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REVIEW ARTICLE

Detrimental Effects of Climate Change on Women

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Abstract
Earth is undergoing inevitable changes in its climate as a result of both natural and man-made activities, e.g., earthquakes, hurricanes, rapid urbanization, population growth, agricultural intensification, etc. Women commonly face higher risks and greater burdens from the impacts of climate change as they are more likely to be economically dependent than men and have less access to education and information that would allow them to manage climate-related risks to agriculture and livestock. Women make up the majority of the world's poor population. They tend to suffer more from the impacts of climate-related disasters and severe weather events due to regional cultural norms and unfair distribution of roles, resources, and power, especially in developing countries. Their role in combating climate change is seldom appreciated even though they give priority to their families even in the times of droughts and scarcity of food and water resources. This paper sheds light on climate change and its relation to women in different scenarios of the changing climate. These include agriculture, biodiversity, water, natural disasters, wars, migration, pollution, health and sanitation, education, disempowerment, security, social and psychological and human rights. Lastly, to mitigate the effects of climate change on women, recommendations to involve international funding organizations are also discussed.

Keywords Vulnerability · Women · Climate change · Policies

1 Introduction

Women are most likely to suffer from climate change, but they are also most capable of creating change and adaptation within their communities. Their vulnerability to climate change can be observed by looking at their daily lives. They generally perform the roles of finding, collecting, carrying, storing, securing, purifying and distributing water and food for various household purposes such as drinking, cleaning, washing, sanitation, feeding families; production of livestock products and household crops; cutting and carrying fuel such as agricultural waste or wood for heating homes, drying clothes, and cooking; cutting and learning about herbs to treat diseases and taking care of the elderly and the sick (United Nations Women Watch 2009; Noreen 1991; Annecke 2010; Ariyabandu 2000). Such close relationship of women to all aspects of nature makes obvious that any adverse effect on the environment will adversely affect women. Major factors accounting for the vulnerability of women are less ownership of land or assets and less work opportunities, high levels of illiteracy, low social status, limited mobility, socially formed barriers of dependence on males, unequal access of resources and less involvement in decision-making processes (United Nations Women Watch 2009).

World Summit on Sustainable Development held in Johannesburg in 2002 has declared climate change as an 'ethical' issue since women and children are the major weight-bearers of the issue (Aureli and Brelet 2004). This is mainly because woman form the majority of the world poor. Of 1.3 billion people in the developing world who live below the poverty line, 70% are women (Arora-Jonsson 2011). Women are more dependent on natural resources than men in terms of consumption of agricultural resources, fuel burning and acquisition of wood, etc., for their livelihood (Roberts 2009). Sixty percent women form part of the

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gravely hungry people in the world. Major General Patrick Cammert, a former UN peacekeeping operation commander said that 'it is now more dangerous to be a woman than to be a soldier in modern conflict (Roberts 2009)'.

Climate change is a major challenge affecting the day to day livelihood and the struggle of survival both in the short-run and the long-run. The common effects can be observed on agriculture, biodiversity and ecosystems, food security, freshwater resources, human health and settlement patterns, and energy, etc. Due to rapid population growth, urbanization and agricultural intensification, natural resources are depleting significantly leading to a global physical imbalance. During the past 39 years, 2015 has been recorded as the hottest resulting in an increase in Earth's temperature and rise in sea-level (Habtezion 2016a). According to the UN Secretary-General Report, an average of $250–$300 billion annually is the cost spent on disasters caused by climate change (United Nations 2015). The condition is worse in the developing countries. A Swedish bill on climate and energy states that 'many developing countries are especially vulnerable to climate effects because of poverty, conflicts of gender and social equality, the environmental degradation and lack of food (Arora-Jonsson 2011)'.

This paper focuses on climate change and its relation with women in different dimensions around the globe including agriculture, biodiversity, water, natural disasters, wars, migration, pollution, health and sanitation, education, disempowerment, security, social and psychological and human rights. In the end, mitigation of the issues is also discussed in detail.

