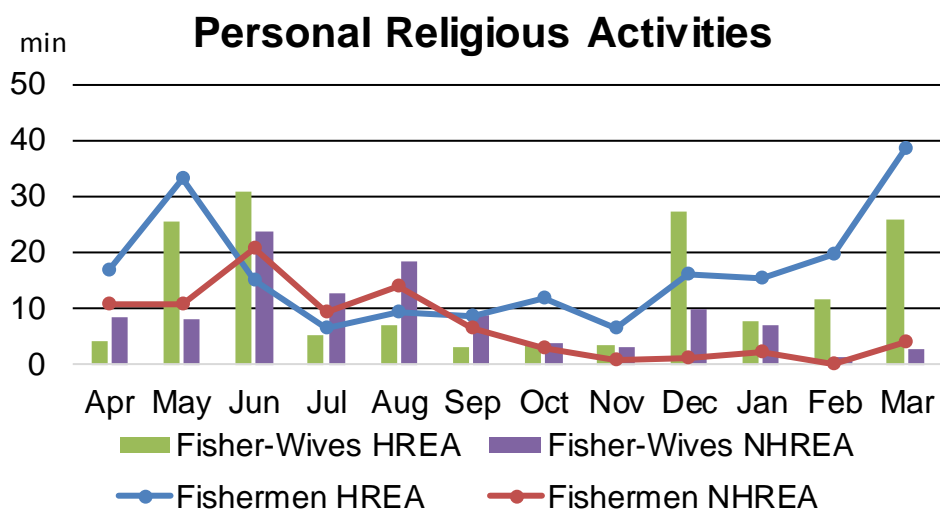


Figure-9. Seasonal time use for personal religious activities

4. DISCUSSION

The present study examined assessing the vulnerability of people's lifestyle and livelihoods in the HREA in comparison to the NHREA. Those living in both areas commonly depend on the fisheries and related activities to make a living. There were little yearly and seasonal differences in the time spent of the category "personal care", which largely corresponded to the sleep-wake cycle. However, the researchers identified several distinct differences in their activities, some of which were largely linked to vulnerable conditions in the HREA as shown in Figure 10.

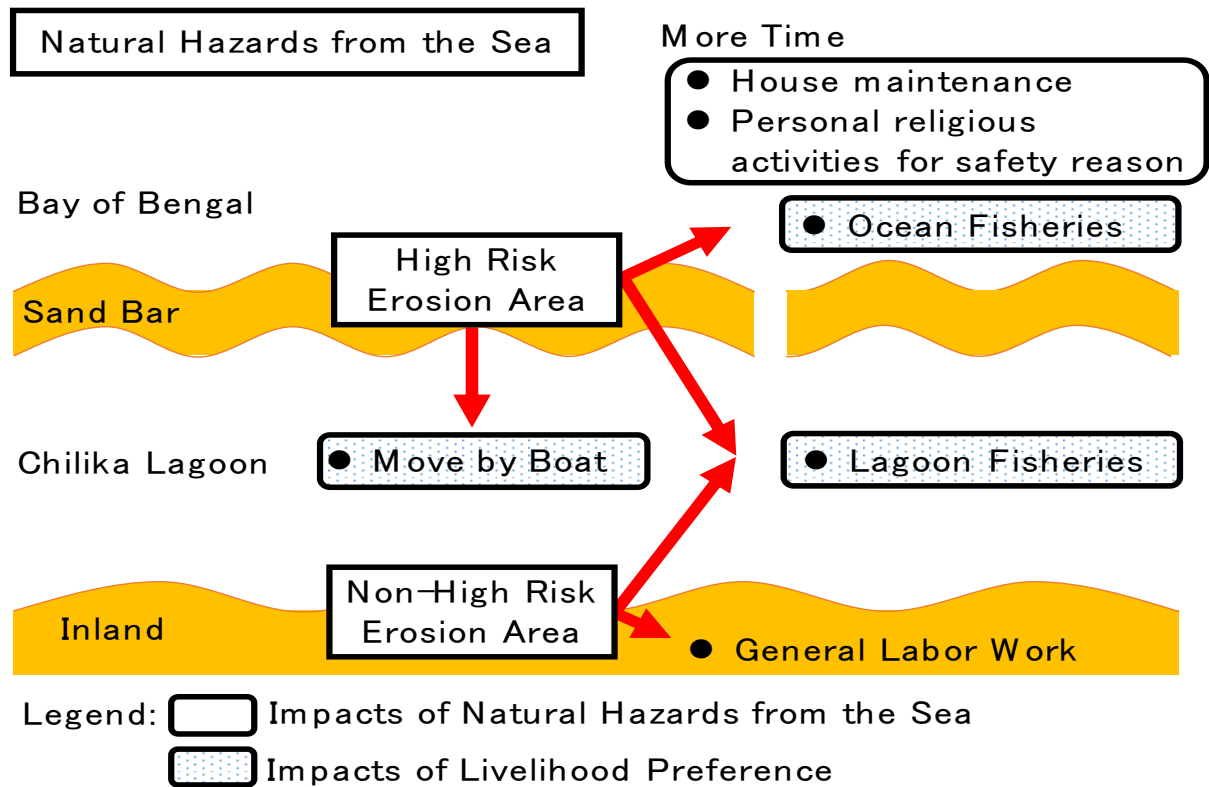


Figure-10. Time use impacts of natural hazards from the sea and livelihood preference between high-risk erosion area and non-high risk erosion area

