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**HOW CAN WOMEN BE MORE ENGAGED WITH ADAPTATION TO
CLIMATIC HAZARDS?**

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A dissertation submitted in partial fulfilment of the degree MSc Sustainability by taught course.

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ABSTRACT

This study provides an initial insight into the barriers which constrain the adaptation of female HH's living in delta environments to climate hazards. The adaptation of female HH's is of particular importance given the projected impacts of climate change on delta communities, and the heightened vulnerability of female HH's to these projected changes. This study seeks to contribute to existing work on adaptation by documenting the barriers faced by female HH's and identifying the perceived opportunities to overcome them. By using largescale quantitative data and semi-structured interviews collected from the Indian Bengal Delta, this study has established the intersectionality of vulnerabilities such as class, marital status and age contributes to the unique socio-cultural barriers experienced by female HH's in West Bengal. Addressing the underlying gender inequalities which prevail in West Bengal will improve the engagement of female HH's with adaptation. This could be achieved by providing employment opportunities to female HH's, ensuring girls have equal access to quality education, increasing representation of women at all levels of government, and continuing to introduce policies aimed at empowering women. Achieving gender equity will act to reduce the vulnerabilities of women living in delta regions to climate hazards whilst supporting the realisation of the UNSDG's on gender equality and climate action.

"I want you to work on this study to show the world the difficulties which we face living in this delta region and how we cope" [Respondent 2]

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ABBREVIATIONS

DECCMA – Deltas, Vulnerability, and Climate Change: Migration and Adaptation

DRM – Disaster Risk Management

GBMD – Ganges Brahmaputra Meghna Delta

HH – Household Head

IBD – Indian Bengal Delta

NGO – Non-Governmental Organisation

OBC – Other Backwards Caste

PAR – Pressure and Release Model

SC – Scheduled Caste

SHG – Self-help Group

ST- Scheduled Tribe

UN – United Nations

UNESCO – United Nations Educational, Scientific and Cultural Organisation

UNFCCC – United Nations Framework Convention on Climate Change

UNSDG – United Nations Sustainable Development Goal

WSHG – Women’s Self-help Group

AR5 – Assessment Report 5

IPCC – Intergovernmental Panel on Climate Change

1.0 INTRODUCTION

Despite accounting for just 1% of global land area (Ericson *et al*, 2006) deltas are home to over 500 million people (Giosan *et al*, 2014) and contribute significantly to food security worldwide (Ericson *et al*, 2006). However, delta regions are also highly vulnerable to climatic hazards and environmental change (Szabo *et al*, 2015a). This vulnerability coupled with the dependence of the local populations on natural resources and agriculture makes those living in deltaic regions highly susceptible to the impacts of climatic hazards (Ericson *et al*, 2006). Despite their global importance and vulnerability, deltaic regions and the people who inhabit them remain relatively under researched (Wassman *et al*, 2004). Improving this understanding and developing adaptation policies is crucial, particularly given current, and projected changes to climatic hazards.

Deltas have population densities greater than 10 times the world average (Foufoula-Georgiou *et al*, 2011), and often comprise of its poorest residents (Jin *et al*, 2018). Furthermore, research has shown the poorest individuals are often the most impacted by climatic events (Mazumdar, *et al*, 2014). Currently around 10% of the world's population live in the 2% of coastal land at, or lower than 10m above sea level and this figure is predicted to rise in the coming years, particularly in the developing world (Neumann *et al*, 2015 and McGranahan *et al*, 2007). Low-elevation coastal regions such as deltas are highly vulnerable to climate hazards including cyclone and flood events, soil salinization and riverbank erosion (Tessler *et al*, 2015 and Whitehead *et al*, 2015). It is this high population density of deltas, combined with the low-lying nature of deltaic land which creates a conflict between the natural climatic events associated with deltas and the security of the populations who inhabit them. The significance of delta systems to support the lives of their populations and wider global systems, further highlights the importance of gaining a better understanding of climatic hazards in delta regions and the subsequent lived experiences of their populations.

The same physical and climatic conditions which give rise to and support the complex ecological systems found in deltas, such as heavy monsoon rainfalls, river discharge and sediment load, are also closely associated with climatic hazards which can threaten the lives of the ecology and populations found there (Whitehead *et al*, 2015, Szabo *et al*, 2015b). These events are often associated with loss of life, economic losses, ill health, and displacement

(Balica *et al*, 2012), and therefore communities and individuals develop behaviours and practices to cope with the challenging climatic conditions in which they live. Climate hazards are natural events, therefore full elimination of the threat they pose is unrealistic, but effective adaptation can minimise the risks associated with them (Hajra *et al*, 2016). The likelihood that projected climate change will increase the intensity and frequency of climatic hazards (Kumar *et al*, 2013), places further pressure on the need to identify and develop effective adaptation practices and policies.

Within climate discourse women are often identified as a marginalised social group with greater vulnerability to climatic hazards and environmental change (Ahmed and Fajber, 2009). Explanations for this gender disparity have cited a number of possible causes, including limited access to resources, and social and cultural norms relating to divisions of labour, and decision making (Terry 2009). Similar factors have also been identified in literature regarding the barriers to adaptation which women face (Ray-Bennett, 2010 and 2011, Nelson *et al*, 2002). The social disadvantage and subsequent increased vulnerability of women to climatic hazards must be addressed if the United Nations Sustainable Development Goals (UNSDG's) targeting female equality and climate action are to be met. Policies and initiatives are increasingly being introduced to try to address the vulnerabilities of people living in deltas to climatic hazards, however gender-blind interventions run the risk of further marginalising those who experience discrimination, reinforcing the gender disparity apparent in global climate discourse (Masika, 2002). Furthermore, constructing interventions which identify the barriers women experience will result in interventions of limited success if women's opinions and perceptions regarding the way these barriers could best be overcome, are not taken into account (Denton, 2002). Within the gendered discourse surrounding climate vulnerability and adaptation female household heads (HH's) are considered to experience unique challenges, be further disadvantaged, and less researched than their male counterparts (Flato *et al*, 2017). Female HH's often carry a higher dependency burden whilst fulfilling the domestic and breadwinner roles within a household, alongside managing the existing gender expectations of women (*ibid*). It is therefore vital that research is carried out to further understand and identify the barriers to adaptation which women face as perceived by female HH's.

This study will use the Indian Bengal Delta (IBD) to investigate the issues female HH's face related to coping with climatic hazards. As the Indian arm of the Ganges-Brahmaputra-

Megna Delta (GBMD), the IBD is a part of one of the largest global delta systems (Nicholls, *et al*, 2007), and classified as a UNESCO Natural World Heritage Site in recognition of the value and significance of the ecosystems it supports (Islam and Gnauck, 2008). The IBD is also considered to be one of the most vulnerable, (Ghosh *et al*, 2018) frequently impacted by cyclone and flood events. Moreover, the IBD has been identified as one of the most under-developed regions of India (Hazra *et al*, 2014), and a region where women are often marginalised in society as a result of sociocultural expectations (Roy and Tisdell, 2002), further exacerbating the vulnerability of female HH's to climatic hazards. Despite these factors research on the IBD remains limited and gendered research more limited still. The culmination of these factors combined with the limited research on the IBD makes this a well-suited area for study, especially considering these characteristics are common to many other deltas across the world.

1.1 AIMS AND RESEARCH QUESTIONS

Using the Indian Bengal Delta as a case study this research aims to identify the opportunities perceived to overcome the barriers to adaptation uniquely experienced by female HH's.

1.12 RESEARCH QUESTIONS

1. How are female HH's adapting to climate hazards in the Indian Bengal Delta?
2. What are the adaptation strategies which female HH's would like to adopt but have not?
3. What are the barriers to adaptation experienced by female HH's?
4. What are the opportunities perceived by female HH's which would enable them to address these barriers? (Qualitative research question)

This exploratory mixed methods study will use a two-phase sequential explanatory method to explore the climatic hazards, adaptations, and barriers to adaptation experienced by female HH's living in the IBD. The first phase will use quantitative research questions to explore the influence of gender on adaptation and the perceived barriers to adaptation across the IBD. Outputs from the first phase will then be investigated further during the secondary, qualitative phase of this study by conducting semi-structured interviews with a sample of female HH's in Dulki and Sonagar. Using quantitative survey data and qualitative

interview data will enable the quantitative outputs to be triangulated and help to better explain patterns found in the quantitative results.

1.2 STUDY AREA

The GBMD of which the IBD constitutes one part, is one of the largest delta systems in the world (DECCMA, 2017). As defined within the DECCMA research project the IBD includes areas within 5 metres of sea level making it highly susceptible to sea level rise, cyclones, soil erosion and storm surges from the Bay of Bengal. The 5m sea level threshold ensures the areas of greatest exposure and therefore more vulnerable to the climatic risks associated with deltas are included in the study site. The extent of the GBM delta is shown in Figure 1 with a purple border surrounding the IBD.

In the past 30 years around 30,000 individuals have lost their homes or been displaced as a result of climatic hazards in the IBD (Ghosh *et al*, 2018). There are concerns, resultant from projected climate change scenarios, that climatic hazards may increase in frequency and magnitude in the IBD thus increasing the number of people affected by climate hazards (Samling *et al*, 2015). The current and future threat of climate hazards to communities in the IBD highlights the importance of studying current adaptation practices and barriers in the region.



Figure 1: IBD as Defined within DECCMA Study (Source: DECCMA, 2017)

1.21 CHARACTERISTICS OF THE IBD

Two administrative districts in West Bengal (North 24 and South 24 Paraganas), make up the IBD and have a combined population of over 18 million (Census, 2011). In addition to being a highly populous area, the IBD is also one of the most under-developed areas in India with 34% of the population living below the poverty line (Hazra *et al*, 2014). Additionally, the IBD has a proportion of marginalised groups such as scheduled tribes (STs), scheduled castes (SCs) and other backwards classes (OBCs) higher than the national average (World Bank, 2018). These factors have been found to increase the vulnerability of groups to climatic hazards.

Across India, and particularly in rural India women often face discrimination and marginalisation (Lahiri-Dutt and Samanta 2006). A growing body of research investigating the formation of gender attitudes has attributed historical and cultural traditions (Dhar *et al*, 2015) and religion, namely Hindu and Muslim teachings, as factors behind this gender disparity (Sinha and Ram, 2018). Moreover, West Bengal is a state which performs below the national average in a number of gender indicators including labour-force participation, child sex ratio and secondary school completion (World Bank, 2018), resulting in heightened vulnerability. Studies of previous climate hazards in the IBD, such as cyclone Aila, have reported women as being more vulnerable both during a climatic event and in post hazard recovery periods (Ghosh *et al*, 2018). Despite the identification of women as a group more vulnerable to climatic hazards, there is limited existing research on how women in the IBD are adapting (Ghosh *et al*, 2018, Bhattacharjee and Behera, 2018) and no research which addresses barriers to adaptation and the perceived opportunities to overcome them. The IBD is therefore a suitable study site for this project and research outputs from it will be able to inform policy and act as a catalyst for further study of the IBD.

1.3 SUMMARY

This study will be constructed in the following manner. Section 2 will provide the theoretical context and review the existing literature on the research topic. Section 3 will then outline the methodology used for both quantitative and qualitative data collection and analysis, this will include discussion of mixed methods research, positionality and limitations of the methods. Next, section 4 will present and discuss the research outputs of the study and analyse these findings alongside existing literature. The final section of this report will

summarise the main findings of this study, provide suggestions for future research and address the wider implications of this study.

2.0 LITERATURE REVIEW

This review will outline the key themes which underpin climate adaptation research, vulnerability, adaptation, and barriers, limits and constraints to adaptation. The theories within these themes will be outlined before being explored from a gendered perspective and critically evaluated to ascertain the challenges and criticisms of each concept. Deltas are relatively under researched regions therefore research which focusses specifically on vulnerability and adaptation in deltas, and even more so into barriers to adaptation or gender remain very limited. Context specific reviews of these themes will therefore draw upon wider research to inform on the current understanding of gender within adaptation and climate study. The purpose of this section is to familiarise the reader with the key concepts underpinning this study.

A review and simple analysis of National and West Bengal State policies and plans surrounding climatic hazards and disaster risk management (DRM) was also undertaken to investigate the extent to which the topics of, climate hazards in the IBD, and gender are addressed in policy and will be explored in this section. Gender specific policies and incentive schemes will also be included to provide greater contextual understanding of the position of women in society.

2.1 VULNERABILITY

The term vulnerability is well established and widely used in non-academic contexts, as well as across numerous academic disciplines from anthropology to engineering (Adger *et al*, 2006). The definition of vulnerability varies between different contexts and is a topic of debate (Blaikie *et al*, 1994; Thywissen, 2006; Manyena, 2006; Birkmann, 2006). Some of the most widely used and cited definitions for vulnerability are those recorded in assessment reports by the Intergovernmental Panel on Climate Change (IPCC). The most recent assessment report, AR5, defines vulnerability as ‘the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt’ (IPCC 2014 pp. 1775). There has been a growth in research on climatic vulnerability as a result of suggestions projected climate change may place the most significant burden upon groups already most vulnerable to climatic events (Hazra *et al*, 2014). This growth has led to the development of

various frameworks and metrics used as a means of assessing vulnerability (Adger and Brooks, 2003; Cardona, 2004; Cutter *et al*, 2008), including the pressure and release (PAR) model (Wisner *et al*, 2004), and the Sustainable Livelihoods Framework (Scoones, 1998). While these models can provide a useful insight into the drivers of vulnerability and enable the identification of vulnerable groups, they are also criticised for their reductive nature (Jayanimitta *et al*, 2018) and inability to capture the dynamic nature and complexity of vulnerability (O'Brien *et al*, 2004).

Despite the disputes over the most effective models and frameworks, vulnerability is most frequently conceptualised as the product of three components; exposure, sensitivity and adaptive capacity.

2.11 EXPOSURE

Exposure refers to 'the presence of people, livelihoods, species or ecosystems, environmental functions, services and resources, infrastructure, or economic, social or cultural assets in places and settings which could be adversely affected' (IPCC, 2014 pp. 1765). While you have to be exposed to a climatic hazard to be vulnerable, it is possible to be exposed and not be vulnerable by using protective infrastructure or by modifying behaviour (Cardona *et al*, 2012). As populations grow and the availability of safe land gradually reduces it seems likely the number of people exposed to climatic hazards will grow (Lavell, 2003). Population projections expect the deltaic population exposed to 1-in-100 year coastal flood events to increase by 80million between 2010 and 2050 (Jongman *et al*, 2012). Increased exposure to climatic hazards is particularly pertinent in the case of deltas where anthropogenic actions such as increased damming upstream and river channelisation disrupt sediment flows (Vörösmarty *et al*, 2003; Syvitski *et al*, 2009). These factors may combine with changes in the intensity of extreme climate events and forecast sea level change to increase land subsidence, reducing the availability of safe land (Knutson *et al*, 2010; Horton *et al*, 2014).

2.22 Sensitivity

Sensitivity is 'the degree to which a system or species is affected, either adversely or beneficially, by climate variability or change. The effect may be direct or indirect' (IPCC, 2014 pp. 1772). Deltas are highly sensitive to climatic variability because of their low lying plains and the reliance of populations upon the agro-economic sector (Wong *et al*, 2014). Climatic

hazards such as flood events regularly inundate farmlands causing soil degradation and resulting in economic loss for many who live in delta plains (Ayeb-Karlsson *et al*, 2016; Duncan *et al*, 2017b). In an effort to reduce their sensitivity to climatic hazards people have diverse livelihood strategies including fishing, arable farming and livestock rearing, however these industries remain reliant on climate (Wilk and Kgathi, 2007; Motsholapheko *et al*, 2011). As climate variability rises, alternative diversification strategies such as migration are becoming an increasingly popular means of livelihood stabilisation (Codjoe *et al*, 2017).

2.13 ADAPTIVE CAPACITY

The initial concept of adaptive capacity stems from Sen's capabilities theory (Sen, 1993) and in its most current form refers to 'the ability of systems, institutions, humans and other organisms to adjust to potential damage to take advantage of opportunities, or to respond to consequences' (IPCC, 2014 pp. 1758). Adaptive capacity is an extensively explored aspect of climate vulnerability research, in part as a result of the difficulties and uncertainties experienced in attempts to quantify and document adaptation (Vincent, 2007). An individual or system's adaptive capacity is determined by a complex web of factors and their interactions (*ibid*), often measured or assessed through the availability of 5 main capitals (Birkmann *et al*, 2013; Tuihedur Rahman *et al*, 2018). These capitals are; social, human, physical, natural and financial respectively (Reed *et al*, 2006; Ifejika Speranza *et al*, 2014).

Considerable progress has been made in identifying which aspects of a population have the greatest influence over, and are therefore good indicators of a population's overall adaptive capacity (Brooks and Adger, 2005; Eakin and Lemos, 2006; Hinkel, 2011). At an individual level it has been established that social phenomena including class, race and gender interact with individual decision making to influence the access of a household or an individual to adaptation strategies (Pelling and High, 2005). Furthermore, the interactions between capital and institutional context means people most vulnerable to climatic events are also the ones with the least influence or input on decision-making, least power and fewest resources (Pelling, 2003; Adger, 2003).

However, although studies have found that adaptive capacity reflects the availability of capitals, it is a measure of the potential for adaptation within a system and does not indicate an individual, community or system will adapt (Eiseneck and Stecker, 2012). One explanation

for this is that although people may have large stocks of a capital or capitals they may not be able to draw upon these capitals to mitigate their vulnerability to a climatic hazard (*ibid*). For example, deltas have high natural capital stocks however the populations do not always have the requisite knowledge (human capital), or technology (physical capital) to capitalise on it. Furthermore, adaptive capacity does not capture the implementation of government initiatives which also influences the likelihood of capacity resulting in adaptation (Westerhoff *et al*, 2011).The relationship between adaptive capacity and adaptation is indirect and understanding the mechanism by which adaptive capacity translates into action requires further research and development (Ford and King, 2013).

It is evident the IBD is highly exposed and sensitive to climatic hazards and its population has a low adaptive capacity, resulting in its population being more vulnerable to climatic hazards. Furthermore, these factors contribute to the high disaster risk of the IBD, as a result of its exposure to cyclone and flood events (Krien *et al*, 2016) (Figure 2).

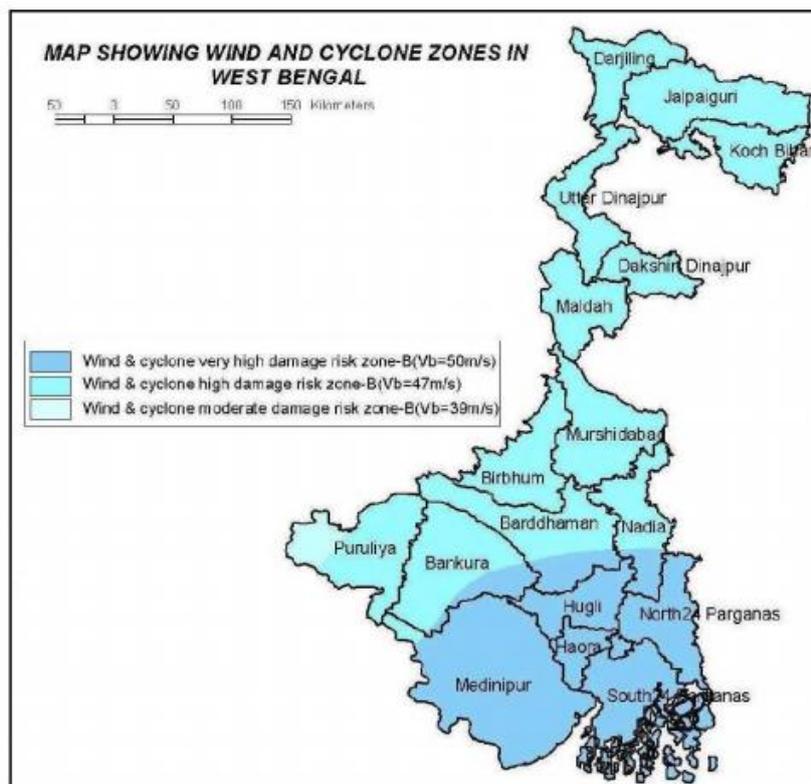


Figure 2: Map of Exposure of West Bengal to Wind and Cyclone Damage (Source: District Disaster Management Plan North 24 Parganas)

2.2 GENDER AND VULNERABILITY

'The promotion of gender equality by ensuring the different needs, experiences and capabilities of all genders are considered in research projects and policy', or gender mainstreaming (Bunce and Ford, 2015 pp.2), has become increasingly popular within vulnerability assessments and adaptation studies as awareness of the heightened vulnerability of females to climatic hazards has grown (Arora-Jonsson, 2011). Since the publication of the 'Gender and Development' issue on climate change including Denton's paper 'Climate Change Vulnerability, Impacts, and Adaptation' there has been a proliferation of research on gender and vulnerability. However, in comparison to other areas of climate vulnerability research gender research remains fairly limited (MacGregor, 2010). Existing studies can generally be categorised into studies which focus on gender related differences (Huynh and Resurreccion, 2014), and studies which focus on the comparison of female and male headed households (Flato *et al*, 2017).