2 Vulnerability of Women to Climate Change

2.1 Women, Climate Change and Agriculture

Climate change is posing great threat to the agriculture sector. Extreme weather conditions, changes in rainfall patterns and increase in global temperature as a result of climate change are leading to failure of crops, outburst of pests and diseases and depletion of land and water resources (Habtezion 2016b). Consequently, four major aspects of food security are under threat, these are, food availability, food accessibility, food utilization and food systems stability (United Nations Women Watch 2009). All these are largely affecting women in rural areas who are the major contributors in agriculture sector activities and responsible for securing, storing and preparing food. In general, men have the liberty to migrate when the conditions are harsh leaving behind women who look after their families, farms and livestock. Talking specifically about African women, William says: 'In Africa, most farmers are women. Decline in agricultural yields increases women's workload to obtain enough yields to feed their families; it directly affects household nutrition and incomes and a decrease in woody vegetation makes it difficult to feed their animals (Williams 1993)'. According to a UN Women Watch report (United Nations Women Watch 2009), 45–80% of all the food production in developing countries is accounted for by women. In Pakistan, women form 73% of the agricultural labor force (Noreen 1991). In Africa, the majority of the female labor force is employed in agriculture (Steady 2014). At present, about 90% of African female labor force and about two-third of the world's female labor force is involved in agriculture (FAO 2018). African women produce 80% of the continent's food with 60% employment in the agriculture sector. Women spend most of their time in agriculture related activities contributing to lower level farming which accounts for 50% of the labor working on the farms (UN Food and Agriculture Organization 1995; Cheryl Doss 2015). Apart from this, women are also involved in afforestation, crop domestication, soil and water conservation, etc. (Habtezion 2016). In spite of their large role in the agricultural sector worldwide, women are not allowed ownership of land (Ndaruzaniye 2013). It is alarming to know that women own 10–20% of the land worldwide (Food and Agriculture Organization (FAO) 2011). As per Women's Environment and Development Organization (WEDO), women own less than 2% land globally (Women's Environment and Development Organization (WEDO) 2018). Most of the irrigated fields are worked by women but it is men who take advantage by owning the land, and dominating the decision-making processes and market affairs (Sandys 2005). Only 5% of agricultural extension services worldwide are received by women and as per resources, in Nigeria, Uganda and Tanzania, gender productivity gaps are 18.6, 30.6 and 27.4%, respectively (Habtezion 2016). It has been found that microfinance which is a system of giving loans for investment in individual projects is difficult for women to get as compared to men and even if they do get, their loans may still be controlled by their male relatives. In rural Paraguay, a survey of 210 households showed that 23% of the women declared that they were credit constrained, but in two-third cases, their husbands asserted that they had adequate access to credit (FAO 2013; Fletschner 2009). In addition, women are also forced to work on less fertile lands as compared to men, as women are considered subservient to men socially (Sandys 2005).

Changing climate can lead to loss of harvests because of changing temperature and rainfall patterns or due to disasters such as droughts or floods (Annecke 2010). This sometimes affects food availability and market prices of the crops increase making food unaffordable. Consequently, women who do not own land and do not have any other sources to earn face loss of income and often loss of their sole sources of food and are faced with the pressure of feeding themselves and their families. As a result, they are dragged into pit of

poverty and health issues such as malnutrition (Annecke 2010).

2.2 Women, Climate Change and Loss of Biodiversity

Climate change is posing significant and progressive threat to the biodiversity and is likely to contribute to its loss by the end of the century. Climate change is contributing significantly to the extinction of many plant and animal species by changing temperature and rainfall patterns, frequent floods, storms and changes in behavior and food sources, etc., leading to imbalance of the entire global ecosystem. It is expected that by 2050, climate change will result in extinction of 25% or more of all species (El-Keblawy 2014). During the past 100 years, temperature of Earth has increased by 0.6 °C. The results are evident from melting of the ice belts, rise in sea-level and depletion of forest resources all over the world (United Nations Women Watch 2009; Ecosystems and Human Well-being 2005). One of the major consequences includes loss of Arctic sea ice which is threatening the biodiversity across an entire biome and beyond (United Nations Women Watch 2009; Shah 2014). Moreover, coastal communities are also under threat due to higher concentrations of carbon dioxide in the atmosphere resulting in ocean acidification. One major contributor of ocean acidification is deforestation which accounts for an average of 20% carbon dioxide emitted into the atmosphere by humans (Shah 2014). Furthermore, the structure of plant and animal communities in coastal regions is limited by the factors that affect the tolerance of species to the environmental conditions such as availability of light, temperature, moisture, disturbance such as storms and fire, tides, water depth, availability of nutrients and salinity (Burkett 2008). All of these limiting factors are affected by climate change. Thus, coastal biodiversity is being affected on which people of coastal communities largely depend for food, water and livelihoods. Major livelihood activities of coastal communities include fishing, seaweed farming, trading and tourism (Jayaweera 2010). Mariette Correa, a gender and development expert stated that women make up half of the total working population worldwide in the seafood industry. They are involved in fisheries, seafood processing, inland fisheries, seaweed and shellfish collection, fishing, weaving and repairing nets, processing, sales, and local and intra-regional trade. In small-scale fisheries, they also play roles in managing finances at the household level and managing aquatic resources at the community level (UN Women, Asia and the Pacific 2015). As a result of loss of biodiversity, coastal women have to suffer from loss of income and livelihoods.