As above mentioned, the time of house maintenance in the HREA was higher than the one in the NHREA. Indeed, the fisher-wives paid 108 min per day to repair their home on average. The sandbar area of Chilika Lagoon is physically and geographically vulnerable to natural hazards such as tropical cyclones, high tides, and strong winds. Poor housing structures in combination with these natural hazards require constant house maintenance in the HREA. Spending time on home repair may affect accumulated livelihood assets and reduce development setbacks related to an unprecedented crisis. The unsanitary environment characterizing poor housing conditions may cause various diseases such as cholera, diarrhea, and viruses, which will have a long-term impact on the ability of those affected to adapt to changes in the environment.

The research also identified vulnerable aspect of people's lifestyle and livelihoods in the HREA, from the viewpoint of psychological anxiety, by focusing on the gap of time for personal religious activities especially in specific months. To some extent, these are linked to cultural rituals and events, but the interview survey found that the time gap for praying was triggered by a fear of natural hazards. The sandbar area of Chilika Lagoon with fragile housing structure is exposed to the full force of the wind, waves, tides, and tropical cyclones, and they rely on God for their safety. Furthermore, the sense of fear was affected by greater efforts of the fisheries in the ocean. The interview survey revealed that the fishers migrated from the NHREA to the sandbar of Chilika Lagoon, taking advantage of easier access to the ocean. According to their knowledge, the ocean fisheries in specific months ranging from winter to summer is expected to catch more fish than the lagoon fisheries do. However, when it comes

to the season, heavy ocean waves become active so that it is difficult for them to ensure the safety in the ocean. For those living in the HREA, the time for praying is likely to correspond to strong exposure to natural hazards along the Bay of Bengal as well as a preference for fishing in the ocean. Hence, it can be said that the time for personal religious activities was determined by the complex interaction among physical environment, housing conditions, and livelihood preference.

5. CONCLUSIONS

In response to rising sea levels and other factors that influence the movement of sand and sediment within a shoreline system, it is estimated that coastal erosion displaces a large number of people around the world living in a low-lying area such as beaches, river deltas, estuaries, and lagoons from their homes, either temporarily or permanently. Loss of land for settlements and workplaces threatens their capacity to adapt to changes in the environment. Even before they are displaced due to coastal erosion, this study identified pressing constraints on people's lifestyle and livelihoods in the HREA of Odisha State in India, from the viewpoint of time use microdata by comparing data with those living in an NHREA.

The findings indicated that there were several major differences between the two communities in the time spent on paid work; unpaid work; and social, cultural, and recreational work. Livelihoods in the HREA were entirely dedicated to fishing and related businesses. Easy access to the ocean motivated them to reside on the sandbar of the Chilika Lagoon. Additionally, the population growth of inland communities, including the sampled NHREA, further motivated their search for open space for housing. Their migration to the HREA, however, faced difficulties in coping with natural hazards, which were reflected by daily time use for house maintenance in each season and for collecting water, especially in winter. A psychological response to reduce the fear of natural hazards was also found by highlighting the time use for personal religious activities.

The lessons learned from the case study imply that time use research is useful to investigate vulnerability created by natural hazards, including coastal erosion issues while identifying coping strategies to mitigate disaster risk in the HREA and to enhance livelihoods. Different and dynamic livelihood strategies in the HREA (strong commitment to fishing) and the NHREA (diverse livelihood activities) were identified by seasonal patterns of livelihood time use. This approach will be a good entry point to develop a better understanding of socio-economic issues created by natural hazards from the sea. Many earlier studies using time use survey tend to collect the data in specific period time (Hirway, 2010) but it is important to be noted that this present study found that fishing lifestyle and livelihoods in both the HREA and NHREA underwent large seasonal variation. In order to develop a better understanding of their vulnerability, time use survey targeting in the agricultural sector should take into more account the seasonal factor.

Lastly, it should be mentioned that this paper applied a small scale time use survey that covered only two coastal fishing communities with 20 participants in total. The survey results may reflect local characteristics of the area and respondents. It is true that the results may not necessarily correspond to other fishing communities living in the HREAs, but the survey can serve as a basis for focusing on the vulnerable conditions of people's lifestyle and livelihoods in HREAs.

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