Women have been identified as more vulnerable to climate hazards for a number of reasons. It is recognised climate hazards affect the poorest most severely due to heightened exposure and lower adaptive capacity (Arora-Jonsson, 2011). Within this it has been identified women account for 70% of the 1.3 billion living below the poverty line in the developing south (Denton, 2002). Furthermore, it is also acknowledged that gender inequalities are often greatest within the poorest communities (Arora-Jonsson, 2011), where socio-cultural norms often limits women's access to capital.

The greater level of poverty amongst female groups in developing nations has been attributed in part to a lack of access to markets (Klasen, *et al*, 2015), limited access to formal and informal credit (Van Aelst and Holvoet, 2016), and reduced access to the labour market in comparison with men (Oostendorp, 2010). In addition to these factors the reproductive role of women combines with the socio-cultural expectations of women in many developing nations, imposing constraints on their mobility and decision making powers (Shabib and Khan, 2014).

Furthermore, the roles and expectations of women as primary care givers, means often in times of climate stress if food supply is limited it is women who will eat last, and eat least (Tibesigwa and Visser, 2016). Women's livelihoods may also be more greatly affected by

climatic hazards because of their roles in livestock rearing, and the collection of water and fuel (MacGregor, 2010).

During times of disaster it has also been found women and girls are at a heightened risk of sexual abuse, trafficking and exploitation (Ray-Bennett, 2011), this threat also reduces the likelihood of women and girls using spaces such as cyclone shelters during times of disaster due to the fear they may fall victim to the same fate (*ibid*).

Alongside the social and cultural vulnerabilities of women, biological and physiological factors also put women at greater risk during disasters (Ray-Bennett, 2018). For example, in societies where women learning to swim is not socially acceptable, women are then more vulnerable during cyclone or flooding events (*ibid*). Furthermore, dress codes such as sarees can limit women's mobility in flood waters (Neumayer and Plumper, 2007).

It is well established the physical assets of HH's are impacted negatively by climate hazards, particularly cyclone events (Davis and Ali, 2014). As outlined above, it is also well established that climatic hazards have gender-specific effects resulting in women being more vulnerable to the effects of climatic events (*ibid*). The combination of both of these factors creates unique challenges for female HH's exposed to climate hazards and can cause further marginalisation of vulnerable groups (Falto *et al*, 2017). It has therefore been identified that female headed households require greater research focus (Klasen *et al*, 2015).

2.21 CRITICISMS OF FEMINIST APPROACHES

Alongside increased gender-mainstreaming within climate vulnerability studies, the number of studies critiquing the current methods of gendered vulnerability assessment has also risen. Some have argued that engagement with gender has been tokenistic and done little to motivate real change to address the identified inequalities (Bunce and Ford, 2015). While some argue the current man vs women methods employed to assess the challenges associated with gender and vulnerability are too reductive in nature (Skinner, 2011; Djoudi and Brockhaus, 2011; Carr and Thompson, 2014). Other researchers have taken this further to say gender should not be seen as an isolated or even primary driver of vulnerability to climatic changes (Arora-Jonsson, 2011) however the gender differentiated impacts of climatic hazards such as flood or cyclone events are supported by a number of empirical studies (*ibid*).

Furthermore, intergroup analysis between men and women risks overlooking the intragroup differences such as marital status which can have a significant influence upon the vulnerability of female HH's (Carr and Thompson 2013). For example, widowhood is identified in India as a cause of economic deprivation (Chen and Dreze, 1992), whereas female HH's whose husbands have migrated often receive remittances improving their household income (Buvinic and Gupta, 1997). Similarly, studies in Tanzania have found national laws which economically disadvantage widows (Dilger, 2006).

Having reviewed the existing literature on gender, climatic hazards and vulnerability it is clear there is not a simple isolated association between gender and vulnerability. Instead it is a complex web of interactions between gender and numerous other social factors. This understanding will inform the methodological design of this study to ensure intragroup analyses are carried out alongside binary gender analyses.

2.3 ADAPTATION

Adaptation to climatic variability is not a new phenomenon, populations have changed their behaviours and lifestyles throughout history to cope with changes in climate (Adger et al, 2003). However, the inadequacy of traditional measures to respond to the pace and magnitude of the climatic changes currently underway has renewed attention on adaptation in research and policy (Bierbaum *et al*, 2012). Furthermore, adaptation is increasingly seen as a vital component of all climate policy (Pielke *et al*, 2007), and as such there has been increased drive to document the impact of new policy interventions in practice.

As seen across many areas of climate study the definition of adaptation remains ambiguous and fragmented (Berrang-Ford, 2011) and definitions even vary between some of the largest authorities on climate science including the UNFCCC and the IPCC (IPCC 2014, UNFCCC, 2018). As the importance of adaptation has become increasingly pertinent within climate discourse efforts to better understand, define and document adaptation have proliferated (Gill et al, 2007; Hansen and Bi 2017). This study will employ the most recent IPCC definition of adaptation to identify adaptive strategies across this project. "The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human

intervention may facilitate adjustment to expected climate and its effects” (IPCC, 2014 pp.1758).

Numerous reasons have been outlined for the growth of adaptation research including; the assertion that the impacts of climatic hazards and climatic change are likely to be greatest in developing countries (Prowse and Scott, 2009), the shortcomings of mitigation strategies (Reid and Huq, 2007), and the delay of the response of natural systems to climatic shifts (Burton *et al*, 2002).

Where studies have previously focussed on theoretical approaches to adaptation such as assessments of adaptive capacity, there is a growing body of research utilising empirical data to document and assess adaptive strategies (Biagini *et al*, 2014). However, studies which document adaptation remain relatively limited and adaptation research in deltas is often focussed upon agricultural adaptation (Wassman *et al*, 2009; Vicuna *et al*, 2012; Liersch *et al*, 2013).

Numerous typologies have been established to categorise and surmise the many adaptation strategies identified within specific studies. The development of typologies enables comparisons to be drawn between areas where otherwise only highly context specific studies would be available. Some studies classify adaptations based upon timing to stimulus, whether an adaptation is autonomous or planned (Tanner and Mitchell, 2009), the form of the adaptation i.e. technological or financial (Smit and Skinner, 2002; Huq *et al*, 2003) or identify different forms of adaptation such as social vulnerability, resilience or targeted adaptation approaches (Eakin *et al*, 2009). Furthermore, adaptations which involve capacity building are one of the primary activities considered vital to help reduce the vulnerability of populations in developing nations to climatic hazards (Tompkins *et al*, 2010).

2.31 GENDER AND ADAPTATION

Current studies on gender differentiated aspects of climate adaptation in developing nations often focus upon agricultural adaptation (Djoudi and Brockhaus, 2011; Musinguzi *et al*, 2017; Carr and Thompson, 2014). For example, some studies have shown female HH’s to have differentiated access to agricultural adaptation practices such as irrigation, due to greater

burdens of household responsibility, and financial adaptations due to difficulties accessing loans (Huynh and Resurreccion, 2014).

It has also been identified that female HH's undertake adaptations differently compared to the spouses of male HH's. For example with the support of their husbands women are increasingly taking up livelihood diversification strategies such as starting small businesses (Smith, 2014), however female HH's often lack the required start-up capital to implement such changes (Van Aelst and Holvoet, 2016). Conversely, female HH's often have greater control over household assets compared to women in male headed households (Chant, 1997) which can mean they have more agency to implement adaptation strategies independently (Jabeen, 2014). Additionally, widowed female HH's experience adaptation differently to women whose husbands have migrated for work as a result of variations in access to financial capital, land and social networks (Klasen *et al*, 2015). There is a growing body of research focussing upon intersectionality between groups of women (Dilger, 2006; Gabrielsson and Ramasar, 2013; Klasen *et al*, 2015) to reduce the risk of overgeneralising complex realities.

Despite the clear interaction between gender and adaptation, studies also stress the importance of remembering the complexity of this relationship due to the interactions of additional social factors such as class, age, household headship and education (Arora-Jonsson, 2011). This is important to recognise throughout this study to ensure findings from this work consider the broader context of climate adaptation.

2.32 CRITICISMS OF ADAPTATION RESEARCH

One of the major criticisms of adaptation research is the assumption an adaptation is climate driven, when in reality adaptations are rarely taken in response to climatic variability alone (Smit and Wandel, 2006). This will be taken into account throughout this project to minimise the risk of exaggerating or oversimplifying the drivers of adaptation.

It is also often assumed adaptation results in positive change to reduce the vulnerability of an individual, household, or community to climatic hazards. However mal-adaptations have also been identified within literature but are less frequently addressed. Furthermore, actions which may have been successful within one context may not transfer effectively to a different

individual or community (Adger *et al*, 2005). Further work exploring the criteria for measuring the level of success for an adaptive intervention is therefore required.

The proliferation of adaptation interventions within climate policy is still in its infancy and as such the long term impacts of adaptive measures upon natural systems and the populations who inhabit them are as yet unknown. It therefore remains to be seen whether current adaptive initiatives will result in long term positive change or not, an aspect which often has not been considered within climate adaptation discussion.

2.4 BARRIERS, CONSTRAINTS AND LIMITS

Having established there is a need to adapt, and understand how people are adapting to climate hazards there has been a growing movement towards assessing how adaptation efforts may be also constrained (Berrang-Ford *et al*, 2011). This is broadly termed barriers research. One of the most prudent reasons for this growth is because there is a deficit between adaptation policies, adaptive capacity and actual adaptation. It is barriers research which seeks to identify and address the reasons for this deficit (Moser and Ekstrom, 2010). Similar to the themes of vulnerability and adaptation, the meaning of the term ‘barrier’ remains relatively ambiguous and various definitions have been proposed by a number of researchers (Boer, 2010; Huang *et al*, 2011, Moser and Ekstrom, 2010). Part of the difficulty in constructing a definitive meaning of the term barriers lies in the complexity and uncertainty of the definition of adaptation.

The terms barrier, constraint and limit are often used interchangeably (Biesbroek *et al*, 2013), however clear distinctions have been made in IPCC AR5 (Klein *et al* 2014). This report defines a barrier or constraint as ‘a factor which makes it harder to plan and implement adaptation actions’ (Klein *et al*, 2014 pp. 907), and a limit is ‘the point at which an actor’s objectives or system’s needs cannot be secured from intolerable risks through adaptive actions’ (Klein *et al*, 2014 pp. 907).

The various limits and barriers to adaptation have previously been categorised broadly into, physical and ecological limits, technological limits, financial barriers, informal and cognitive barriers and social and cultural barriers (Adger *et al*, 2007). Although some argue the categorisation of barriers is subjective and reduces understanding of the complex interactions

between different barriers and limits to adaptation (Biesbroek *et al*, 2013), it could also be said that without such categorisation the processes which constrain people's ability to adapt would be too complex to document effectively.

GENDER AND BARRIERS, CONSTRAINTS AND LIMITS

The interaction of gender with barriers to adaptation is an under researched study area, however the research is growing. Gender has been identified as being a factor which influences barriers to adaptation as a result of the numerous differences between the asset bases of males and females. Women have been identified as having; lower education levels compared to men (Fordham, 2003), reduced access to and ownership of land (Nielsen and Reenberg, 2010), less decision making power (Rakib and Matz, 2016), and experiencing gender norms which exclude them from alternative livelihood opportunities (Terry, 2009).

The factors which are perceived as, or considered barriers to adaptation are determined by how an individual or a group may perceive previous events and this is itself influenced by an individual's own values, and beliefs (O'brien, 2009). Furthermore, in the Indian context it is often the case female participation in decision making processes at both the household and community level is lower acting as a barrier to adaptation. However, the control of female HH's over household decision making processes provides a platform from which they can introduce changes to better adapt to the threats posed by climatic hazards (Gabrielsson and Ramasar 2013; Sugden *et al*, 2014).

Furthermore, uncertainty about climate hazards and concern for the environment influences people's decision making regarding adaptation and can act as a limit (Moser, 2005; Oppenheimer and Todorov, 2006). The heightened environmental concern of women acts to reduce the likelihood of women experiencing subjective constraints, thus increasing the likelihood of female HH's engaging meaningfully with adaptation to climate hazards (Sutton and Tobin, 2011).

Conversely, women in monogamous households and female headed households experience different constraints to adaptation (Carr and Thompson, 2013). For example, although a cyclone shelter may be provided, women in female headed households, particularly with adolescent daughters may not access it in times of need (Ray-Bennett, 2011). The reasons

behind this have been attributed to concerns over harassment by males, inability to maintain their values of honour in a shared sex space, and a lack of appropriate sanitary provisions for women (*ibid*). These same circumstances also highlight the instance of an intolerable risk or limit whereby women will remain in their homes until the threat to theirs and their families lives becomes too great (Ray-Bennett, 2011). However, gender does not act independently from other factors to constrain adaptation, the interactions of gender with class, caste, race, religion and age are extensive and create unique barriers between female headed households of varying circumstance (Enarson, 2001; Denton, 2002).

Overall the reproductive, productive and community work burdens of female HH's, despite enabling some behavioural change, highlight the importance of addressing gender disparities in climate policy to ensure responses to climatic hazards are not constrained by entrenched gender norms (Terry, 2009).

CRITICISMS OF BARRIERS APPROACH

As the body of research into the barriers, constraints and limits to adaptation grows, so too does the critical discussion of whether barriers research should be the mechanism by which adaptation decision making is assessed.

Firstly, it has been argued that the labelling of processes or factors as barriers reduces the complex network of factors which determine decision making outcomes to an oversimplified process (Biesbroek *et al*, 2014). By treating them as individual and independent factors, the interactions between different barriers and socio-political circumstances are omitted (Burch, 2010a). It has been argued that it is these interactions which often drive an individual's perception of whether a factor acts as a barrier or an opportunity to their adaptation (Burch, 2010b).

Despite a growing amount of research identifying and cataloguing various barriers, there is limited work suggesting the means by which barriers should or could be overcome (Biesbroek *et al*, 2013). There's also little advice to policy makers on how interventions should be implemented to improve adaptation outcomes (Clar *et al*, 2013).

Despite the criticisms of barriers thinking the approach remains relatively new and as such will continue to evolve in response to the criticisms identified. The criticisms of barriers

thinking does not negate its use in adaptation study, however it is important to remain mindful and critical of the associated limitations of barriers research throughout this study.

2.5 POLICY REVIEW

India has repeatedly demonstrated its commitment to addressing issues of conservation and combatting climate change. From attending the first United Nations (UN) conference on the human environment and development in 1972, to ratifying its commitment to the Paris Agreement on Climate Change in October 2016. Reviewing the existing policies and plans in place within India is therefore important within this study to ascertain the current priorities, plans and omissions in climate policy. This section will also review a number of existing policies and initiatives on gender to provide an insight into the position of and challenges faced by women in India and how gender inequality is being addressed.

A brief review of existing policies and plans to address climatic hazards found a number of emergent themes (Appendix A). Firstly, although there are policies related to both climatic hazards and gender the two are addressed as mutually exclusive matters. That is to say, the acknowledgement of gender related issues within climate policy is limited and vice versa. A quick frequency analysis for the terms 'women', 'female', 'girl' and 'gender' found 44 instances across national climate policies and plans and 33 instances across state policies and plans (Appendix A). Similarly a frequency analysis for the terms 'climate', 'environment', 'cyclone' 'disaster' and 'flood' found 10 instances across national gender policies and plans and 1 instance across state policies and plans (Appendix A). There are a number of issues associated with this separation between subjects in particular, the vulnerability of populations to climatic hazards is an inherently gendered issue therefore its inclusion within policy is vital (Fukuda-Parr, 1999; Carr and Thompson 2013).

Furthermore, despite the recognition of women as more vulnerable to climatic hazards, the initiatives to address this disparity remain poorly established (Shabib and Khan 2014). This finding has also been recognised within this review where inclusion of gender related issues is minimal and where gender has been addressed it often identifies the vulnerability of female groups but provides no guidance on how to address it. The existing plans and policies in place in relation to climatic hazards cite the importance of taking proactive measures as opposed to reactive disaster management techniques. For example one of the main objectives of the

West Bengal State Disaster Management Policy and Framework is “To establish and maintain a proactive programme of risk reduction...” The need for local and national governments to take preventative steps to mitigate the threat of climatic hazards is commonly cited within research (Ngwenya *et al*, 2017; Ahmed *et al*, 2018). Furthermore, Mirza (2003) also suggests shifts of this kind can help to reduce gender inequality. This contradicts others who argue gender-blind interventions exacerbate existing gender inequalities (Masika, 2002; Gaard, 2015).

Self-help groups (SHG's) are identified within climate policy in India as a means of addressing gender disparity and increasing the adaptive capacity of women. This initiative is supported within literature where SHG's have been identified as a successful means of addressing gender disparities, helping to increase the independence of women within households and communities (Ghosh *et al*, 2018). However, a certain level of financial capital is required for a woman to join a SHG, therefore these schemes can often remain inaccessible to the poorest women or those without regular incomes (Shanthi *et al*, 2017). This reinforces the necessity for gender and climate policy to take an integrated approach to ensure both aspects can be addressed effectively.

Furthermore, the Kanyashree Prakalpa scheme provides financial support and the bikes for girls' scheme improves the safety of girls when travelling to and from school. These schemes are aimed at helping girls to stay in school and prevent child marriage which remain significant issues in the IBD. The focus of schemes upon young women will help to improve the agency of women as they grow up. Unlike the widows' pension scheme which provides financial assistance to women previously dependent on their husband's livelihoods, the Kanyashree Prakalpa and Bike scheme supports young women and girls to have greater independence. These new initiatives highlight the changing attitude towards women and their role in society. Furthermore, the focus on education and societal change in younger generations will help in combatting the factors which have historically driven the lower adaptive capacity and heightened vulnerability of women to climate hazards (Yadav and Lal, 2018).

Overall, although climate policies have been introduced, the omission of gender specific issues within climate policy will act as a barrier to reducing the vulnerability of women in the IBD (Nelson *et al*, 2002). Furthermore, previous work on the effectiveness of climate policy

has found participation and influence in decision making processes is vital to ensuring adaptations are legitimate (Adger *et al*, 2005). However, it is clear from this policy review and from current academic literature that women, particularly in the global south, are underrepresented in all spheres of climate governance and disaster management (Ahmed and Fajber 2009).

2.6 SUMMARY

Much of the existing literature on climate hazards focusses on vulnerability assessments, consequently the vulnerability of populations within deltas to climatic hazards is well established. Adaptation studies are an increasing field of research however much research, particularly in deltas, remains small sample with limited application of a gendered perspective. Additionally, of the existing studies on barriers to adaptation, few address the perceived opportunities to overcome the barriers identified and no research currently exists which addresses this in the context of women living in delta regions.

3.0 METHODOLOGY

3.1 MIXED METHODS APPROACH

Mixed methods approaches are commonly used in health and social science research and involve the combination or association of both quantitative and qualitative approaches within a single study (Creswell, 2014). Using a mixed approach is beneficial because it applies the strengths of both qualitative and quantitative research to better understand a research problem (*ibid*), and helps to offset the weaknesses of using one approach in isolation (Rossman and Wilson, 1991). Furthermore, it's considered the use of mixed methods in environmental social science research assists efforts to understand the barriers to engagement with the relationship between human behaviours and the physical environment (Schmidt, 2005). This study will use a sequential explanatory design to combine unpublished quantitative survey data, collected between December 2016 and February 2017, for DECCMA's project on adaptation in deltas, with qualitative data collected in July 2018 for the purpose of this research. A visual model for the study design procedures is shown in Figure 3.

Using a sequential approach is appropriate because the study utilises data collected before the project was established, and uses analysis of this dataset to justify and provide the structure for the subsequent qualitative phase (Driscoll *et al*, 2007). There are a number of benefits to using a sequential design. For example, any unexpected results from the quantitative data can be examined in more detail during the qualitative phase (Morse, 1991). Furthermore, the implementation of this method is very clear as a result of the distinct stages identified in the approach.

The weaknesses of using a sequential explanatory approach are the time consuming nature and the practicality of resourcing for collection and analysis of both data types (Moghaddam *et al*, 2003; Ivankova *et al*, 2006; Bryman, 2016). As a result of quantitative data collection being carried by the DECCMA project prior to the start of this project, the time consuming nature of sequential studies does not act as a constraint to this project. Similarly, the support of the study from the DECCMA research project and the partnership with Jadavpur University meant the availability of resources for data collection was not an issue during qualitative data collection. The explanatory approach taken within this project will allow for the triangulation

of quantitative findings, a common use of mixed methods, and enable greater understanding of the quantitative outputs to establish why certain findings are occurring (Creswell, 2014).