Similarly, forest ecosystems are also undergoing significant biodiversity loss. In Asia and Africa wood, agricultural crops and residue, forest resources are substantial to the survival of men and women and to fulfill their energy requirements. The constant climate changes are leading to depletion of these resources, hence affecting the livelihoods of millions of people (Chan 2018). Women are primarily responsible for collecting and carrying fuel wood and forest resources and walk fairly long distances that consumes lot of time affecting domestic activities; education and health, e.g., arthritis and spinal deformities (Lambrou 2006). Collection and carrying of fuel can consume from 2 to 20 or more hours of women per week. However, as resources become scarce, women are required to travel greater distances for finding and collecting resources which consumes more of their time (United Nations Women Watch 2009). Women, continuously working in the close proximity to the nature, have great knowledge about patterns of seed development and production, plant and animal species, weather conditions, and food supply, so they can contribute tremendously in dealing with issue of loss of biodiversity and climate change (WEDO 2018).

2.3 Women, Climate Change and Water Resources

Mother Nature has blessed Earth with many precious renewable resources which are being subjected to an increasing deadly threat by the human impact. Among these freshwater may be the most mighty and unforgiving. Not only it is crucial to survival but to existence of life itself. Its purification and transportation are one of the most arduous tasks. Climate change is affecting water supplies as a consequence of pollution, floods, acidification, etc. Bridget Mahoney in her report mentions that about 663 million people lack access to safe water (Bridget Mahoney 2016). According to the estimate of UN-water, about 5.5 billion people, which are about two-thirds of the world's population, will face water shortage by 2025 (Aureli and Brelet 2004). As per Global Consultation on Safe Water and Sanitation, about 80 countries supporting 40% of the world population is already facing water shortage and supply and scarcity is constantly accelerating (Yoon 1993). It has been estimated that 75–250 million people will face water shortage by 2020 and rain-fed agricultural yields will be reduced by 50% (Steady 2014). As per UNDP report, water resources in Pakistan are likely to dry up by 2025 (Shams 2017).

Though water in all the water-bodies of the world may seem unbounded, it is very much limited. This finite commodity has a direct bearing on almost all the sectors of economy and every aspect of life. Major issues related to water are freshwater availability and access. Water and women have deep relationship. Women are major sufferers of shortage of water since they are the ones that carry out management of water at household level (UN Chief Executives Board (CEB) 2007). They are the primary collectors and users of water for cooking, cleaning, washing, hygiene,

child care, waste disposal, vegetable growing, food processing, and sanitation. Water being necessary for household purposes, agriculture and also electricity production is disturbing every aspect of women's life. Not only the burden of work is increasing, but health, education, privacy and safety of women is also affected. Additionally, at the onset of crisis, it has been found that men migrate to lucrative areas leaving behind women to take responsibility of water management. As shown by the research in Sonari village in the Thar area of Pakistan, not a single man could be found in the village and women were overburdened by domestic tasks and water related matters with their lives revolving only around donkeys, goats and malnourished children. These women had to fetch brackish water from the wells and food from the trees (Ariyabandu 2000).