Existing research on barriers to adaptation in deltas predominantly uses small sample qualitative data to provide context specific descriptive insights (Biesbroek *et al*, 2013). By using mixed methods this study presents a unique opportunity for large n quantitative data, to be used alongside small n spatially specific data. This allows the study to identify and establish a deeper understanding of the opportunities perceived by and for female HH's to overcome the barriers to adaptation which are experienced.

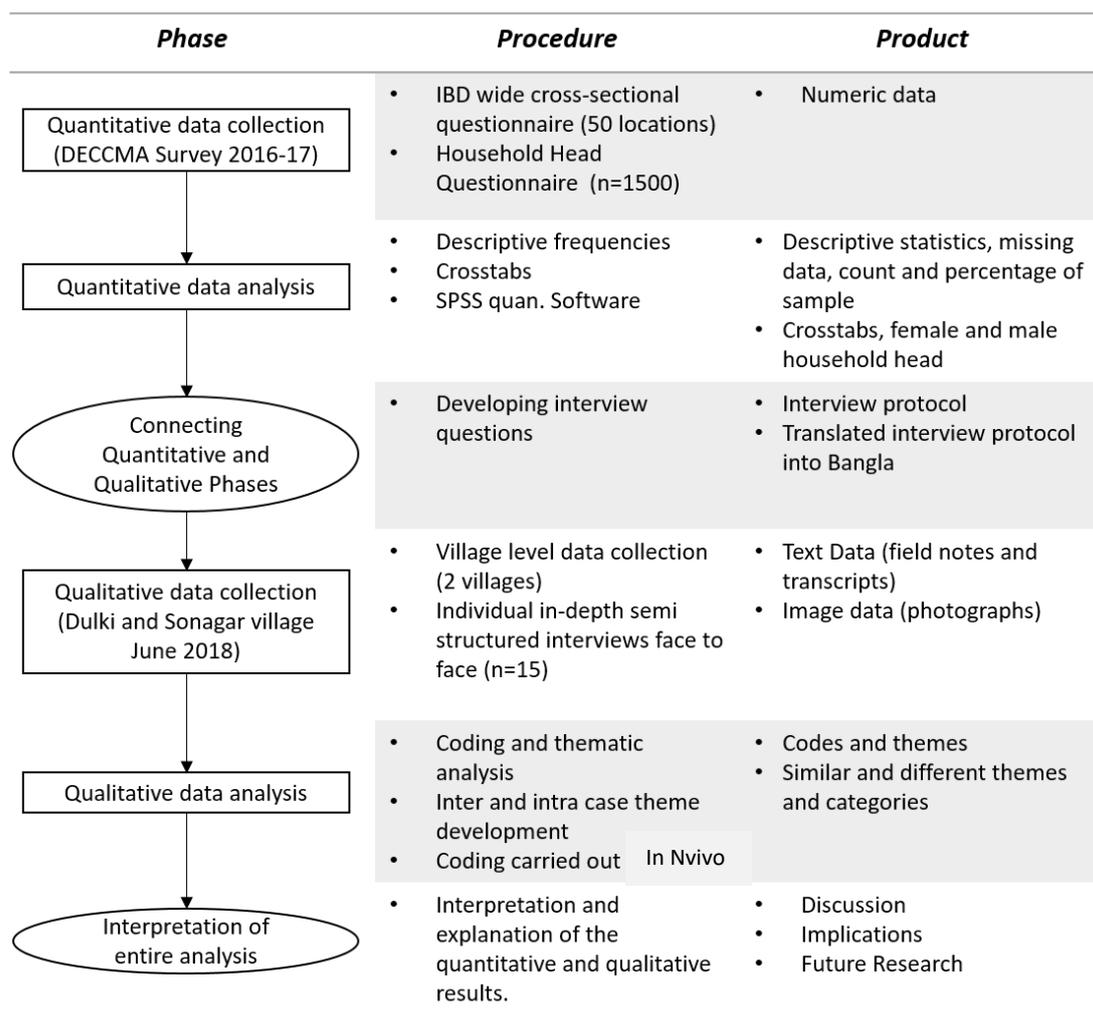


Figure 3: Visual Model for Mixed-Methods Sequential Explanatory Design Procedures (Source: Adapted from Ivankova *et al*, 2006)

3.2 QUANTITATIVE DATA

3.2.1 USE OF QUESTIONNAIRES

The DECCMA project involved the design of a largescale household questionnaire to be completed by the HH, and a female only questionnaire to be completed by females within the household. These questionnaires were carried out across three deltas including the Indian section of the GBMD, the IBD. The female only questionnaire was not completed by female HH's therefore only the HH questionnaire will be used in this study. There are many existing studies on adaptation to climate hazards which have used questionnaires in their research design (Bhattacharjee and Behera, 2018; Pandey and Jha, 2011; Duncan *et al*, 2017b), however the DECCMA dataset is unique in its scale and location. 1500 households across the IBD were included and the survey covers under researched aspects of adaptation including; barriers to adaptation, the gendered dimensions of adaptation, and migration as an adaptation strategy (DECCMA, 2018). The DECCMA survey area covered areas within 5m of sea level (Figure 4).

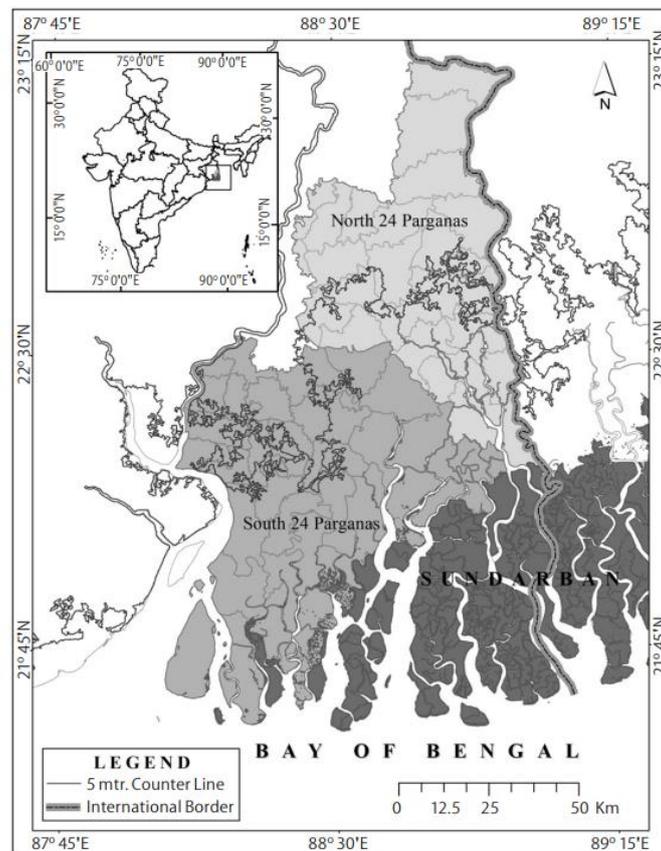


Figure 4: DECCMA Survey Area (Source: Ghosh *et al*, 2018)

3.22 QUESTIONNAIRE DESIGN

DESIGN AND CONTENT

The HH questionnaire designed by DECCMA covers 8 sections (Table 1), and was designed to address the research objectives of DECCMA. The focus of DECCMA on gender meant the questionnaire was developed to enable gender comparison and gendered analysis; making it appropriate for use within this research project. Sections 1 and 5 of the questionnaire were used for analysis to identify the gender of the HH, and address questions of adaptation and perceived barriers to adaptation.

Table 1: Household Head Questionnaire (Source: DECCMA)

Section number	Section content
Section 1	Household Roster
Section 2	Material Wellbeing
Section 3	Subjective Wellbeing
Section 4	Migration
Section 5	Adaptation
Section 6	Environmental Stress and Change
Section 7	Thresholds
Section 8	Economics

DISTRIBUTION AND SAMPLING

A two stage cluster sampling technique was used in the implementation of the household survey. Initially a village level multi-hazard map was produced (flood, cyclone and erosion). In each multi-hazard zone, locations were identified proportional to the number of households in each location. 10,000 households were listed based upon their demographic and migration characteristics; 1500 households were then selected for inclusion within the study proportional to the number of migrant sending and non-migrant households. Cluster sampling was an ideal sampling technique to use in this instance because of the impracticality of attempting to capture all aspects which comprise the population of the IBD (Babbie, 2007). Using this technique ensured the most exposed areas of the delta were captured and households with the characteristics required for this objectives of DECCMA's research were included, thus reducing the risk of non-response bias (Flowerdew and Martin, 2013).

CRITICISMS OF THE QUESTIONNAIRE

The DECCMA dataset has collected detailed accounts for the research sites of the study, however the scale of the DECCMA project and its focus on cross delta comparison means there are a number of weaknesses in this questionnaire. Firstly, the scale of the project required closed questions to be used; by limiting people's answers to a specific set of pre-determined choices participants may adopt a false position and therefore introduce bias into the questionnaire (Flowerdew and Martin, 2013). Combining analysis of this dataset with qualitative research will go some way to address this issue (*ibid*). Furthermore, the cross country focus meant not all of the questions included in the questionnaire were appropriate within the context of the IBD. The inclusion of questions which may not be relevant to respondents in the IBD, combined with the long length of the interview may have meant some responses suffer from fatigue bias or missing data (Flowerdew and Martin, 2013).

This questionnaire was designed in English and then translated into Bengali, this may have resulted in issues of mistranslation or misinterpretation of the terms used in the questions. A pilot test was therefore carried out to address any issues related to language translation (Flowerdew and Martin, 2013). The scale of the project meant enumerators were employed and trained to conduct the questionnaire. Technical difficulties experienced during fieldwork also meant responses were recorded on hard copies; this led to a greater number of omissions and errors in data entry.

The most significant limitations of the use of this dataset for this study are as a result of the gendered perspective of this research. As a result of the socio-cultural position of women living in the IBD there were difficulties gathering female responses to the questionnaire. In some instances men would not permit their wife to participate in the study or women felt their husbands or sons were better placed to answer the questions. Additionally, although the DECCMA project has captured responses from female HH's, they were not the sole focus of the questionnaire therefore the sample size is limited.

ETHICS

The DECCMA project has full ethics approval (Ethics ID: 18173) and the requirements stipulated within the ethics form will be adhered to in use of the DECCMA dataset in this study. Combining qualitative and quantitative data can increase the risks of participant identification. These risks were removed by aggregating the data and removing all location information or identifying characteristics from the quantitative analysis.

3.23 QUANTITATIVE QUESTIONNAIRE ANALYSIS

The literature review informed the quantitative analysis of this study carried out using SPSS. Having established there to be distinct differences in adaptation between men and women; the analysis of this dataset was constructed so as to discover and display any such differences between male and female HH's in the context of the IBD. It was also expected that the adaptations which female HH's would like to implement, but have not, and the perceived barriers to adaptation would vary to male HH's. Each of these aspects were therefore approached from a gendered perspective.

ANALYSIS METHOD

As seen from other studies which address the gender differentiated aspects of climate adaptation, descriptive frequency analysis are often used when analysing quantitative data sets (Ngigi *et al*, 2017) and was therefore judged to be suitable for this project.

The limited sample size of female HH's in the survey meant many adaptations had sample sizes less than 10 therefore parametric significance testing of the differences between male and female HH's was not appropriate (Pett, 1997). In order to test significance using either parametric or non-parametric tests transformation of the data would have been required, manipulating the data to the extent outputs were no longer meaningful (Harris and Jarvis, 2013).

DATA CLEANING

Initially the dataset was cleaned to ensure any ambiguity regarding the gender of the HH was removed. This left a sample size of 1300, 1113 male HH's and 187 female HH's respectively.

A number of the questions on adaptation included in this study contained multiple clauses which led to ambiguity in the adaptation which respondents were undertaking. To overcome

this questions were recoded so each clause of the variable was recorded in a separate variable, shown in Figure 5.

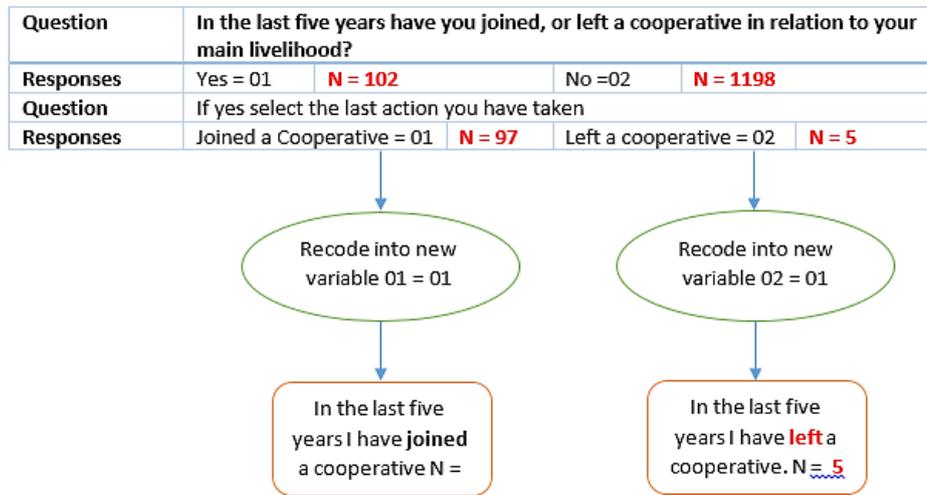


Figure 5: Variable Recoding Method

To ensure the adaptations included within the study were only those driven by environmental factors (Table 2), descriptive frequency analysis was carried out on the male HH's and female HH's separately and the three drivers most commonly cited were recorded for each adaptation in the study. By analysing this variable by gender it was possible to see whether the drivers for implementing an adaptation were different between male HH's and female HH's.

Table 2: Environmental Drivers of Adaptation

Climatic drivers of adaptation

Slow negative change to the environment
Weather shock
Unpredictable weather
Provision of government/ NGO disaster support

RESEARCH QUESTIONS 1 AND 2

Using cross tabs whereby the gender of the HH was the independent variable, and each adaptation variable acted as a separate dependent variable addressed research questions 1 and 2 respectively. The adaptations were then grouped into 6 different categories (Table 3). The percentage of the sample implementing each adaptation, or wanting to implement each

adaptation, was calculated to allow for comparison between the different sample sizes of male and female HH's.

Table 3: Adaptation Groupings

Adaptation group	Explanation
Agricultural	Adaptations directly relevant to farming and fishing livelihoods such as intensifying labour, or changing crop types (Morton, 2007)
Disaster response	Short term behavioural responses to climatic hazards, such as moving to a shelter or reducing the amount of food consumed.
Financial	New finance, cooperative or insurance strategies to mitigate the effects of climatic hazards (Biagini <i>et al</i> , 2014).
Government/ NGO assistance	Adaptations which households can access through government and external agencies (Smit <i>et al</i> , 2000).
Livelihood diversification	Migration, land use change or uptake of work by women reduces the economic vulnerability of a household to climatic hazards by drawing from multiple sources of income (Hossain <i>et al</i> , 2018).
Physical	Changes or improvements made to an individual's home which aim to protect against climatic hazards (Biagini <i>et al</i> , 2014).

RESEARCH QUESTION 3

Research question 3 was addressed using cross tabs where the gender of the HH acted as the independent variable and the barrier to adaptation was the dependent variable. The variables for barriers to adaptation had been split into 8 possible barriers and recorded as ordinal variables; whereby each respondent had ranked the three most important reasons preventing them from making changes in the last 5 years. Percentages were calculated to allow for cross group comparison. Only one question addressed barriers to adaptation in the questionnaire therefore the barriers associated with each individual adaptation could not be assessed.

The differences between female and male HH's found during quantitative analysis justified the gendered approach taken in this study and guided the design of the qualitative phase of the study.

3.3 QUALITATIVE DATA

3.31 USE OF INTERVIEWS

Qualitative data collection was carried out between 5th June 2018 and 12th June 2018. The reason for the limited period for data collection was as a result of the difficult weather conditions associated with the onset of the monsoon rainfall. Semi-structured interviews

were used to allow interviewees to construct their own accounts of experiences (Flowerdew and Martin, 2013). Semi-structured interviews are often used in climate adaptation and vulnerability research (Ray-Bennett 2011) and by using semi-structured interviews in this study the complexity of women’s lived experienced was captured. Collecting qualitative data provided a rich source of information and enabled areas of interest to be explored in more detail in a more conversational context (Bryman, 2016).

3.32 INTERVIEW STUDY AREA AND SAMPLING

South 24 Parganas was selected as the district for qualitative study because it is the district which accounts for the greatest area of the IBD. From South 24 Parganas 2 villages were chosen for this study, Dulki and Sonagar in Gosaba block. Using these villages as case studies within this research will enable deeper analysis of the complex interactions which drive the vulnerability of female HH’s in the IBD (Cohen and Manion, 1995). These villages were chosen because, as observed from the DECCMA risk map, they are villages categorised as high risk to climatic hazards, and the number of female HH’s within the villages is high compared to other villages in the delta. GPS coordinate data was collected whilst in the field and this was used in the interview study site map to display the area within each village where interviews were carried out (Figure 6).

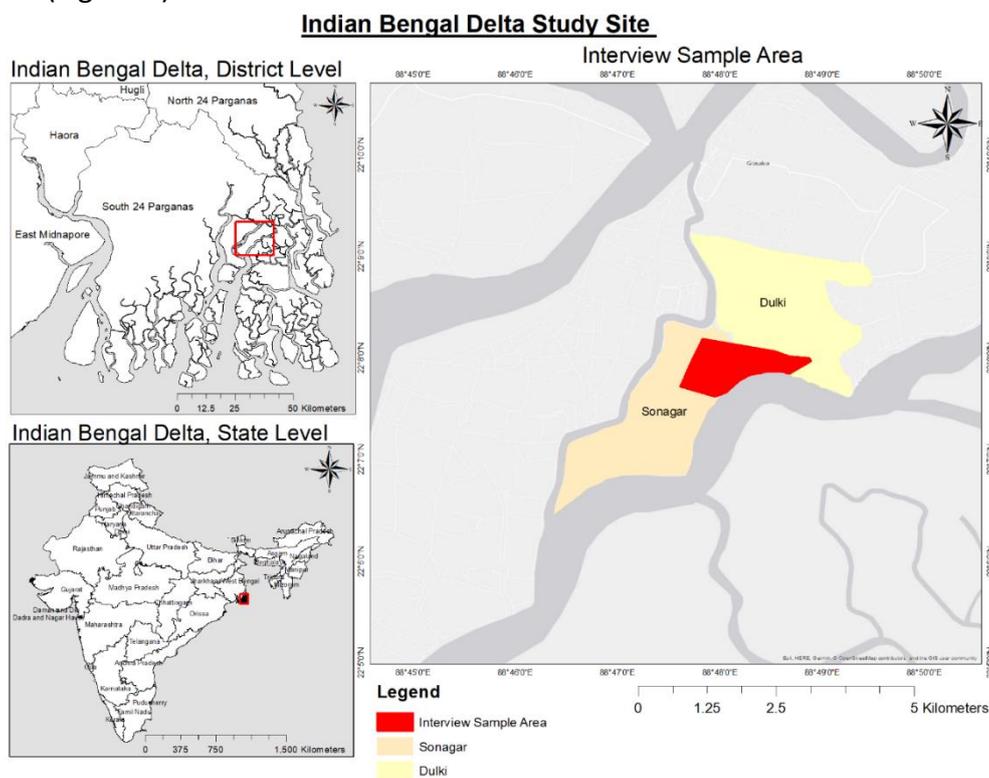


Figure 6: Interview Sample Area

Purposive sampling was used in this study because it enabled individuals to be selected with direct relevance to the research questions of the study (Bryman, 2016). A household listing was undertaken by staff at Jadavpur University and local guides prior to fieldwork to identify female HH's willing to participate in the study. This was useful given the time constraints of the fieldwork. However, the selection of households based upon those listed by the local guides could have introduced bias to the sample, whereby only those who the guide felt would contribute effectively to the study would have been interviewed. This was partially overcome by the researcher's random selection of target households off of a list of potential respondents as provided by the local guide (Ray-Bennett 2010).

Creswell (2014) suggests using a sample size of between 5 and 30 for semi-structured interviews, this study adheres to this recommendation having carried out 15 interviews. The time constraints of data collection, combined with the challenging weather conditions meant further interviews could not be carried out. However, within qualitative study, it is considered the required number of interviews for a study is not the point of greatest significance (Saunders and Townsend, 2016); instead it is the depth and quality of each interaction which influences the value of qualitative research findings (Kitchin and Tate, 2013).

3.33 ETHICS AND RISK ASSESSMENT

The ethics and research governance online (ERGO) process was completed and approval was received prior to the collection of any data (ERGO ID: 41167). The risks associated with the fieldwork were identified and included within the ERGO submission along with appropriate participant information, consent and debriefing forms, these documents were also translated into Bengali to ensure participants were able to provide informed consent.

3.34 INTERVIEW PROTOCOL

15 Semi-structured interviews were administered by a group of three individuals; the researcher, a student from Jadavpur University who worked as a translator, and a local guide who ensured appropriate households were approached for participation. The interviews were carried out at a location chosen by the interviewee helping to put the participant at ease (Le Masson, 2013). However, one of the difficulties in doing so meant a number of interviews were in the presence of men which may have had an influence over the responses women felt comfortable giving. To minimise the influence of others on the interviewee the local guide

made efforts to engage them in conversation and move them away from the interview location.

Interviews began with impersonal, contextual questions to enable a rapport to be built up between the interviewer, translator and interviewee and help put the participant at ease before asking more personal, gender sensitive questions (Kitchin and Tate, 2013) (Appendix F). The interview was designed to ensure questions were open and leading questions were avoided (Hay, 2016) however where individuals had difficulty understanding what the question was asking the question was rephrased and various prompts were used to provide contextually relevant examples. Further prompts such as 'can you explain why you feel this way?' were also used to encourage participants to go into more detail and explore their responses in greater depth.

The interviews were held in Bengali by a translator and recorded to allow for verbatim transcription post data collection (Appendix C). Recording allows for a more detailed account to be taken and enables the researcher to engage fully with the interview, and respond to visual cues (Flowerdrew and Martin, 2013). Conversely, conversations can be misinterpreted or mistranslated by a translator (Althor, 2018), however the use of a translator was the most appropriate option for data collection given the language barrier between the researcher and respondent. Throughout the interview the translator made brief notes enabling the researcher to ask follow up questions where appropriate. The method for carrying out the interviews was pilot tested on the 5th June 2018; no major difficulties in data collection were encountered, therefore the pilot interviews were included within this study.

3.35 POSITIONALITY

Positionality defined as when 'a researcher's social, cultural and subject positions (and other psychological processes) affect: the questions they ask; how they frame them [and] the theories that they are drawn to' (Johnston *et al*, 2009) influences any research, particularly when researching in different cultural contexts (Flowerdrew and Martin, 2013).

Anthropologists have established the importance of recognising how a researcher's own subjectivity, cultural background, and viewpoints may influence or limit their ability to interpret their findings and observations (Le Masson, 2013). Within studies of gender this

influence is made more significant by the different gender values and behaviours transferred through different cultures (*ibid*). The influence of the researcher's positionality was recognised from the outset of the project, enabling a number of measures to be taken to reduce the influence of their own position upon research findings.

The researcher's limited knowledge of the study area combined with their different cultural background could have influenced the questions which were asked and how they were framed. To overcome this the researcher worked alongside the translator when finalising the interview schedule. There were some probing questions which were highlighted by the translator as being inappropriate to ask participants directly. One example of this was 'Would doing this not be appropriate within Indian tradition and culture?', by working with the translator to finalise the interview questions it gave the researcher a better understanding of the culture, and helped to ensure questions were framed in way which would be engaging and inoffensive to the participant.

The involvement of others within this research project; the translator and accompanying students and fieldwork supervisors will have influenced the interpretation of findings, this has been recognised throughout the project, however Turner (2010) argues, the involvement of multiple team members in the field can enable a more nuanced understanding of local gender dynamics. This was particularly relevant in the case of this research because the local knowledge of the translator and local guide meant they had a large knowledge base to draw upon when interpreting responses. To assist with the interpretation of findings, both the translator administering the interview and the researcher recorded their own perceptions, inferences and feelings throughout the interviews. By both recording their experiences it was possible to combine their perceptions and ensure the researcher's interpretations of the emotions and feelings held by the participant were an accurate reflection of the feelings expressed during the interviews.

In an effort to ensure participants were comfortable discussing gender-sensitive topics female researchers were used (Durrant *et al*, 2010). However, questions have been raised regarding the legitimacy of the assumption female researchers are better at researching female issues, and whether the life of a western female researcher shares enough common ground with women in the global south (Le Masson, 2013). It is often cited people are more likely to

engage in conversation with those they feel they share similarities to (Vercruyssen *et al*, 2017), therefore the presence of a translator who was of Indian nationality and could speak Bengali may have influenced the willingness of women to participate in this project. However, it could be argued the female research team's position as highly educated young women, will have influenced the study (Liamputtong, 2007). This influence is particularly pertinent as a result of the potentially exploitative power relationship between the researchers and the participants. Power relations cannot be eliminated from the research however critical reflexivity, a common mitigation strategy, was employed throughout data collection in an effort to negotiate this limitation (Hay, 2016).

3.36 QUALITATIVE INTERVIEW ANALYSIS

THEMATIC CODING

An inductive approach was primarily taken to analyse the qualitative data (Glaser and Strauss, 1967), however some codes relating to gender disparities and power relations were provisionally considered prior to fieldwork having been informed by the quantitative phase of the study (Miles and Huberman, 1994). The transcription of data recordings and initial transcript analysis occurred simultaneously allowing emerging themes to be identified from interviews. These themes could then inform later interview questions as data collection progressed (Marshall and Rossman 1995).

The coding structure was emergent, and as transcripts were reviewed, numerous categories or codes were assigned to the text. These codes were used to identify and classify events, behaviours and attitudes to adaptation from the perspective of the research participant (Strauss 1987). Prior categories can influence what the researcher looks for or the way the researcher interprets material to find said categories within the text. Using an inductive, open coding approach which aggregates initial codes up to broader groups, or primary codes helped to overcome this issue (Crang and Cook, 1995). Furthermore, where this research has been undertaken in a new context using a grounded theory approach enabled the key themes to emerge from the research to inform the development of future frameworks for analysis.

The interview transcripts were analysed in Nvivo alongside field notes; this ensured the emotional context and interpersonal relationships which led to the content of the recorded interview data (Portelli, 1981), were not removed from the analysis. Attribute codes such as

age were assigned to participants enabling patterns and relationships between different groups of female HH's to be identified during the analysis. The majority of codes used were descriptive and in vivo codes. This captured the changes taking place alongside how respondents felt about the changes being made and challenges they were facing.

A word cloud was also generated in Nvivo to display the 100 most frequently used words across all 15 interviews. This created a visual representation of some of the key themes which recurred throughout discussions.

3.4 SUMMARY

This section has outlined the methodological approach taken in this research. A mixed methods exploratory approach was used to combine the DECCMA HH dataset with 15 in-depth semi-structured interviews from female HH's living in the IBD to triangulate quantitative findings and explore inter and intra group differences in more depth. These findings are discussed in Section 4.

Table 4: Interview Respondents and Attribute Codes

<i>Respondent Reference Attribute Codes</i>				
<i>Respondent Number</i>	Total HH Members	Reason for being HH	Estimated Age	Brick or mud and thatch house
1	5	Widow	55	Mud and thatch
2	4	Migrant husband	25	Mud and thatch
3	3	Husband is unwell	36	Mud and Thatch
4	3	Husband is unwell	47	Mud and Thatch
5	3	Widow	62	Mud and Thatch
6	4	Migrant Husband	36	Mud and Thatch
7	5	Migrant Husband	37	Mud and Thatch
8	9	Widow	40	Mud and Thatch
9	6	Widow	43	Brick
10	1	Widow	63	Mud and Thatch
11	5	Widow	80	Mud and Thatch
12	4	Widow	55	Brick
13	3	Widow	34	Mud and Thatch
14	5	Widow	57	Brick
15	4	Migrant Husband	46	Mud and thatch

4.2 RESEARCH QUESTION 1

What adaptations are being undertaken by female headed households?

The adaptations to climatic hazards identified in Table 5 and the qualitative data will be grouped as shown in Table 3. These groupings were informed by findings from the literature review.

Table 5 displays the adaptations which were found to be driven by environmental factors. Greyed out boxes display adaptations which either had 0 counts or which were not environmentally driven adaptations. A number of adaptation strategies have been adopted in the IBD where environmental factors are not the primary drivers, predominantly these are driven by family disruptions and changes to household income (Appendix D).

Male HH's in the IBD were found to be undertaking 26 different adaptations in response to environmental drivers (Appendix D). In comparison, female HH's were found to be undertaking just 19. (Appendix D). Furthermore, environmental drivers were listed in the top three causes of adaptation 52 times out of a possible 78 instances, or 67% by male HH's. Similarly, female HH's cited environmental drivers to adaptation 37 times out of a possible 57

instances, or 65% (Table 5). This initial finding suggests there are similar levels of concern for the environment among both male and female HH's in the IBD. However, male HH's are undertaking a greater number of adaptations suggesting female HH's must experience unique barriers (Terry, 2009). Furthermore, the concern of women over environmental issues is widely documented in literature and often extends to the contentious rhetoric identifying women as having greater concern for the environment than men (Stern *et al*, 1993; Tranter 2011; MacGregor, 2017). The frequent identification of environmental factors as drivers of change in the IBD is also supported in literature where it has been identified that often areas which experience the consequences of climate hazards are more motivated to make changes (Whitmarsh, 2008; Spence *et al*, 2011; Van der Linden, 2014). However, greater exposure to climate hazards does not always translate to adaptation (Van der Linden *et al*, 2015).

Table 5: Adaptations Taking Place and Desired Adaptations

Type of Adaptation (taken in the last 5 years)	People Adopting Adaptation Strategy				Would like to Take up Adaptation but Have Been Unable To			
	Count of Male HH	Of Male HH sample (%)	Count of Female HH	Of female HH sample (%)	Count of Male HH	Of Male HH sample (%)	Count of Female HH	Of female HH sample (%)
Agricultural Adaptations								
Started using hired labour	179	16.08	16	8.56	174	18.63	23	13.45
Stopped using hired labour	19	1.71	2	1.07				
Diversified types of crop grown	62	5.57	2	1.07	42	4.00	3	1.62
Reduced variety of crops grown	19	1.71	1	0.53				
Started planting climate tolerant crops	59	5.30	2	1.07	45	4.27	2	1.08
Stopped planting climate tolerant crops	3	0.27	0	0.00				

Type of Adaptation (taken in the last 5 years)	People Adopting Adaptation Strategy				Would like to Take up Adaptation but Have Been Unable To			
	Count of Male HH	Of Male HH sample (%)	Count of Female HH	Of female HH sample (%)	Count of Male HH	Of Male HH sample (%)	Count of Female HH	Of female HH sample (%)
Increased use of fertiliser	144	12.94	6	3.21	9	0.92	0	0
Reduced use of fertiliser	9	0.81	1	0.53				
Put in irrigation	107	9.61	4	2.14	36	3.58	1	0.55
Took out irrigation	2	0.18	0	0.00				
Bought farming/fishing equipment	68	6.11	2	1.07	58	5.55	3	1.62
Sold farming/fishing equipment	1	0.09	0	0.00				
Fished new breeds in ponds	5	0.45	1	0.53	15	1.35		
Disaster Response Adaptations								
Organised own protection during a storm or flood	39	3.50	7	3.74	556	51.77	83	46.11
Used a community shelter during a storm or flood	71	6.38	15	8.02				
Stopped using a community shelter during a storm or flood	2	0.18	0	0.00				
Financial Adaptations								
Taken out a loan	564	50.67	90	48.13	165	30.05	19	19.59

Type of Adaptation (taken in the last 5 years)	People Adopting Adaptation Strategy				Would like to Take up Adaptation but Have Been Unable To			
	Count of Male HH	Of Male HH sample (%)	Count of Female HH	Of female HH sample (%)	Count of Male HH	Of Male HH sample (%)	Count of Female HH	Of female HH sample (%)
Joined a cooperative	76	6.83	21	11.23	319	30.76	40	24.10
Left a Cooperative	4	0.36	1	0.53				
Government / NGO Assistance Adaptations								
Received government/ NGO assistance	289	25.97	42	22.46	712	86.41	129	88.97
Stopped receiving government/ NGO assistance	1	0.09	1	0.53				
Received training on new fishing/ farming methods	12	1.08	1	0.53	122	11.08	1	0.54
Livelihood Diversification Adaptations								
Women in the household started working outside of the house	36	3.23	17	9.09	219	20.33	53	31.18
Sent a household member to work outside of the village	168	15.09	61	32.62	214	22.65	26	20.63
Changed land-use to mixed farming/ fishing production	18	1.62	0	0.00	44	4.02	4	2.14
Physical Adaptations								
Modified or improved house	476	42.77	72	38.50	461	72.37	82	71.30

Type of Adaptation (taken in the last 5 years)	People Adopting Adaptation Strategy				Would like to Take up Adaptation but Have Been Unable To			
	Count of Male HH	Of Male HH sample (%)	Count of Female HH	Of female HH sample (%)	Count of Male HH	Of Male HH sample (%)	Count of Female HH	Of female HH sample (%)
Started cutting down trees around the home	85	7.64	15	8.02	85	8.27	11	6.40
Stopped cutting down trees around the home	75	6.74	11	5.88				
Started to plant trees around the home	393	35.31	45	24.06	376	52.22	75	52.82
Stopped planting trees around the home	24	2.16	3	1.60				
Moved to a new house within the same village	45	4.04	13	6.95	138	12.92	16	9.20

Perhaps surprisingly given the dependence of rural delta populations on agriculture (Ericson *et al*, 2006), only 4.7% of male HH's and 1.5% of female HH's were found to be implementing agricultural adaptations. Men, as the HH's, are generally more engaged with breadwinning activities and women with household duties such as cooking and cleaning (Kelebe *et al*, 2017; Farzana *et al*, 2017), providing some explanation for why female HH's were found to be less frequently engaged in agricultural adaptations. Further explanations for this difference may reside in issues surrounding women's access to land. Studies have identified women in South Asia often face legal and cultural barriers inheriting property and women-owned holdings can be too small for many agricultural adaptations to be practicable (Sugden *et al*, 2014).

The highest proportion of participation by female HH's was in financial adaptations; 29.7% of the maximum combined count of loan taking and cooperative initiatives. In comparison, just 0.3% of the total possible count of male HH's were adopting loan taking. Contrastingly, few interview respondents were involved in loan taking and where they had been accessed

respondents rarely gave positive accounts of formal loan taking due to fears over repayment difficulties [1,3]. More frequently respondents discussed the informal borrowing of money from neighbours and friends or participation in SHG's, these financial adaptation measures were framed more positively than formal loan taking from banks [2,3,12] (Ghosh *et al*, 2018). Informal loan taking was often used to cope with family disruptions such as illness rather than climatic hazards or other direct environmental drivers [2]. The difficulty of differentiating between environmental drivers of adaptation and other motivations is widely discussed in literature and perhaps unsurprising given the complexity of interactions between adaptation, livelihoods, availability of capitals, and vulnerability to climatic hazards. The focus of this project upon environmentally driven adaptations may therefore omit some adaptations, a limitation of this study.

Many interview respondents worked outside of the home and often participated in more than one livelihood, highlighting the diversity of the livelihoods of female HH's. The diversification strategies generally involved *"daily wage labour"* [7,15], and *"prawn and shrimp cultivation"* [11]. Studies in Vietnam have similar findings identifying that female HH's are often more engaged with daily wage labour rather than higher earning self-employed activities, and this diversification is rooted in a need to survive (Huynh and Resurreccion, 2014). Adaptations as essential measures to ensure their family's survival were also identified throughout this study;

"To protect myself from the calamities...I had to elevate my house. It was a strategy for survival which I adopted" [11]

"I sell wood sometimes, sometimes I sell a few fish. This is how I survive. Difficulty is there in every step" [10].

Adaptation to ensure survival contrasts with the viewpoint of many researchers which feel adaptations should be implemented as a means of development (Eriksen *et al*, 2011; Eakin *et al*, 2014). However, the motivation for adaptation is a contentious topic within current adaptation research and raises moral questions over whether researcher's are in a position to, or indeed should, be the authority on what is defined as a 'coping' strategy and which adaptations are 'maladaptation's'.

Furthermore, a number of respondents discussed the migration of their husbands in response to the low productivity of agricultural land, particularly in the aftermath of cyclone Aila [14]. Migration has been identified as both a consequence of, and an adaptation to climate hazards (Kabir *et al*, 2018), and is increasingly discussed in policy and research due to the effect climate change may have on population flows in different nations (Black *et al*, 2011). The effect of increased soil salinity upon agricultural productivity is widely documented in academic literature and frequently associated with the incidence of climatic hazards (Chhotray and Few, 2012; Duncan *et al*, 2017a). This migration may not have been captured in the DECCMA survey because migration was only asked about in the context of the last 5 years. Furthermore, whether the adaptation was driven by environmental factors may have been masked because of the influence of low agricultural productivity upon household income (Appendix D).

Physical adaptations were found to account for the greatest number of counts of adaptation by female HH's. 159 counts of adaptation were recorded, 72 of which were making modification or improvements to the house. Physical adaptations were also the most frequently recorded type of adaptation being undertaken by male HH's. This finding was echoed in interviews with female HH's where making "*improvements to the house*" [1,3,5,11-15] and "*planting trees*" [1,7,9,11] around the area and "*digging channels to divert flood water away from the house*" [3,4] were identified as popular methods to protect their homes from climatic hazards. Despite the considerable uptake of physical adaptations at the household level they are rarely discussed as an adaptation undertaken by delta communities (Ling *et al*, 2015). Instead, studies have identified community wide physical protection measures and livelihood based adaptations (Kolawole *et al*, 2016; Gustafson *et al*, 2017). The receipt of government and NGO assistance was often discussed by those whose houses had been modified and were built using brick rather than mud. Financial assistance had been received by a number of families to assist with the rebuilding of homes post Aila. However, it was clear this assistance was not universally distributed "*There are so many relief schemes... but I have not been able to get anything*" [8]. The unequal distribution of government assistance has been identified in numerous studies on Indian welfare and disaster relief schemes (Chhotray and Few, 2012; Jha *et al*, 2015), highlighting the importance that barriers to access are overcome to address vulnerability to climate hazards. Other government assistance which

had been received in the case study area was embankment strengthening through the replanting of mangrove trees and the concrete surfacing and elevation of the main road through the study villages [2-6,13,14]. Although the strengthening of embankments by mangrove reforestation has been well received respondents acknowledged there are limits to the protection which can be provided by the embankments “The embankments are very high but these cannot prevent the water from getting in” [1]. This response highlights a clear limit to adaptation which is widely supported by existing research on adaptation (Klein *et al*, 2014; Ahmed *et al*, 2018)

DECCMA’s survey identified relatively few counts of disaster response adaptation, 112 male HH’s and 22 Female HH’s. This is surprising given the exposure of the IBD to climatic hazards such as flood and cyclone events and reinforces the limitation of the study focussing upon adaptations in the past 5 years. In contrast, all 15 interview respondents spoke at length about disaster response measures taken during cyclone Aila in 2009 including “*moving to higher ground*”[1], “*receiving water and food supplies*”[9] and “*living in relief tents*”[13]. The receipt of government assistance is a common measure used to provide relief to households most vulnerable to climatic events (Motsholapheko *et al*, 2011). There have been clear improvements in disaster management in India as a result of better implementation of disaster response policies and plans (Jha *et al*, 2015). However, the slow and ongoing recovery of the IBD from cyclone Aila highlights weaknesses in the long-term disaster response plans of West Bengal. The use of cyclone Aila as a reference point within everyone’s lives;

“Aila was one of the most damaging calamities I have ever witnessed” [15]

highlights the impact of the cyclone in the IBD, from which the population are still recovering.

Generally interviews supported findings of the DECCMA survey, with the exception of disaster response adaptations, which interviewees stated were very significant in the lives of female HH’s in the IBD. Furthermore, the high participation of women in physical adaptation strategies supports literature that a women’s role is to look after the house (Ray-Bennett, 2018). In contrast, the findings of Gabrielsson and Ramasar (2013), that female HH’s undertake unique adaptations as a result of their decision making power in the household is unsupported by findings from the IBD. The narrow range of adaptations discussed during

interviews with female HH's as discussed during interviews, further supports the implications from the DECCMA survey that female HH's in the IBD are experiencing unique barriers to adaptation.

4.3 RESEARCH QUESTION 2

What adaptations would female HH's like to undertake but are unable to?

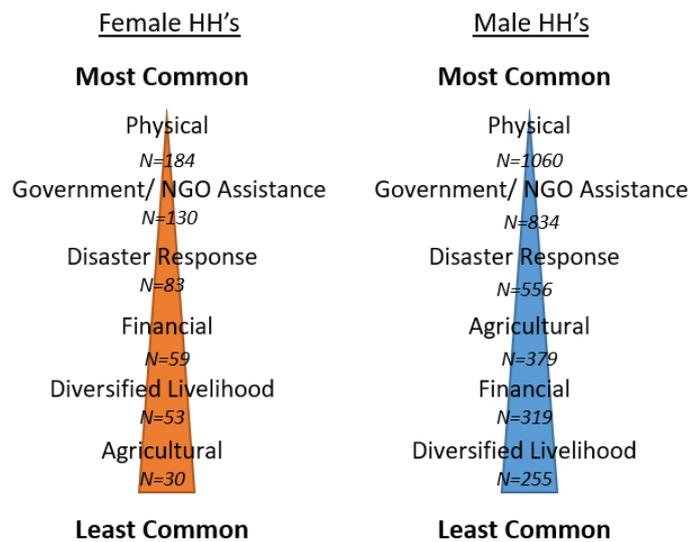


Figure 8: Most Frequently Desired Adaptations Ranked By Grouping

The top three aspirational adaptation groups revealed from the DECCMA survey were the same between both male and female HH's (Figure 8). However, agricultural adaptations were the least frequently identified aspirational adaptation group among female HH's where only 32 of a possible count of 1086 (2.95%) were interested in implementing agricultural adaptations. Furthermore, Male HH's have a lower desire to implement financial adaptations relative to Female HH's (Figure 8). Similarly to adaptations currently being undertaken by female HH's, this difference could be attributed to the lower participation of women in formal agricultural work (Sugden *et al*, 2014; Kelebe *et al*, 2017).

The interviews carried out with female HH's highlighted the desire of women to take up work opportunities to support the needs of their families. Interestingly, many other adaptations women were hopeful to introduce; physical, livelihood diversification or government assistance measures, were also centred on ensuring they could provide for their families, supporting the initial themes which emerged in the word cloud generated (Figure 8).

Prioritising the care of their families is something which has also been documented in literature (Gimenez-Nadal and Molina, 2015; Tibesigwa and Visser, 2016). Furthermore, although many female HH's were keen to take up employment opportunities it was clear this should only be done providing it did not interfere with their child care roles and household duties "*Women are meant for household work but what do I do after I complete that?*" [7]. Many respondents, particularly women with grandchildren discussed the fact women's independence is growing but the conversations with respondents often contradicted the conventional understanding of independence. For example, respondents said; "*Women shouldn't be HH's*" [4,5] and "*I want my son to take over duties*" [4]. These responses highlight the inequalities which exist in communities, are echoed in current studies, and will continue to proliferate in the absence of intervention (Occhionero and Nocenzi, 2009).

Younger women whose husbands had migrated often held greater aspirations surrounding the socio-economic betterment of their family. For example;

"I would like to convert my temporary house into a permanent one... this will help me to expand my opportunities and lifestyle" [2]

The migration of a family member and receipt of remittances has been linked with the aspirations sometime held by migrant families (Dao *et al*, 2018). Additionally, respondents generally associated labour migration with male family members highlighting the gendered dimension of migration and its interaction with socio-cultural power relations (Carling and Collins, 2017). The receipt of remittances was a common factor enabling respondents to increase financial capital. Existing studies on migration have drawn attention to the upwards social mobility which can be afforded to migrant families in receipt of remittances due to their increased stocks of financial capital (Nyberg-Sorensen *et al*, 2002). Furthermore, studies have identified that alongside providing an alternate source of income, migration also reduces the number of people who are dependent on the household livelihood, and this is termed the maximisation of household-utility (Stark and Levari, 1982).

The provision of, and access to government and NGO assistance was discussed by 11 female HH's as a highly desirable adaptive strategy [1,3-5,7-13]. In contrast to adaptations currently being undertaken the hope to receive government assistance was frequently discussed in the

context of enabling development rather than a strategy for survival; *“with the relief and the help and support we could uplift ourselves a little more than previously”* [9], *“Getting help will help me to have a better standard of living”* [12]. This finding draws upon research which identifies the availability of financial capital as a major determinant of and barrier to the development of resilient communities (Cassidy and Barnes 2012; Mutzabazi *et al*, 2015).

For both male and female HH’s it was found that within physical adaptations making modifications or improvements to the house was the most frequently identified aspirational adaptation (Table 5). This was also supported by the 13 female HH’s interviewed who identified physical adaptations as a priority in order to reduce vulnerability to climatic hazards [2-7,9-15];

“I would like to make changes to my home to stay safe and prevent hazards” [11].

“I think it is very important to plant more trees...beneficial for humans, help to control and maintain the temperature and reduce the impact of extreme heat” [2]

From the adaptations identified in Table 5 it was found a greater proportion of male HH’s display a desire to implement adaptive strategies across 5 of the 6 groupings (Appendix D) suggesting female HH’s are less interested in implementing new adaptive strategies. This is surprising considering research has identified women have greater environmental concern which can manifest itself through greater engagement of female HH’s with adaptation. However, while the transcripts from interviews with female HH’s found a strong will amongst female HH’s to make changes to reduce their vulnerability to climatic hazards, they also documented a range of unique barriers and experiences preventing these measures from being implemented. This could be the cause of the lower interest of female HH’s in adaptation. Conversely, there could be an alternate unidentified explanation for this which has been omitted due to the fact the qualitative phase of this study did not include the experiences of male HH’s (Djoudi and Brockhaus, 2011).

4.4 RESEARCH QUESTION 3

What are the barriers to adaptation perceived by female HH's?

Barriers to adaptation identified from the DECCMA survey results are shown in Table 6 and 7. Values in red indicate the three barriers ranked as most important and green cells indicate the barriers with the greatest overall count.

Table 6: Barriers to Adaptation Perceived By Male HH's

Male HH								
Barrier	Most important		Second most important		Third most important		Total Barrier	Total sample
	Count	%	Count	%	Count	%	Count	Count
No Time	125	12.03	70	6.74	96	9.24	291	1039
Not enough labour available to do this	89	8.57	40	3.85	58	5.58	187	1039
Household or community is not supportive	72	6.93	97	9.34	144	13.86	313	1039
No information/ support on how to do this	216	20.79	323	31.09	200	19.25	739	1039
Worried that this may go wrong and the household could be worse off	84	8.08	200	19.25	257	24.74	541	1039
Could not afford to do this	406	39.08	229	22.04	142	13.67	777	1039
No one has done this before	46	4.43	72	6.93	128	12.32	246	1039
Other	1	0.10	1	0.10	3	0.29	5	1039

Table 7: Barriers to Adaptation Perceived By Female HH's

Female HH								
Barrier	Most important		Second most important		Third most important		Total Barrier	Total sample
	Count	%	Count	%	Count	%	Count	Count
No Time	9	5.14	15	8.57	15	8.57	39	175
Not enough labour available to do this	3	1.71	10	5.71	11	6.29	24	175
Household or community is not supportive	20	11.43	9	5.14	28	16.00	57	175
No information/ support on how to do this	40	22.86	55	31.43	42	24.00	137	175
Worried that this may go wrong and the household could be worse off	22	12.57	23	13.14	34	19.43	79	175
Could not afford to do this	76	43.43	51	29.14	24	13.71	151	175
No one has done this before	5	2.86	12	6.86	20	11.43	37	175
Other	0	0.00	0	0.00	0	0.00	0	175

4.41 HOUSEHOLD RESPONSIBILITIES

The three most common barriers perceived by both male and female HH's were; lack of money, lack of information on how to carry out an adaptation and concern an adaptation may go wrong and the household would be worse off (Table 6 and 7). However, when assessing the most important barriers to adaptation men identified lack of time as most important rather than concern an adaption may go wrong (Table 6). In contrast, many female HH's highlighted they felt a large amount of "pressure" and "stress" in their roles as HH's due to having to provide for the family alongside fulfilling their traditional household roles expected of women [2,13]. Similarly, although concern an adaptation may go wrong is the second

largest perceived barrier by both groups, 15% of male HH's rank it most important compared to 27% of female HH's (Table 6 and 7) further highlighting the pressure felt by female HH's to successfully provide for and protect their families. Existing research on female HH's also highlights the additional pressure of female HH's due to their dual responsibilities (Chant, 2014). This pressure meant women placed themselves in more vulnerable situations during cyclone Aila to prioritise the safety of the rest of their family.

"As a woman... It's my responsibility to send everyone to safer places first and then move" [3]

"I was the last to leave during Aila" [4]

These accounts display the sacrifices female HH's will make to uphold the traditional household responsibilities of a woman, and could provide some explanation for the higher incidence of female mortality in natural disasters such as cyclones (Ray-Bennett, 2018). The prioritisation of the family is echoed in studies which have found in times of food insecurity such as during weather shocks women will forfeit food to provide for their families (Asfaw and Maggio, 2017).

4.42 SAFETY CONCERNS

Where women had been working to diversify their livelihoods and try to earn money to support their families many respondents had taken up prawn and shrimp collection. However, there were concerns inferred by respondents over the safety of taking up work like this due to the risk of animal attacks and trafficking in the area;

"I feel scared because many people have been attacked by crocodiles... my husband has instructed me not to go." [15]

Furthermore, the presence of middle-men both in agriculture and prawn and shrimp collection exploits female HH's as they are paid less for their produce than they would receive at market (Sabar, 2015). This exploitation reduces women's earnings *"they do not give me the amount I am due"* [15], reducing their access to financial capital acting as a further barrier to adaptation. Multiple reasons were given by respondents as to why they were unable to go to the market themselves, for example;

"I do not have time to go and sell the additional eggs in the market" [1]

“Nothing is possible without asking permission from my husband...It is better that women stay indoors rather than go outside” [6]

The lack of time stated by respondents [14,15], supports discourse surrounding the difficulty of managing the double burden of household responsibilities. However, lack of time was identified relatively infrequently within the DECCMA survey. Suggesting the influence of lack of time over adaption varies across the IBD, or perhaps lack of time is not one of the most important barriers experienced. Furthermore, the excerpt taken from respondent 6 highlights the reduced mobility and low autonomy of some female HH's whose husbands have migrated away from the home. This may act as a barrier to adaptation by limiting women's ability to act independently (Ray-Bennett, 2011).

4.43 AVAILABILITY OF FINANCIAL CAPITAL

Money was identified throughout interviews as a major constraint reducing women's ability to implement adaptive strategies, particularly when discussing their desire to make improvements to their homes such as constructing the house from brick rather than mud. Financial barriers to adaptation are commonly cited in the literature for both male and female HH's in delta regions around the world (Bosma *et al*, 2012; Brown *et al*, 2018). Given the high proportion of delta inhabitants which live at or below the poverty line it is unsurprising this barrier is consistently identified. However, differences lie between the ability of male and female HH's to address this barrier and financial barriers are often closely linked with physical capital. For example, female HH's often *“do not have any land”* [3] limiting their access to the agricultural sector. The unequal land rights of females has been identified as a barrier to reducing women's overall social and economic vulnerability (Kelkar, 2014; Wineman and Liverpool-Tasie, 2017). This acts as a barrier to addressing poverty, a factor which has been closely associated with the vulnerability of women to climate hazards (Mazumdar *et al*, 2014; Ajala, 2017). Furthermore, in rural communities such as the IBD land assets are suggested to be more useful than household income because they can be used to access credit or training to increase agricultural productivity which are financial and agricultural adaptations in themselves (Johnson *et al*, 2016). This literature clearly highlights the importance of addressing underlying gender inequality to overcome the barriers to adaptation experienced by female HH's.

For all female HH's interviewed, financial barriers played a significant part in preventing adaptation, however for widow households the significance of the barrier seemed to be more pertinent. The marginalisation of widows has been recognised across India, resulting in the introduction of widow allowance schemes. However, numerous barriers to access means the widow allowances are doing little to relieve the financial strain on widowed female HH's in the IBD.

"My husband died outside of the village therefore I have no death certificate for him" [12]

"I do not have access to any widow allowance... I am already 60 years old but still I do not receive any government benefits" [11].

There are numerous documents required in order to claim widow allowance in West Bengal, including a death certificate and proof of income. Furthermore, many of the widow respondents were illiterate and therefore unable to complete the application form without assistance. This finding highlights the need for the Government of West Bengal to ensure allowances are not only provided, but are accessible to those in need of them.

4.44 COMMUNITY AND HOUSEHOLD SUPPORT

Further differences are found within each barrier. For example, of female HH's who considered lack of household or community support a barrier 35% compared to 23% of male HH's rank it as most important (Table 6 and 7). When this was investigated in greater detail during interviews a number of differences in experience were discovered. For example, some respondents whose husbands had died revealed they had been ostracised from their in-law family and their sons. The social exclusion of widows from their families has been attributed to four reasons; being a burden on the family, being an unwanted claimant of their husband's property; being perceived as a sexual threat, and being an unwanted claimant of patrilineal inheritance (Battacharyya and Singh, 2017). All of these reasons bar their perception as a sexual threat were spoken of by widow respondents [9,12].

Further themes surrounding support also arose during discussions with female HH's;

*"Amar ache tomar ache, esho boshi khai,
I have, you have, let us sit together and eat,
amar ache tomar nai, kisher amar bhai" [9]
Where I have, you don't have then you are not my brother.*

This quote is a common phrase in Bengali and highlights the experiences of some households who find people are unwilling to help them [9,11].

Furthermore, the dialect used by another respondent during discussions was indicative of her being from a different area. West Bengal has a long history of migration which predates its existence (Shamshad, 2017) and this migration can lead to animosity between groups (*ibid*). This may provide some explanation for the violence, “*People have bitten and scratched me all over*” [11], and lack of community support this respondent has experienced. This finding suggests the intersectionality of ethnicity and being a female HH can reduce the level of community support experienced, acting as a barrier.

“Artho dite parina kintu swartho dite pari” [2,5,13]

What my friends and family cannot provide financially they provide in selfless love, care and support

This quote contrasts with previous themes and highlights the support some respondents received from their in-laws and neighbours. This support was most notable amongst younger female HH’s who had a number of dependent children to support. For example;

“Other women call me when they find work in the village... sometimes women employ me to work in their houses or on their agricultural land” [13].

The support networks between women, especially between other female HH’s has emerged as an important enabler of adaptation within other research projects (Sugden *et al*, 2014). This network has been discussed previously in the context of WSHG’s in the IBD, enabling financial adaptations and increasing financial stability (Ghosh *et al*, 2018). However, there has been limited discussion of the emotional support networks female HH’s can provide for one another. Although this is a small point, the importance of recognising the positive influence of support networks between women should not be overlooked.

Furthermore, there seems to be ongoing rhetoric that women are a burden on the household which may also affect how supported women feel. For example, marrying off daughters was frequently framed as beneficial to the rest of the family whilst the payments associated with marrying off a daughter were spoken of as an additional hardship to the family, [4] (Heath and Tan, 2016). Similarly, the accounts widowed women provided regarding their relationship with their sons reiterated the feeling that women are a burden in the family [9]. The exclusion

of widows by their own children supports existing research on the topic (Bhattacharyya and Singh, 2017), and reinforces the need for differentiated gender policies which recognise the marginalisation of widow HH's. An even more extreme case of this 'burden' rhetoric became clear in the account given by respondent 15 whose daughter had been severely injured in an accident at work;

"My daughter is in such critical condition and her husband does not look after her. Her in-laws have abandoned her so now she stays with me. I will have to help her survive". [15]

This extract exemplifies the decision making power of men over the lives of women and the treatment of women as property, something which has been recognised in prior literature (Bhattacharyya, 2014). The perception of themselves as a burden upon their family may act as a barrier to adaptation where women are reluctant to disrupt the status quo and act of their own accord. For one respondent their decision to take matters into her own hands and try to go against the decisions of their in-law family and son had violent repercussions;

"My son whom I have brought up with my own blood and tiresome love beat me in the middle of the road." [9].

The rhetoric surrounding a lack of community support and the perception of women, especially widows, as a burden, not only acts as a barrier to the adaptation of female HH's to climate hazards but brings to the fore a wider social issue, well catalogued in existing literature, surrounding the autonomy of women and son preference in India (Mitra, 2014).

4.45 POWER TO MAKE CHANGE

The power to make change within their families is a theme where responses varied between women. For example some women showed low levels of self-efficacy;

"Men cannot prevent flooding so how could I as a woman prevent it?" [1]

"Men are more knowledgeable and intelligent, they can face anything that comes" [5].

"To make agriculture productive you need a male member in the house" [12]

Whereas other HH's, predominantly, younger women, considered women to be strong agents of change;

"Regarding the knowledge to prepare oneself for hazards women are capable enough to protect themselves." [3]

"All women have the capacity to adapt to disasters." [4]

This finding suggests women are becoming more independent. However, the self-perception of older women as powerless or incapable in comparison to men identifies an additionally factor causing the heightened vulnerability of older, widowed HH's (Torri and Martinez, 2013). This barrier reinforces the importance of recognising intragroup variability in measures designed to improve the engagement of female HH's with adaptation.

4.46 SUMMARY

Although not all barriers experienced by female HH's are unique to women, such as age or availability of financial capital, the experiences of these barriers differ between genders. Additionally, there are also a number of unique barriers to adaptation primarily centred on the traditional expectations of women and their roles within the household. Furthermore, it can largely be seen it is not one particular barrier which prevents female HH's from adapting to climatic hazards. Instead it is the intersectionality of all of these factors which reduces the ability of female HH's to adapt, and produces variations between different groups of female headed households. Although female HH's are adapting less compared to male HH's there is also a clear difference between different groups of female HH's. For example, the multiplicity of numerous barriers means elderly, widowed HH's are less able to adapt than HH's whose husbands have migrated, receive remittances, and are supported by their in-laws and neighbours. The variation between groups of female HH's reinforces the findings of a number of other researchers which have started to highlight the importance of addressing the heterogeneity of female HH's (Huyn and Resurreccion, 2014; Wineman and Liverpool-Tasie, 2017).

4.5 RESEARCH QUESTION 4

What are the opportunities perceived by female HH's which would enable them to address these barriers?

Discussions surrounding the way in which the barriers and challenges female HH's face could be overcome were interpreted differently between different respondents. This in itself is interesting to note, indicating the varying levels of agency different female HH's perceive themselves to have. For example, some women felt having a male HH would be most beneficial to reducing the barriers to adaptation which they face [12]. This highlights the perception some female HH's had of their limited ability to be agents of change in their own lives (Torri and Martinez, 2013).

4.51 EMPLOYMENT

Further interpretations of the question found employment opportunities would be valuable in addressing the barriers female HH's face;

"If I am supported by being provided with employment sitting back home this will benefit all of the women in the village at large". [11]

This response highlights the importance of employment opportunities which fit the circumstances of female HH's. This would allow them to contribute to their households financially (Torri and Martinez, 2011), alongside managing their dual role as caregiver and breadwinner in the family. Thus, employment opportunities would improve the asset base of female HH's reducing barriers to adaptation.

4.52 EMPOWERMENT OF WOMEN

Another interpretation of the question found the importance of addressing underlying gender inequalities and social issues. Although many respondents discussed the fact the position of women in society is changing and women are becoming more independent;

"Women should be going outside and this is because change has taken place. There have been changes across the generations, now transformation is taking place in the roles women play" [10].

It is clear more progress still needs to be made if the barriers to adaptation are to be overcome. Primarily, respondents spoke of the need for a multifaceted approach involving education, policy and female representation.

EDUCATION

Multiple women felt the education of women and girls is vital to empowering women [2,4,8-10]. Current programmes such as the Kayashree Prakalpa scheme have been well received [13], and it is clear education is highly regarded throughout the community. Education has been identified as a means to increase the independence of women through a number of channels. For example, Landesa, 2013 and 2014 has identified that education can be used as a tool to sensitise both boys and girls to the rights and benefits of land ownership and the detrimental impact dowries can have on the empowerment of women. Similarly, Gibbs *et al*, 2012 highlights the impact education of women has upon their access to income, aspirations, and health. These studies support the perception of respondents that education can be used to empower women.

POLICY

While respondents had positive opinions of the Kanyashree and Sabooj Bicycle scheme women felt more policy interventions were needed to support the independence of women. For example;

“Women need to be given training in adopting different farming practices and seed” [10]

“Women need training in handicrafts and techniques” [13].

This perceived opportunity to provide skills training for women is closely related to the provision of employment opportunities. However, the intra-group differences in experience of barriers to adaptation also suggests a need for policies which do not address gender inequalities in isolation but consider the many intersecting factors such as age and marital status more effectively. For example, some women may benefit from agricultural extension services. Whereas women unable to take up agricultural work due to age or household responsibilities, may benefit most from home-based work (Torri and Martinez, 2011). Policy can also be used to improve women’s inheritance and marital rights (Caron, 2018), further supporting the importance of policy to promote gender equity.

REPRESENTATION

Female HH’s felt female representation in government positions is needed to empower women;

“More representation of females in government is good. Our ‘didi’ has given us many schemes and policies which are helping women to achieve more educational qualifications.” [15]

Here respondent 15 is referring to the female chief minister of West Bengal who has been in office since 2011 (WBCMO, 2018a), and introduced schemes such as Kanyashree in efforts to address gender inequality (WBCMO, 2018b). Furthermore, wider benefits of increased female representation on members of the public have been identified including feeling more empowered and able to speak out in public (Htun and Weldon, 2010; Burnet, 2011; Krook and O’Brien, 2012)

4.53 LIMIT

The difficulty some women had identifying measures which would assist them in overcoming the barriers to adaptation suggests there are limits to adaptation in the IBD;

“The embankments are very high but these cannot prevent the water from getting in so how can I make my house high enough to stop the water?” [1].

This response highlights a limit to adaptation in the delta regardless of gender differentiated experiences. This statement stresses the overarching exposure of communities in the IBD to climatic hazards and supports the notion that not all climatic hazards can be overcome through adaptation (Hajra *et al*, 2017). This point is particularly significant given models have predicted the magnitude of climatic hazards in the Sundarbans region is likely to increase (Kumar *et al*, 2013).

4.54 SUMMARY

Overall the perceived opportunities identified by female HH’s to overcome the barriers they face are measures primarily aimed at addressing the underlying social issues which continue to reproduce gender inequalities across India. However, the extent to which addressing the barriers to adaptation will remove the vulnerability of women or men to climatic hazards is limited by the exposure of the IBD to high magnitude climatic hazards.

5.0 CONCLUSION

This section summarises the findings of the 4 research questions discussed in section 4 before addressing the overall aim of this study. The contribution of this study to gender and adaptation research will then be outlined, recommendations for future work will be given, and limitations of the study will be discussed.

5.1 RESEARCH QUESTION 1

How are female HH's adapting to climate hazards in the IBD?

Physical, and disaster response adaptations are most frequently undertaken by female HH's in the IBD because these changes fall within the traditional responsibility of women to support the needs of the family and be good homemakers. Additionally, disaster responses and physical adaptations reduce the exposure of the family, offering protection from the immediate impacts associated with climatic hazards.

5.2 RESEARCH QUESTION 2

What are the adaptation strategies which female HH's would like to adopt but have not?

The adaptations female HH's would like to implement, frequently involve diversifying their livelihoods and women wish to participate more actively in the labour force. These adaptations are associated with having greater independence whilst supporting their husbands and providing for their families. Additionally, many women spoke of their desire to access government, particularly financial, support. This support was often discussed in the context of enabling women to implement physical adaptations, in particular, elevating their house or constructing it from brick.

5.3 RESEARCH QUESTION 3

What are the barriers to adaptation experienced by female HH's?

While many barriers to adaptation are the same for both female and male HH's, they are often experienced differently between genders. Female HH's also experience unique barriers to adaptation compared to their male counterparts as a result of the socio-cultural expectations of, and attitudes towards women. Furthermore, the intersectionality of vulnerabilities such as socio-economic position, marital status and age, have a multiplicative

effect upon the barriers to adaptation which female HH's experience resulting in intragroup differences and exacerbating the vulnerability of particular groups.

5.4 RESEARCH QUESTION 4

What are the opportunities perceived by female HH's which would enable them to address these barriers?

The opportunities female HH's perceive to overcome the barriers they face reinforces the perpetuating effects of gender inequality upon women's perceived ability to adapt to climatic hazards. Education, access to job opportunities and representation of women in all levels of government were identified as measures which would address the underlying gender inequalities experienced by female HH's. Gender equity would enable greater uptake of adaptation strategies, whilst improving quality of life.

5.5 AIM

What are the perceived opportunities to overcome the barriers to adaptation uniquely experienced by female HH's?

Overall it can be seen the most effective way of improving the engagement of women with adaptation to climatic hazards is to address the underlying socio-cultural gender divisions which currently determine female HH's experience of barriers to adaptation.

The underlying gender inequalities seen in the IBD will take time to overcome due to the society-wide attitude change required in rural communities; traditionally more conservative than urban areas (Thornton 2006). However, it is not time alone which will ensure the closure of the gender gap in West Bengal. If the history of the pursuit for equity of any kind reveals anything it is that this ambition requires continuous reinforcement through multiple channels (Pascall and Lewis, 2004; Occhionero and Nocenzi, 2009);

- 1.) Ongoing representation of women in all areas of public discourse (Latu *et al*, 2013).
- 2.) Continuous implementation of policies and schemes aimed at the ensuring all children receive an equal education (Eger *et al*, 2018).
- 3.) Employment opportunities for female HH's which support their dual roles as breadwinner and primary caregiver within the household (Le Mare, 2012).

Additionally, progress towards meeting India's commitments to UNSDG's 5 and 12 will assist, and simultaneously be assisted by actions taken to address the unique barriers to adaptation faced by female HH's (Bhadra, 2017). These commitments have necessitated the introduction

of policies such as the Kanyashree Prakalpa Scheme and West Bengal state policy for the empowerment of women, and continue to highlight the importance of gender mainstreaming in all areas of policy. Furthermore, if the underlying gender equality issues in West Bengal are not confronted and overcome, initiatives specifically aimed at assisting female HH's to adapt to climatic hazards will have limited long-term success.

5.6 RECOMMENDATIONS

- Provide vocational skills based training for female HH's.
- Provide training to farm labourers on agricultural adaptations which can be implemented to increase productivity.
- Consider introducing gender quotas within government
- Continue to support and introduce schemes which ensure children have equal access to quality education.
- Improve access to government support schemes such as widow's allowance support.

While government schemes and changes to policy are required to improve the engagement of female HH's with adaptation, it is important to recognise the scope for the introduction of community lead initiatives to overcome barriers to adaptation. For example, sharing the burden of childcare between households would improve the ability of able female HH's to take up work outside of the household. This would improve the financial capital of female HH's alongside building social capital between frequently marginalised groups.

To date, the existing published research on adaptation in deltas is limited and has focussed on assessing vulnerability and documenting adaptations with little coverage of barriers or the influence of gender. This research differs in that it identifies the unique barriers to adaptation and opportunities to overcome them from the perspective of female HH's. The importance of this work therefore lies in its identification of the significance of addressing underlying gender inequality to enable the adaptation of female HH's. These findings can also potentially be extended to other rural delta regions across the global south such as the Mekong delta in South-East Asia, where similar socio-cultural gender expectations exist (Swain *et al*, 2008, Thao, 2012).

5.7 FUTURE WORK

There are opportunities for expansion of this study to other regions or deltas. This could involve carrying out the qualitative phase in a number of additional areas of the IBD or the

other deltas which the DECCMA survey has collected data for such as the Volta, GBMD or Mahanadi allowing for comparison between areas. Furthermore, a longitudinal study would provide a deeper insight into the lived experiences of female HH's, potentially enabling more insightful identification of the opportunities to overcome barriers and facilitate the monitoring of gendered policy impact.

This study provides an initial exploration of the measures female HH's feel would benefit them most. Further research involving policy makers would benefit the development of a holistic approach to increasing adaptation implementation.

While it is not always possible for adaptation to fully protect a population from the effects of climatic hazards, it can act to mitigate impacts and support livelihoods in rural communities (Hajra *et al*, 2017). However, unless the contextual gender inequalities engrained in communities across the world are continuously addressed in all areas of policy, women will continue to bare a greater burden of the risks associated with our global weather system.

5.8 LIMITATIONS

As with all studies, this project is not without its limitations. While methodological limitations were addressed in section 3 there are a number of additional limitations to be mindful of when evaluating the conclusions of this study.

Firstly, the size of the sample of female HH's used in the quantitative phase of this study has been a limitation due to the inability to perform statistical analyses which could ascertain the significance of the gender differences found in the dataset.

Additionally, where this project has focussed primarily on the barriers which are uniquely experienced by women, it has given little acknowledgement of additional socio-cultural factors such as caste, class and ethnicity which influence the vulnerability of groups, to climatic hazards. In a similar vein the gendered approach taken in this study risks oversimplifying the complex interactions which occur between barriers.

While the use of a case study within the qualitative phase of this study has provided depth, a multiple case study would have enabled comparison across areas to show differences in experience between areas within the IBD. Similar limitations can be attributed to the use of

the IBD overall as a case study area which risks overgeneralising the experiences of female HH's in other deltas around the world.

REFERENCES

- Adger WN, Agrawala S, Mirza MMQ, Conde C, O'Brien K, Pulhin J, Pulwarty R, Smit B, Takahashi K (2007) *Assessment of adaptation practices, options, constraints and capacity. Climate change 2007: impacts, adaptation and vulnerability*. In: Parry ML, Canziani OF, Palutikof JP, van der Linden PJ, Hanson CE (eds) Contribution of Working Group II to the fourth assessment report of the intergovernmental panel on climate change. Cambridge University Press, Cambridge, pp 717–743
- Adger, N. (2003) Social Capital, Collective Action and Adaptation to Climate Change *Economic Geography* 79(4) pp.387-404
- Adger, N. Arnell, N. and Tompkins, E. (2005). Successful adaptation to climate change across scales. *Global Environmental Change*, 15(2), pp.77-86.
- Adger, N.W. and Brooks, N. (2003) *Does Global Environmental Change Cause Vulnerability to Disaster?* In Pelling, M. 2003 Natural Disaster and Development in a Globalising world London: Routledge
- Adger, W. (2006). Vulnerability. *Global Environmental Change*, 16(3), pp.268-281.
- Adger, W., Huq, S., Brown, K., Conway, D. and Hulme, M. (2003). Adaptation to climate change in the developing world. *Progress in Development Studies*, 3(3), pp.179-195.
- Ahmed, F., Moors, E., Khan, M., Warner, J. and Terwisscha van Scheltinga, C. (2018). Tipping points in adaptation to urban flooding under climate change and urban growth: The case of the Dhaka megacity. *Land Use Policy*, 79, pp.496-506.
- Ahmed, S. and Fajber, E. (2009). Engendering adaptation to climate variability in Gujarat, India. *Gender & Development*, 17(1), pp.33-50.
- Ajala, T. (2017) Gender Discrimination in Land Ownership and the Alleviation of Women's Poverty in Nigeria: A call for New Equities, *International journal of Discrimination and the Law* 17(1) pp.51-66
- Althor, G., Mahood, S., Witt, B., Colvin, R. and Watson, J. (2018). Large-scale environmental degradation results in inequitable impacts to already impoverished communities: A case study from the floating villages of Cambodia. *Ambio*.
- Arora-Jonsson, S. (2011). Virtue and vulnerability: Discourses on women, gender and climate change. *Global Environmental Change*, 21(2), pp.744-751.
- Asfaw, S. and Maggio, G. (2017). Gender, Weather Shocks and Welfare: Evidence from Malawi. *The Journal of Development Studies*, 54(2), pp.271-291.

Ayeb-Karlsson, S., van der Geest, K., Ahmed, I., Huq, S. and Warner, K. (2016). A people-centred perspective on climate change, environmental stress, and livelihood resilience in Bangladesh. *Sustainability Science*, 11(4), pp.679-694.

Babbie, E. (2007) *The practice of social research* 11th edition Belmont California, Wadsworth/Thomson

Balica, S., Wright, N. and van der Meulen, F. (2012). A flood vulnerability index for coastal cities and its use in assessing climate change impacts. *Natural Hazards*, 64(1), pp.73-105.

Berrang-Ford, L., Ford, J. and Paterson, J. (2011). Are we adapting to climate change?. *Global Environmental Change*, 21(1), pp.25-33.

Bhadra, S. (2017). Women in Disasters and Conflicts in India: Interventions in View of the Millennium Development Goals. *International Journal of Disaster Risk Science*, 8(2), pp.196-207.

Bhattacharjee, K. and Behera, B. (2018). Determinants of household vulnerability and adaptation to floods: Empirical evidence from the Indian State of West Bengal. *International Journal of Disaster Risk Reduction*, 31, pp.758-769.

Bhattacharyya, R. (2014). Understanding the spatialities of sexual assault against Indian women in India. *Gender, Place & Culture*, 22(9), pp.1340-1356.

Bhattacharyya, R. and Singh, S. (2017). Exclusion (and seclusion): geographies of disowned widows of India. *GeoJournal*, 83(4), pp.757-774.

Biagini, B., Bierbaum, R., Stults, M., Dobardzic, S. and McNeeley, S. (2014). A typology of adaptation actions: A global look at climate adaptation actions financed through the Global Environment Facility. *Global Environmental Change*, 25, pp.97-108.

Bierbaum, R., Smith, J., Lee, A., Blair, M., Carter, L., Chapin, F., Fleming, P., Ruffo, S., Stults, M., McNeeley, S., Wasley, E. and Verduzco, L. (2012). A comprehensive review of climate adaptation in the United States: more than before, but less than needed. *Mitigation and Adaptation Strategies for Global Change*, 18(3), pp.361-406.

Biesbroek, G., Klostermann, J., Termeer, C. and Kabat, P. (2013). On the nature of barriers to climate change adaptation. *Regional Environmental Change*, 13(5), pp.1119-1129.

Biesbroek, G., Termeer, C., Klostermann, J. and Kabat, P. (2014). Rethinking barriers to adaptation: Mechanism-based explanation of impasses in the governance of an innovative adaptation measure. *Global Environmental Change*, 26, pp.108-118.

Birkmann, J., (2006) *Measuring Vulnerability to Natural Hazards – Towards Disaster Resilient Societies*. United Nations University Press, Tokyo, Japan, 450 pp

- Birkmann, J., Cardona, O., Carreño, M., Barbat, A., Pelling, M., Schneiderbauer, S., Kienberger, S., Keiler, M., Alexander, D., Zeil, P. and Welle, T. (2013). Framing vulnerability, risk and societal responses: the MOVE framework. *Natural Hazards*, 67(2), pp.193-211.
- Black, R. Kniveton, D. and Schmidt-Verkerk, K. (2011) Migration and Climate Change: Towards an Integrated Assessment of Sensitivity *Environment and Planning A: Economy and Space* 43(2) pp. 431-450
- Blaikie, P., T. Cannon, I. Davis, and B. Wisner (1994) *At Risk: Natural Hazards, People, Vulnerability, and Disasters*. Routledge, London, UK
- Boer, H. (2010). Policy options for, and constraints on, effective adaptation for rivers and wetlands in northeast Queensland. *Australasian Journal of Environmental Management*, 17(3), pp.154-164.
- Bosma, R., Nhan, D., Udo, H. and Kaymak, U. (2012). Factors affecting farmers' adoption of integrated rice-fish farming systems in the Mekong delta, Vietnam. *Reviews in Aquaculture*, 4(3), pp.178-190.
- Brooks, N., Neil Adger, W. and Mick Kelly, P. (2005). The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. *Global Environmental Change*, 15(2), pp.151-163.
- Brown, P., Tuan, V., Nhan, D., Dung, L. and Ward, J. (2018). Influence of livelihoods on climate change adaptation for smallholder farmers in the Mekong Delta Vietnam. *International Journal of Agricultural Sustainability*, 16(3), pp.255-271.
- Bryman, A. (2016). *Social Research Methods*. 5th ed. Oxford: Oxford University Press.
- Bunce, A. and Ford, J. (2015). How is adaptation, resilience, and vulnerability research engaging with gender?. *Environmental Research Letters*, 10(12), p.123003.
- Burch, S. (2010a). In pursuit of resilient, low carbon communities: An examination of barriers to action in three Canadian cities. *Energy Policy*, 38(12), pp.7575-7585.
- Burch, S. (2010b). Transforming barriers into enablers of action on climate change: Insights from three municipal case studies in British Columbia, Canada. *Global Environmental Change*, 20(2), pp.287-297.
- Burnet, J. (2011). Women Have Found Respect: Gender Quotas, Symbolic Representation, and Female Empowerment in Rwanda. *Politics & Gender*, 7(03), pp.303-334.
- Burton, I. Huq, S. Lim, B. Pilifosova, O. and Schipper, E.M. (2002) 'From Impacts Assessment to Adaptation Priorities: The Shaping of Adaptation Policy', *Climate Policy* 2 pp.145–59

Buvinic, M. and Gupta, G.R. (1997) Female-Headed-Households and Female-Maintained Families: Are they worth targeting to reduce poverty in developing countries? *Economic Development and Cultural Change* 45(2) pp.259-80

Cardona OD, van Aalst MK, Birkmann J, Fordham M, McGregor G, & Mechler R (2012). *Determinants of risk: Exposure and vulnerability*. In: *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*. Eds. Field, CB, Barros, V & Stocker, TF, Cambridge: Cambridge University Press.

Cardona, O.D., (2004) *The need for rethinking the concepts of vulnerability and risk from a holistic perspective: A necessary review and criticism for effective risk management*. In: *Mapping Vulnerability: Disasters, Development and People* [Bankoff, G., G. Frerks, and D. Hilhorst (eds.)]. Earthscan Publishers, London, UK, pp. 37-51.

Carling, J. and Collins, F. (2017). Aspiration, desire and drivers of migration. *Journal of Ethnic and Migration Studies*, 44(6), pp.909-926.

Caron, C.M. (2018) Creating the 'Girl Effect': Including boys and men to promote girls' land and asset ownership *Progress in Development Studies* 18(4) pp.223-234

Carr, E. and Thompson, M. (2014). Gender and Climate Change Adaptation in Agrarian Settings: Current Thinking, New Directions, and Research Frontiers. *Geography Compass*, 8(3), pp.182-197.

Cassidy, L., and G. D. Barnes. (2012) Understanding household connectivity and resilience in marginal rural communities through social network analysis in the village of Habu, Botswana. *Ecology and Society* 17(4): 11.

Census (2011) District Census 2011 Available at: <https://www.census2011.co.in/district.php>
Date Accessed: 20/06/2018

Chant, S. (1997). Women-Headed Households: Poorest of the Poor?: Perspectives from Mexico, Costa Rica and the Philippines. *IDS Bulletin*, 28(3), pp.26-48.

Chant, S. (2014). Exploring the "feminisation of poverty" in relation to women's work and home-based enterprise in slums of the Global South. *International Journal of Gender and Entrepreneurship*, 6(3), pp.296-316.

Chen, M., & Dreze, J. (1992). Widows and Health in Rural North India. *Economic and Political Weekly*, 27(43/44) pp. WS81- WS92.

Chhotray, V. and Few, R. (2012). Post-disaster recovery and ongoing vulnerability: Ten years after the super-cyclone of 1999 in Orissa, India. *Global Environmental Change*, 22(3), pp.695-702.

Clar, C., Prutsch, A. and Steurer, R. (2013). Barriers and guidelines for public policies on climate change adaptation: A missed opportunity of scientific knowledge-brokerage. *Natural Resources Forum*, 37(1), pp.1-18.

Codjoe, S., Nyamedor, F., Sward, J. and Dovie, D. (2017). Environmental hazard and migration intentions in a coastal area in Ghana: a case of sea flooding. *Population and Environment*, 39(2), pp.128-146.

Cohen, L. and Manion, L. (1995) *Research Methods in Education*, London: Routledge.

Crang, M. and Cook, I. (1995) *'Doing ethnographies'*, Norwich: Geobooks

Creswell, J. (2014). *Research design: Qualitative Quantitative and Mixed Methods Approaches*. 4th ed. London: SAGE Publications.

Cutter, S., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E. and Webb, J. (2008). A place-based model for understanding community resilience to natural disasters. *Global Environmental Change*, 18(4), pp.598-606.

Dao, T., Docquier, F., Parsons, C. and Peri, G. (2018). Migration and development: Dissecting the anatomy of the mobility transition. *Journal of Development Economics*, 132, pp.88-101.

Davis, P. and Ali, S. (2014) Exploring Local Perceptions of Climate Change Impact and Adaptation in Rural Bangladesh, IFPRI Discussion Paper 01322 Available at: <https://ssrn.com/abstract=2405696> Date Accessed: 02/08/2018

DECCMA (2017) The Indian Bengal Delta: Understanding the present state of climate change, adaptation and migration. Available at: http://generic.wordpress.soton.ac.uk/deccma/wp-content/uploads/sites/181/2017/10/68439-A4-DECCMA-IBD_final_web.pdf Date Accessed: 20/07/2018

DECCMA (2018) DECCMA's Ideas and Goals Available at: <http://generic.wordpress.soton.ac.uk/deccma/about/what-where/> Date accessed: 20/07/2018

Denton, F. (2002). Climate change vulnerability, impacts, and adaptation: Why does gender matter? *Gender & Development*, 10(2), pp.10-20.

Dey, S. et al, 2016. Review of West Bengal State Adaptation Policies, Indian Bengal Delta. DECCMA Working Paper, Deltas, Vulnerability and Climate Change: Migration and Adaptation, IDRC Project Number 107642. Available at: www.deccma.com, Date accessed: 04/08/2018

Dhar, D., Jain, T. and Jayachandran, S. (2015). Intergenerational Transmission of Gender Attitudes: Evidence from India.

Dilger, H. (2006). The power of AIDS: kinship, mobility and the valuing of social and ritual relationships in Tanzania. *African Journal of AIDS Research*, 5(2), pp.109-121.

Dilger, H. (2006). The power of AIDS: Kinship, mobility and the valuing of social and ritual relationships in Tanzania. *African Journal of AIDS Research*, 5, pp.109–121.

District Disaster Management Plan, North 24 Parganas, (2016). District Disaster Management Department. Government of West Bengal Available at: <http://wbdmd.gov.in/writereaddata/uploaded/DP/North%2024%20parganas.pdf> Date Accessed: 20/07/2018

District Disaster Management Plan, South 24 Parganas, (2016). District Disaster Management Department. Government of West Bengal, Available at: <http://www.s24pgs.gov.in/s24p/#> Date Accessed: 20/07/2018

Djouidi, H. and Brockhaus, M. (2011). Is adaptation to climate change gender neutral? Lessons from communities dependent on livestock and forests in northern Mali. *International Forestry Review*, 13(2), pp.123-135.

Driscoll, I. D., Appiah-Yeboah A., Salib, P., and Rupert, D.J. (2007) Merging Qualitative and Quantitative Data in Mixed Methods Research: How To and Why Not *Ecological and Environmental Anthropology* 3(1) pp. 19-28

Duncan, J., Dash, J. and Tompkins, E. (2017). Observing adaptive capacity in Indian rice production systems. *AIMS Agriculture and Food*, 2(2), pp.165-182.

Duncan, J., Tompkins, E., Dash, J. and Tripathy, B. (2017b). Resilience to hazards: rice farmers in the Mahanadi Delta, India. *Ecology and Society*, 22(4).

Dupuis J, Biesbroek GR (2012) *The dependent variable problem in comparing and evaluating climate change adaptation policies in Western European Countries*. Second Nordic International Conference on climate change adaptation, Helsinki, Finland

Durrant, G.B., Groves, R.M., Staetsky, L., and Steele, F., (2010) Effects of interviewer attitudes and behaviours on refusal in household surveys. *Public Opinions Quarterly*, 74(1) pp.1-36.

Eakin, H. and Lemos, M. (2006). Adaptation and the state: Latin America and the challenge of capacity-building under globalization. *Global Environmental Change*, 16(1), pp.7-18.

Eakin, H., Lemos, M. and Nelson, D. (2014). Differentiating capacities as a means to sustainable climate change adaptation. *Global Environmental Change*, 27, pp.1-8.

Eakin, Hallie, Tompkins, Emma L., Nelson, Donald R. and Anderies, John M. (2009) *Hidden costs and disparate uncertainties: trade-offs involved in approaches to climate policy*. Adger,

- W. Neil, Lorenzoni, Irene and O'Brien, Karen L. (eds.) In *Adapting to Climate Change: Thresholds, Values, Governance*. Cambridge University Press. 514 pp, pp. 212-226
- Eger, C., Miller, G. and Scarles, C. (2018). Gender and capacity building: A multi-layered study of empowerment. *World Development*, 106, pp.207-219.
- Eiseneck, K. and Stecker, R. (2012) A framework for analysing climate change adaptations as actions *Mitigation and Adaptation Strategies for Global Change* 17 pp.243- 260
- Enarson, E. and Fordham, M. (2001). From women's needs to women's rights in disasters. *Environmental Hazards*, 3(3), pp.133-136.
- Ericson, J., Vorosmarty, C., Dingman, S., Ward, L. And Meybeck, M. (2006). Effective sea-level rise and deltas: Causes of change and human dimension implications. *Global and Planetary Change*, 50(1-2), pp.63-82.
- Eriksen, S., Aldunce, P., Bahinipati, C., Martins, R., Molefe, J., Nhemachena, C., O'brien, K., Olorunfemi, F., Park, J., Sygna, L. And Ulsrud, K. (2011). When not every response to climate change is a good one: Identifying principles for sustainable adaptation. *Climate and Development*, 3(1), pp.7-20.
- Farzana, F., Rahman, A., Sultana, S., Raihan, M., Haque, M., Waid, J., Choudhury, N. and Ahmed, T. (2017). Coping strategies related to food insecurity at the household level in Bangladesh. *PLOS ONE*, 12(4), p.e0171411.
- Flatø, M., Muttarak, R. and Pelsler, A. (2017). Women, Weather, and Woes: The Triangular Dynamics of Female-Headed Households, Economic Vulnerability, and Climate Variability in South Africa. *World Development*, 90, pp.41-62.
- Flowerdew, R. and Martin, D. (2013). *Methods in human geography*. 2nd ed. London: Routledge.
- Ford, J. and King, D. (2013). A framework for examining adaptation readiness. *Mitigation and Adaptation Strategies for Global Change*, 20(4), pp.505-526.
- Fordham, M. (2003) Gender, disaster and development: The necessity for integration *Natural Disasters and Development in a Globalising World* pp.57-74.
- Foufoula-Georgiou, E., Syvitski, J., Paola, C., Hoanh, C., Tuong, P., Vörösmarty, C., Kremer, H., Brondizio, E., Saito, Y. and Twilley, R. (2011). International Year of Deltas 2013: A proposal. *Eos, Transactions American Geophysical Union*, 92(40), pp.340-341.
- Fukuda-Parr, S. (1999). What Does Feminization of Poverty Mean? It Isn't Just Lack of Income. *Feminist Economics*, 5(2), pp.99-103.

Gaard G. (2015) Ecofeminism and climate change. *Women Student International Forum* 49 pp. 20–33

Gabrielsson, S. and Ramasar, V. (2013) Widows: Agents of change in a climate of water uncertainty *Journal of Cleaner Production* 60 pp. 34-42

Ghosh, A.K. et al, (2016) Review of national adaptation policies, India, DECCMA Working Paper, Deltas, Vulnerability and Climate Change: Migration and Adaptation, IDRC Project Number 107642. Available at: www.deccma.com, Date Accessed: 05/08/2018

Ghosh, A.K., Banerjee, S., and Naaz, F., (2018) Adapting to Climate Change- induced Migration, Women in Indian Bengal Delta. *Economic and Political Weekly* LIII(17) pp.63-69.

Gibbs, A., Willan, S., Misselhorn, A. and Mangoma, J. (2012). Combined structural interventions for gender equality and livelihood security: a critical review of the evidence from southern and eastern Africa and the implications for young people. *Journal of the International AIDS Society*, 15(3(Suppl 1)).

Gill, S., Handley, J., Ennos, A. and Pauleit, S. (2007). Adapting Cities for Climate Change: The Role of the Green Infrastructure. *Built Environment*, 33(1), pp.115-133.

Gimenez-Nadal, J. and Molina, J. (2015). Commuting time and household responsibilities: evidence using propensity score matching. *Journal of Regional Science*, 56(2), pp.332-359.

Giosan, L., Syvitski, J., Constantinescu, S. and Day, J. (2014). Climate change: Protect the world's deltas. *Nature*, 516(7529), pp.31-33.

Glaser, B.G. and Strauss, A.L. (1967) The discovery of grounded theory: strategies for qualitative research. New York Aldine de Gruyter

Gustafson, S., Joehl Cadena, A., Ngo, C., Kawash, A., Saenghkaew, I. and Hartman, P. (2017). Merging science into community adaptation planning processes: a cross-site comparison of four distinct areas of the Lower Mekong Basin. *Climatic Change*, 149(1), pp.91-106.

Hajra, R., Szabo, S., Tessler, Z., Ghosh, T., Matthews, Z. and Foufoula-Georgiou, E. (2017). Unravelling the association between the impact of natural hazards and household poverty: evidence from the Indian Sundarban delta. *Sustainability Science*, 12(3), pp.453-464.

Hansen, A. and Bi, P. (2017). Climate change adaptation: no one size fits all. *The Lancet Planetary Health*, 1(9), pp.e353-e354.

Harris, R. and Jarvis, C. (2011). *Statistics for geography and environmental science*. Harlow, Essex, England: Pearson Education Limited.

Hay, I. (2016). *Qualitative research methods in human geography*. 4th ed. Ontario: Oxford University Press.

Hazra S, Das I, Samanta K, Bhadra T (2014) Impact of climate change in Sundarban area West Bengal, India. School of Oceanographic Studies, Earth Science & Climate Book 9326/17.02.00. Report submitted to Caritas India, SCiAF

Heath, R. and Tan, X. (2016) Intra-household Bargaining, Female Autonomy, and labour Supply: theory and Evidence from India, Available at: https://economics.nd.edu/assets/227115/hsa_heathtan.pdf Date Accessed: 15/08/2018

Hinkel, J. (2011). "Indicators of vulnerability and adaptive capacity": Towards a clarification of the science-policy interface. *Global Environmental Change*, 21(1), pp.198-208.

Horton, B., Rahmstorf, S., Engelhart, S. and Kemp, A. (2014). Expert assessment of sea-level rise by AD 2100 and AD 2300. *Quaternary Science Reviews*, 84, pp.1-6.

Hossain, M., Ahmed, M., Ojea, E. and Fernandes, J. (2018). Impacts and responses to environmental change in coastal livelihoods of south-west Bangladesh. *Science of The Total Environment*, 637-638, pp.954-970.

Htun, M. and Weldon, S. (2010). When Do Governments Promote Women's Rights? A Framework for the Comparative Analysis of Sex Equality Policy. *Perspectives on Politics*, 8(01), p.207.

Huang, C., Vaneckova, P., Wang, X., FitzGerald, G., Guo, Y. and Tong, S. (2011). Constraints and Barriers to Public Health Adaptation to Climate Change. *American Journal of Preventive Medicine*, 40(2), pp.183-190.

Huq, S., Reid, H., Konate, M., Rahman, A., Sokona, Y. and Crick, F. (2003). Mainstreaming adaptation to climate change in Least Developed Countries (LDCs). *Climate Policy*, 4(1), pp.25-43.

Huynh, P. and Resurreccion, B. (2014). Women's differentiated vulnerability and adaptations to climate-related agricultural water scarcity in rural Central Vietnam. *Climate and Development*, 6(3), pp.226-237.

Ifejika Speranza, C., Wiesmann, U. and Rist, S. (2014). An indicator framework for assessing livelihood resilience in the context of social-ecological dynamics. *Global Environmental Change*, 28, pp.109-119.

Indira Gandhi National Widow Pension Scheme (Not Specified) Government of India, Available at: <https://govinfo.me/indira-gandhi-national-widow-pension-scheme/> Date Accessed: 20/07/2018

IPCC, 2014: *Annex II: Glossary* [Agard, J., E.L.F. Schipper, J. Birkmann, M. Campos, C. Dubeux, Y. Nojiri, L. Olsson, B. Osman-Elasha, M. Pelling, M.J. Prather, M.G. Rivera-Ferre, O.C. Ruppel, A. Sallenger, K.R. Smith, A.L. St. Clair, K.J. Mach, M.D. Mastrandrea, and T.E. Bilir (eds.)]. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1757-1776

Islam, S. and Gnauck, A. (2008). Mangrove wetland ecosystems in Ganges-Brahmaputra delta in Bangladesh. *Frontiers of Earth Science in China*, 2(4), pp.439-448.

Ivankova, N. Y., Creswell, J. W. and Stick, S. I. (2006) Using Mixed-Methods Sequential Explanatory Design: From theory to practice *Field Methods* 18:1 pp.3-20

Jabeen, H. (2014) Adapting to Built Environment: The role of gender in shaping vulnerability and resilience to climate extremes in Dhaka Environment and Urbanisation 26(1) pp.147-165

Jayanimitta, M., Puspasari, D., Widyahantari, R., Kristina, D., Ratnaningtyas, T., Setionurjaya, A. and Anindita, Y. (2018). Beyond Vulnerability Assessment: Impact of Developments toward Local Adaptive Capacity in Kemijen City Village, Semarang City. *IOP Conference Series: Earth and Environmental Science*, 123, p.012007.

Jha, A., Basu, R. and Basu, A. (2015). Studying Policy Changes in Disaster Management in India: A Tale of Two Cyclones. *Disaster Medicine and Public Health Preparedness*, 10(01), pp.42-46.

Jin, L., Whitehead, P., Rodda, H., Macadam, I. and Sarkar, S. (2018). Simulating climate change and socio-economic change impacts on flows and water quality in the Mahanadi River system, India. *Science of The Total Environment*, 637-638, pp.907-917.

Johnson, N., Kovarik, C., Meinzen-Dick, R., Njuki, J. and Quisumbing, A. (2016). Gender, Assets, and Agricultural Development: Lessons from Eight Projects. *World Development*, 83, pp.295-311.

Johnston, R., Gregory, D., Pratt, G. and Watts, M. (2009) *The Dictionary of Human Geography*. Blackwell: Chichester.

Jongman, B., Ward, P. and Aerts, J. (2012). Global exposure to river and coastal flooding: Long term trends and changes. *Global Environmental Change*, 22(4), pp.823-835.

Kabir, M., Serrao-Neumann, S., Davey, P., Hossain, M. and Alam, M. (2018). Drivers and temporality of internal migration in the context of slow-onset natural hazards: Insights from north-west rural Bangladesh. *International Journal of Disaster Risk Reduction*, 31, pp.617-626.

Kanyashree Prakalpa Scheme (Not Specified) Government of West Bengal, Available at: https://www.wbkanyashree.gov.in/kp_4.0/index.php Date Accessed: 20/07/2018

Kelebe, H., Ayimut, K., Berhe, G. and Hintsu, K. (2017). Determinants for adoption decision of small scale biogas technology by rural households in Tigray, Ethiopia. *Energy Economics*, 66, pp.272-278.

Kelkar, G. (2014) Women's Inheritance and Land Rights: The Fog of Entitlement, *Economic and Political Weekly* 49(33)

Kitchin, R. and Tate, N. (2013). *Conducting research in human geography*. London: ROUTLEDGE.

Klasen, S., Lechtenfeld, T. and Povel, F. (2015). A Feminization of Vulnerability? Female Headship, Poverty, and Vulnerability in Thailand and Vietnam. *World Development*, 71, pp.36-53.

Klein, R.J.T., G.F. Midgley, B.L. Preston, M. Alam, F.G.H. Berkhout, K. Dow, and M.R. Shaw, (2014) Adaptation opportunities, constraints, and limits. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 899-943.

Knutson, T., McBride, J., Chan, J., Emanuel, K., Holland, G., Landsea, C., Held, I., Kossin, J., Srivastava, A. and Sugi, M. (2010). Tropical cyclones and climate change. *Nature Geoscience*, 3(3), pp.157-163.

Kolawole, O., Motsholapheko, M., Ngwenya, B., Thakadu, O., Mmopelwa, G. and Kgathi, D. (2016). Climate Variability and Rural Livelihoods: How Households Perceive and Adapt to Climatic Shocks in the Okavango Delta, Botswana. *Weather, Climate, and Society*, 8(2), pp.131-145.

Krien, Y., Mayet, C., Testut, L., Durand, F., Tazkia, A., Islam, A., Gopalakrishna, V., Becker, M., Calmant, S., Shum, C., Khan, Z., Papa, F. and Ballu, V. (2016). Improved Bathymetric Dataset and Tidal Model for the Northern Bay of Bengal. *Marine Geodesy*, 39(6), pp.422-438.

Krook, M. and O'Brien, D. (2012). All the President's Men? The Appointment of Female Cabinet Ministers Worldwide. *The Journal of Politics*, 74(3), pp.840-855.

Kumar, P., Wiltshire, A., Mathison, C., Asharaf, S., Ahrens, B., Lucas-Picher, P., Christensen, J., Gobiet, A., Saeed, F., Hagemann, S. and Jacob, D. (2013). Downscaled climate change projections with uncertainty assessment over India using a high resolution multi-model approach. *Science of The Total Environment*, 468-469, pp.S18-S30.

Lahiri-Dutt, K. And Samanta, G. (2006). Constructing Social Capital: Self-Help Groups and Rural Women's Development in India. *Geographical Research*, 44(3), pp.285-295.

Landesa (The Rural Development Institute) (2013) Security for girls through land: Pilot evaluation- 2012–2013. Seattle, WA Available at <http://www.landesa.org/wp-content/uploads/Landesa-Girls-Project-Baseline-Study.pdf> Date Accessed: 31/08/2018

Landesa (2014) Girls project: Creating opportunities for girls through land rights. Seattle, WA Available At: <http://www.landesa.org/wp-content/uploads/Girls-Project-Fact-Sheet-April-2014.pdf> Date Accessed: 31/08/2018

Latu, I., Mast, M., Lammers, J. and Bombari, D. (2013). Successful female leaders empower women's behaviour in leadership tasks. *Journal of Experimental Social Psychology*, 49(3), pp.444-448.

Lavell, A., 2003: *Local Level Risk Management: Concept and Practices*. CEPREDENAC-UNDP, Quito, Ecuador.

Le Mare, A. (2012). 'Show the world to women and they can do it': Southern Fair Trade Enterprises as agents of empowerment. *Gender & Development*, 20(1), pp.95-109.

Le Masson, V. (2013) *Seeing both sides: ethical challenges of conducting gender sensitive fieldwork* In Lunn, J. (2014) *Fieldwork in the Global South: Ethical Challenges and Dilemmas* London Routledge

Liamputtong, P. (2007) *Researching the Vulnerable: A guide to sensitive research methods* London, Sage

Liersch, S., Cools, J., Kone, B., Koch, H., Diallo, M., Reinhardt, J., Fournet, S., Aich, V. and Hattermann, F. (2013). Vulnerability of rice production in the Inner Niger Delta to water resources management under climate variability and change. *Environmental Science & Policy*, 34, pp.18-33.

Ling, F., Tamura, M., Yasuhara, K., Ajima, K. and Trinh, C. (2015). Reducing flood risks in rural households: survey of perception and adaptation in the Mekong delta. *Climatic Change*, 132(2), pp.209-222.

- MacGregor, S. (2010). 'Gender and climate change': from impacts to discourses. *Journal of the Indian Ocean Region*, 6(2), pp.223-238.
- MacGregor, S. (2017) *Gender and the Environment: An Introduction*, in Macgregor S. *Handbook on Gender and the Environment*, Oxford, Routledge
- Manyena, S. (2006). The concept of resilience revisited. *Disasters*, 30(4), pp.434-450.
- Marshall, C., and Rossman, G.B., (1995) *Designing Qualitative Research*, 2nd Edition. Sage, London.
- Masika, R. (2002) *Gender, development, and climate change*. Oxford: Oxfam.
- Mazumdar, S., Mazumdar, P., Kanjilal, B. and Singh, P. (2014). Multiple Shocks, Coping and Welfare Consequences: Natural Disasters and Health Shocks in the Indian Sundarbans. *PLoS ONE*, 9(8), p.e105427.
- McGranahan, G., Balk, D. and Anderson, B. (2007). The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones. *Environment and Urbanization*, 19(1), pp.17-37.
- Miles, M.B. and Huberman, A.M. (1994) *Qualitative Data: An Expanded Sourcebook*. London: Sage.
- Mirza, M.M.Q., (2003) Climate change and extreme weather events: can developing countries adapt? *Climate policy* 3 pp. 233-248
- Mitra, A. (2014) Son Preference in India: Implications for Gender Development, *Journal of Economic Issues* 48(4) pp.1021-1037
- Moghaddam, F. M., B. R. Walker, and R. Harre. (2003) *Cultural distance, levels of abstraction, and the advantages of mixed methods*. In *Handbook on mixed methods in the behavioural and social sciences*, ed. A. Tashakkori and C. Teddlie, 51–89. Thousand Oaks, CA: Sage.
- Mohammad Rashed Alam Bhuiyan and Tasneem Siddiqui. 2015. Migration in the Indian Bengal Delta and the Mahanadi Delta: a review of the literature. DECCMA Working Paper, Deltas, Vulnerability and Climate Change: Migration and Adaptation, IDRC Project Number 107642. Available at: www.deccma.com , Date accessed: 05/08/2018
- Morse, J. M. 1991. Approaches to qualitative-quantitative methodological triangulation. *Nursing Research* 40:120–23.
- Morton, J. (2007). The impact of climate change on smallholder and subsistence agriculture. *Proceedings of the National Academy of Sciences*, 104(50), pp.19680-19685.

Moser, S. (2005). Impact assessments and policy responses to sea-level rise in three US states: An exploration of human-dimension uncertainties. *Global Environmental Change*, 15(4), pp.353-369.

Moser, S. and Ekstrom, J. (2010). A framework to diagnose barriers to climate change adaptation. *Proceedings of the National Academy of Sciences*, 107(51), pp.22026-22031.

Motsholapheko, M., Kgathi, D. and Vanderpost, C. (2011). Rural livelihoods and household adaptation to extreme flooding in the Okavango Delta, Botswana. *Physics and Chemistry of the Earth, Parts A/B/C*, 36(14-15), pp.984-995.

Musinguzi, L., Natugonza, V., Efitre, J. and Ogutu-Ohwayo, R. (2017). The role of gender in improving adaptation to climate change among small-scale fishers. *Climate and Development*, 10(6), pp.566-576.

Mutabazi, K., Amjath-Babu, T. and Sieber, S. (2015). Influence of livelihood resources on adaptive strategies to enhance climatic resilience of farm households in Morogoro, Tanzania: an indicator-based analysis. *Regional Environmental Change*, 15(7), pp.1259-1268.

National Action Plan on Climate Change, (2008). Government of India, Available at: <http://www.moef.nic.in/downloads/home/Pg01-52.pdf> Date Accessed: 20/07/2018

National Disaster Management Guidelines, (2008). National Disaster Management Authority. Government of India, Available at: <https://ndma.gov.in/images/guidelines/cyclones.pdf> Date Accessed: 20/07/2018

National Disaster Management Guidelines: Management of Floods (2008) National Disaster Management Authority, Government of India Available at: <https://ndma.gov.in/images/guidelines/flood.pdf> Date Accessed: 20/07/2018

National Environment Policy (2006) Ministry of Environment and Forests, Government of India. Available at: <http://unpan1.un.org/intradoc/groups/public/documents/apcity/unpan042378.pdf> Date Accessed: 20/07/2018

National Policy for the Empowerment of Women, (2001). Ministry of Women and Child Development. Government of India, Available at: <http://www.wcd.nic.in/sites/default/files/National%20Policy%20for%20Empowerment%20of%20Women%202001.pdf> Date Accessed: 20/07/2018

National Policy on Disaster Management, (2009). National Disaster Management Authority, New Delhi. Government of India, Available at: <https://ndma.gov.in/images/guidelines/national-dm-policy2009.pdf> Date Accessed: 20/07/2018

- Nelson, V., Meadows, K., Cannon, T., Morton, J. and Martin, A. (2002). Uncertain predictions, invisible impacts, and the need to mainstream gender in climate change adaptations. *Gender & Development*, 10(2), pp.51-59.
- Neumann, B., Vafeidis, A., Zimmermann, J. and Nicholls, R. (2015). Future Coastal Population Growth and Exposure to Sea-Level Rise and Coastal Flooding - A Global Assessment. *PLOS ONE*, 10(3), p.e0118571.
- Neumayer, E. and Plümper, T. (2007). The Gendered Nature of Natural Disasters: The Impact of Catastrophic Events on the Gender Gap in Life Expectancy, 1981–2002. *Annals of the Association of American Geographers*, 97(3), pp.551-566.
- Ngigi, M., Mueller, U. and Birner, R. (2017). Gender Differences in Climate Change Adaptation Strategies and Participation in Group-based Approaches: An Intra-household Analysis From Rural Kenya. *Ecological Economics*, 138, pp.99-108.
- Ngwenya, B., Thakadu, O., Magole, L. and Chimbari, M. (2017). Memories of environmental change and local adaptations among molapo farming communities in the Okavango Delta, Botswana — A gender perspective. *Acta Tropica*, 175, pp.31-41.
- Nicholls, R.J., P.P. Wong, V.R. Burkett, J.O. Codignotto, J.E. Hay, R.F. McLean, S. Ragoonaden and C.D. Woodroffe, (2007) *Coastal systems and low-lying areas. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 315-356.
- Nielsen, J. and Reenberg, A. (2010). Cultural barriers to climate change adaptation: A case study from Northern Burkina Faso. *Global Environmental Change*, 20(1), pp.142-152.
- Nyberg-Sorensen, N., Hear, N. and Engberg-Pedersen, P. (2002). The Migration-Development Nexus Evidence and Policy Options State-of-the-Art Overview. *International Migration*, 40(5), pp.3-47.
- O'Brien, K., S. Eriksen, A. Schjolen, and L. Nygaard, (2004) What's in a word? Conflicting interpretations of vulnerability in climate change research. CICERO Working Paper 2004:04, CICERO, Oslo University, Oslo, Norway.
- O'Brien, H. (2009). Exploring engagement in the qualitative research process. *Proceedings of the American Society for Information Science and Technology*, 46(1), pp.1-4.
- Occhionero, M. and Nocenzi, M. (2009). Gender inequalities: the integrated approach to the gender dimension in Europe. *International Review of Sociology*, 19(1), pp.155-169.

- Oostendorp, R. (2010) Globalisation and the Gender Wage Gap *World Bank Economic Review*, 23(1)
- Oppenheimer M, Todorov A (eds) (2006) Global warming: the psychology of long-term risk. *Climate Change* 77(1/2):1–210
- Pandey, R. and Jha, S. (2011). Climate vulnerability index - measure of climate change vulnerability to communities: a case of rural Lower Himalaya, India. *Mitigation and Adaptation Strategies for Global Change*, 17(5), pp.487-506.
- Pascall, G. and Lewis, J. (2004). Emerging Gender Regimes and Policies for Gender Equality in a Wider Europe. *Journal of Social Policy*, 33(03), p.373.
- Pelling, M. (2003). *The vulnerability of cities*. London: Earthscan.
- Pelling, M. and High, C. (2005). Understanding adaptation: What can social capital offer assessments of adaptive capacity?. *Global Environmental Change*, 15(4), pp.308-319.
- Pett, M.A. (1997) *Nonparametric Statistics for Health Care Research*, London, Sage
- Pielke, R. Prins, G. Rayner, S. and Sarewitz, D. (2007) 'Lifting the Taboo on Adaptation', *Nature* 445 pp.597–8
- Portelli, A. (1981) The Peculiarities of Oral History. *History Workshop Journal* 12:96-107.
- Prowse, M. and Scott, L. (2009) Assets and Adaptation: An Emerging Debate. *IDS Bulletin* 39 (4) 42-52
- Rakib, M. and Matz, J. (2016) The impacts of Shocks on Gender-differentiated asset dynamics in *Bangladesh Journal of Development Studies* 52(30) pp. 377-395
- Ray-Bennett, N. (2010) The role of microcredit in reducing women's vulnerabilities to multiple disasters. (2009). *Disasters*, 34(1), pp.240-260.
- Ray-Bennett, N. (2011). The influence of caste, class and gender in surviving multiple disasters: A case study from Orissa, India. *Environmental Hazards*, 8(1), pp.5-22.
- Ray-Bennett, N. (2018). Disasters, Deaths, and the Sendai Goal One: Lessons from Odisha, India. *World Development*, 103, pp.27-39.
- Reed, M., Fraser, E. and Dougill, A. (2006). An adaptive learning process for developing and applying sustainability indicators with local communities. *Ecological Economics*, 59(4), pp.406-418.
- Reid, H. and Huq, S. (2007) How we are Set to Cope with the Impacts, IIED Briefing, London: International Institute of Environment and Development Available At: <http://pubs.iied.org/pdfs/17006IIED.pdf> Date Accessed: 03/08/2018

Report of the Working Group on Women's Agency and Empowerment: XII Five Year Plan, (2011). Ministry of Women and Child Development. Government of India, Available at: http://planningcommission.nic.in/aboutus/committee/wrkgrp12/wcd/wgrep_women.pdf
Date Accessed: 20/07/2018

Rossmann, G., and B. Wilson 1991 Numbers and Words Revisited: Being "Shamelessly Eclectic." *Evaluation Review* 9(5):627–643

Roy, K. and Tisdell, C. (2002). Property rights in women's empowerment in rural India: a review. *International Journal of Social Economics*, 29(4), pp.315-334.

Sabar, B. (2015), Hunger amidst Plenty: Locating Vulnerability in a Resource-Rich Region in India. *Journal of Asian and African Studies*, 52(5), pp.670-690.

Sabooj Sathi Bicycle Distribution Scheme (2015) Government of West Bengal, Available at: <http://vikaspedia.in/education/education-best-practices/west-bengal-saboojsathi-bi-cycle-distribution-scheme?content=small> Date Accessed: 20/07/2018

Samling, C.L., Ghosh, A.K., Hazra, S. (2015) Resettlement and Rehabilitation: Indian Scenario. DECCMA Working Paper, Deltas, Vulnerability and Climate Change: Migration and Adaptation, IDRC Project Number 107642. Available online: www.deccma.com, Date Accessed: 02/08/2018

Saunders, M. and Townsend, K. (2016). Reporting and Justifying the Number of Interview Participants in Organization and Workplace Research. *British Journal of Management*, 27(4), pp.836-852.

Schmidt, G. (2005) Ecology & Anthropology A Field Without a Future? *Ecological and Environmental Anthropology* 1(1) pp. 13-15.

Scoones, I., (1998) *Sustainable Rural Livelihoods: A Framework for Analysis*, IDS Working Paper 72. Available at <https://www.staff.ncl.ac.uk/david.harvey/AEF806/Scoones1998.pdf>
Date Accessed 03/08/2018

Sen, A. (1993) *Capability and Well-Being*, in Martha Nussbaum and Amartya Sen (eds.) *The Quality of Life*, pp. 30 – 53. Oxford, UK: Clarendon Press

Shabib, D. and Khan, S. (2014). Gender-sensitive adaptation policy-making in Bangladesh: status and ways forward for improved mainstreaming. *Climate and Development*, 6(4), pp.329-335.

Shamshad, R. (2016). Bengaliness, Hindu nationalism and Bangladeshi migrants in West Bengal, India. *Asian Ethnicity*, 18(4), pp.433-451.

Shanthi, B., Mahalakshimi, P. and Chandrasekaran, V. (2017). Assessment of challenges faced by the coastal women due to the impact of climatic change in selected coastal districts of Tamil Nadu, India. *Indian Journal of Fisheries*, 64.

Sinha, A., and Ram, F., (2018) Formation of Traditional Gender Attitudes among Young Married Women in Rural North Dinajpur, West Bengal: Does Religion Play a Role? *Journal of Population and Social Studies*, 26(2) pp.83-100

Skinner, E. (2011). Gender and climate change: Overview report. Bridge.

Smit, B. and Skinner, M. (2002). Adaptation options in agriculture to climate change: a typology. *Mitigation and Adaptation Strategies for Global Change*, 7(1), pp.85-114.

Smit, B. and Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change*, 16(3), pp.282-292.

Smit, B., Burton, I., Klein, R. and Wandel, J. (2000). An anatomy of Adaptation to Climate Change and Variability. *Climatic Change*, 45(1), pp.223-251.

Smith, N. (2014). Gender and Livelihood Diversification: Maasai Women's Market Activities in Northern Tanzania. *The Journal of Development Studies*, pp.1-14.

Spence, A. Poortinga, W. Butler, C. and Pidgeon, N.F. (2011) Perceptions of Climate Change and Willingness to Save Energy related to flood experience. *Nature Climate Change* 1 pp. 46-49

Stark, O. and Levhari, D. (1982) On migration and risk in LDC's economic development and cultural change 31 pp. 191-196

Stern, P., Dietz, T. and Kalof, L. (1993). Value Orientations, Gender, and Environmental Concern. *Environment and Behaviour*, 25(5), pp.322-348.

Strauss, A. (1987) *Qualitative Analysis For Social Scientists*. Cambridge: Cambridge University Press.

Sugden, F., Maskey, N., Clement, F., Ramesh, V., Philip, A. and Rai, A. (2014). Agrarian stress and climate change in the Eastern Gangetic Plains: Gendered vulnerability in a stratified social formation. *Global Environmental Change*, 29, pp.258-269.

Sutton, S.G., Tobin, R.C. (2011) Constraints on community engagement with Great Barrier Reef climate change reduction and mitigation, *Global environmental change* 21(3) pp. 894-905

Swain, R., Van Sanh, N. and Van Tuan, V. (2008). Microfinance and Poverty Reduction in the Mekong Delta in Vietnam. *African and Asian Studies*, 7(2-3), pp.191-215.

- Syvitski, J., Kettner, A., Overeem, I., Hutton, E., Hannon, M., Brakenridge, G., Day, J., Vörösmarty, C., Saito, Y., Giosan, L. and Nicholls, R. (2009). Sinking deltas due to human activities. *Nature Geoscience*, 2(10), pp.681-686.
- Szabo, S., Hossain, M., Adger, W., Matthews, Z., Ahmed, S., Lázár, A. and Ahmad, S. (2015a). Soil salinity, household wealth and food insecurity in tropical deltas: evidence from south-west coast of Bangladesh. *Sustainability Science*, 11(3), pp.411-421.
- Szabo, S., Renaud, F., Hossain, M., Sebesvári, Z., Matthews, Z., Foufoula-Georgiou, E. and Nicholls, R. (2015b). Sustainable Development Goals Offer New Opportunities for Tropical Delta Regions. *Environment: Science and Policy for Sustainable Development*, 57(4), pp.16-23.
- Tanner, T. and Mitchell, T. (2009). Entrenchment or Enhancement: Could Climate Change Adaptation Help to Reduce Chronic Poverty?. *IDS Bulletin*, 39(4), pp.6-15.
- Terry, G. (2009). No climate justice without gender justice: an overview of the issues. *Gender & Development*, 17(1), pp.5-18.
- Tessler, Z., Vorosmarty, C., Grossberg, M., Gladkova, I., Aizenman, H., Syvitski, J. and Foufoula-Georgiou, E. (2015). Profiling risk and sustainability in coastal deltas of the world. *Science*, 349(6248), pp.638-643.
- Thao, V. (2012). Making a Living in Rural Vietnam from (Im)mobile Livelihoods: a Case of Women's Migration. *Population, Space and Place*, 19(1), pp.87-102.
- The World Bank (2018) India States Briefs – West Bengal, Available at: <http://www.worldbank.org/en/country/india/brief/india-states-briefs-west-bengal> Date Accessed: 28/07/2018
- Thornton, M. (2006). Widening access, widening participation, widening success: an Indian case study. *Research in Post-Compulsory Education*, 11(1), pp.19-30.
- Thywissen, K., (2006) Core terminology of disaster risk reduction: A comparative glossary. In: *Measuring Vulnerability to Natural Hazards* [Birkmann, J. (ed.). UNU Press, Tokyo, Japan, pp. 448-496.
- Tibesigwa, B. and Visser, M. (2016). Assessing Gender Inequality in Food Security among Small-holder Farm Households in urban and rural South Africa. *World Development*, 88, pp.33-49.
- Tompkins, E., Adger, W., Boyd, E., Nicholson-Cole, S., Weatherhead, K. and Arnell, N. (2010). Observed adaptation to climate change: UK evidence of transition to a well-adapting society. *Global Environmental Change*, 20(4), pp.627-635.

Torri, M. and Martinez, A. (2013). Women's empowerment and micro-entrepreneurship in India: Constructing a new development paradigm?. *Progress in Development Studies*, 14(1), pp.31-48.

Torri, M.C. and Martinez A. (2011) Gender Empowerment and Equality in Rural India: Are WOMEN'S Community-Based Enterprises the Way Forward? *Journal of International Women's Studies* 12(1) pp.157-176

Tranter, B. (2011). Political divisions over climate change and environmental issues in Australia. *Environmental Politics*, 20(1), pp.78-96.

Tuihedur Rahman, H., Robinson, B., Ford, J. and Hickey, G. (2018). How Do Capital Asset Interactions Affect Livelihood Sensitivity to Climatic Stresses? Insights From the Northeastern Floodplains of Bangladesh. *Ecological Economics*, 150, pp.165-176.

Turner (2010) Research Note: The silenced assistant. Reflections of invisible interpreters and research assistants. *Asia Pacific Viewpoint*, 51(2): 206-219

UNFCCC (2018) Definition of Adaptation, Available At <https://unfccc.int/topics/resilience/resources/adaptation-databases> Date Accessed: 07/08/2018

Van Aelst, K. and Holvoet, N. (2016). Intersections of Gender and Marital Status in Accessing Climate Change Adaptation: Evidence from Rural Tanzania. *World Development*, 79, pp.40-50.

Van Der Linden, S.L. (2014) The socio-psychological determinants of climate change risk perceptions: Towards a comprehensive model *Journal of Environmental Psychology* 41 pp. 112-124

Van Der Linden, S.L. Maibach, E. and Leiserowitz, A. (2015) Improving public engagement with climate change five "best practice" insights from psychological science, *Perspectives on psychological science* 10(6) pp. 758-763

Vercruyssen, A., Wuyts, C. and Loosveldt, G. (2017). The effect of sociodemographic (mis)match between interviewers and respondents on unit and item nonresponse in Belgium. *Social Science Research*, 67, pp.229-238.

Vicuña, S., McPhee, J. and Garreaud, R. (2012). Agriculture Vulnerability to Climate Change in a Snowmelt-Driven Basin in Semiarid Chile. *Journal of Water Resources Planning and Management*, 138(5), pp.431-441.

Vincent, K. (2007). Uncertainty in adaptive capacity and the importance of scale. *Global Environmental Change*, 17(1), pp.12-24.

Vörösmarty, C., Meybeck, M., Fekete, B., Sharma, K., Green, P. and Syvitski, J. (2003). Anthropogenic sediment retention: major global impact from registered river impoundments. *Global and Planetary Change*, 39(1-2), pp.169-190.

Wassmann, R., Hien, N., Hoanh, C. and Tuong, T. (2004). Sea Level Rise Affecting the Vietnamese Mekong Delta: Water Elevation in the Flood Season and Implications for Rice Production. *Climatic Change*, 66(1/2), pp.89-107.

Wassmann, R., Jagadish, S., Sumfleth, K., Pathak, H., Howell, G., Ismail, A., Serraj, R., Redona, E., Singh, R. and Heuer, S. (2009). Chapter 3 Regional Vulnerability of Climate Change Impacts on Asian Rice Production and Scope for Adaptation. *Advances in Agronomy*, pp.91-133.

WBCMO (2018a) Chief Minister of West Bengal, Chief Minister's Office, Government of West Bengal Available at: <http://wbcmo.gov.in/profile.aspx> Date Accessed: 20/07/2018

WBCMO (2018b) Kanyashree, Chief Minister's Office, Government of West Bengal, Available at: <http://wbcmo.gov.in/kanyashree.aspx> Date Accessed: 20/07/2018

West Bengal State Action Plan on Climate Change, (2012). Department of Environment, Government of West Bengal, Available at: <http://www.moef.nic.in/downloads/public-information/West-Bengal-SAPCC.pdf> Date Accessed: 20/07/2018

West Bengal State Disaster Management Policy & Frame Work (Not Specified) Department Of Disaster Management. Government of West Bengal Available at: http://wbmdm.gov.in/writereaddata/WEST_BENGAL_DISASTER_MANAGEMENT_POLICY.pdf Date Accessed: 20/07/2018

West Bengal State Policy for Empowerment of Women (Not specified). Department of Women & Child Development and Social Welfare. Government of West Bengal, Available at: <https://wb.gov.in/portal/documents/10180/0/West+Bengal+State+Policy+for+Empowerment+of+Women/b7c90e2a-d9ca-4649-acb1-8999697d0d35?version=1.0> Date Accessed: 20/07/2018

West Bengal Widow Pension Scheme (Not Specified) Available at: <http://www.nari.nic.in/schemes/west-bengal-widow-pension-scheme> Date Accessed: 20/07/2018

Westerhoff, L., Keskitalo, E. and Juhola, S. (2011). Capacities across scales: local to national adaptation policy in four European countries. *Climate Policy*, 11(4), pp.1071-1085.

Whitehead, P., Barbour, E., Futter, M., Sarkar, S., Rodda, H., Caesar, J., Butterfield, D., Jin, L., Sinha, R., Nicholls, R. and Salehin, M. (2015). Impacts of climate change and socio-economic scenarios on flow and water quality of the Ganges, Brahmaputra and Meghna (GBM) river

systems: low flow and flood statistics. *Environmental Science: Processes & Impacts*, 17(6), pp.1057-1069.

Whitmarsh, L. (2008) Are flood victims more concerned about climate change than other people? The role of direct experience in risk perception and behavioural response. *Journal of Risk reduction* 11(3) pp. 351-374

Wilk, J. and Kgathi, D. (2007). Risk in the Okavango Delta in the face of social and environmental change. *GeoJournal*, 70(2-3), pp.121-132.

Wineman, A. and Liverpool-Tasie, L. (2017). Land Markets and Land Access Among Female-Headed Households in Northwestern Tanzania. *World Development*, 100, pp.108-122.

Wisner, B., Blaikie, P., Cannon, T. and Davis, I., (2004) At Risk: Natural Hazards, *People's Vulnerability and Disasters* (second ed) New York: Routledge

Wong, P.P., I.J. Losada, J.-P. Gattuso, J. Hinkel, A. Khattabi, K.L. McInnes, Y. Saito, and A. Sallenger, (2014) *Coastal systems and low-lying areas*. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 361-409.

Yadav, S. and Lal, R. (2018). Vulnerability of women to climate change in arid and semi-arid regions: The case of India and South Asia. *Journal of Arid Environments*, 149, pp.4-17.