Since women are collectors of water in most rural areas, women face certain problems whenever issue of water shortage arises. They have to find the sources of water, think about the methods to draw, collect, transport the water and places to store it. Moreover, distributing water for various purposes depending upon the quality of water and purifying water by different techniques proves to be another arduous task. Consequently women have to walk for considerable distances to collect water from their homes to water wells or water plants carrying water buckets that may weigh up to 40 kg in some instances. In countries like Pakistan, in rural areas, women spend an average of 4 h a day fetching and carrying water on their heads due to the lack of transportation (Noreen 1991). In a factual report written by Bridget Mahoney, it has been mentioned that in African countries women are five times more likely to collect drinking water and on average, a distance of 3.7 miles per day is covered by females and 5 gallons per trip are carried. Globally, every day, 200 million hours are spent by women in carrying water to their houses. It also states that water requirement for a family of six people means carrying the water for an average of 3 h per day. According to World's Women report of 2010, 63% women in Sub-Saharan Africa collect water in comparison to 11% of men in rural areas while about 29% women collect water compared to 10% men in urban areas (United Nations Statistics Division 2010). Data obtained from eight countries shows that women are more involved in affairs of water collection and distribution as compared to men as given by example of Guinea where women spend 30 min per day in water collection while men spend only 8 min (Women's Environment and Development Organization (WEDO) 2018). In an interview in Lalibela district of Ethiopia, women reported that during drought period, time taken to fetch water substantially increased as it would take up to 6 h a day while previously it just took 2 h (Swarup 2011). Thus, women have to work tirelessly at the expense of their health, time, education and this leads to their disempowerment. Even this amount of water is sometimes not enough to meet their needs since it is often contaminated. Thus, women face effects of poor sanitation (UNICEF 2018).

Water scarcity is not only affecting women's domestic lives but their livelihoods as well. Due to shortage of water, women have to travel greater distances and have to spend greater amount of time in collection of water. This time pressure hampers their income-generating activities such as running cottage industries and selling hand-made products and crafts. In addition, women form major portion of the world's agricultural labor force as mentioned above. However, women still lack access to resources such as agricultural equipment and technology which can be used to buffer the effects of climate and water variability, and agricultural water management policies and investments which are critical to poor working women are often gender-blind. Thus, when there is shortage of water, their fields and crops are wasted and women have to suffer from loss of livelihoods and consequently, poverty. Also, women have fewer opportunities to do off-farm jobs or migrate to urban areas to earn livelihood as compared to men. Stress caused by requirement of greater time for collection of water puts women in a dilemma of choosing to work on neighbors' farms to earn food for today, tending to their own fields to grow food for tomorrow or putting both at risk to collect water for household use (Parker et al. 2016).

2.4 Women, Climate Change and Natural Disasters

As mentioned earlier, the temperature of earth is increasing rapidly leading to Global warming and melting of ice caps. As a consequence, the rise in sea-level, extinction of species, changes in rainfall and humidity patterns are being observed. All these are contributing to frequently occurring natural disasters such as droughts, famines, floods, cyclones, hurricanes, typhoons, mudslides, etc., and also slowly occurring disasters such as desertification and salinization of coastal areas. According to Sir John Holmes, in the last 20 years, the number of natural disasters recorded has increased from 200 to 400 per year and about nine out of every ten natural disasters are related to climate (Holmes J, Under-Secretary-General for Humanitarian Affairs and Emergency Relief Coordinator 2008). The primary consequence of natural disasters is disturbed patterns of human settlement, migration or displacement. Other consequences of natural disasters include health issues and deaths, loss of shelter, poverty, agricultural losses, loss of education and empowerment.

It has been found that women and children are the major consequence-bearer of natural disasters. They face many social, educational and employment, privacy and health issues. Majorly, they face poverty more than men as a consequence of disasters. According to a research, death rate of women and children is 14 times greater than that of men in natural disasters (Soroptimist International of the Americas

2008). In 2004 Asian tsunami, 70% of the dead were women (Soroptimist International of the Americas 2008) and as per another report, women were 80% of the dead in 2004 tsunami of Asia (APWLD 2005). Of 140,000 people killed in 1991 Bangladesh cyclone, mortality rate of women above age 40 was 31% greater (Bern et al. 1993). In Hurricane Katrina that hit USA in 2005, more women lost their livelihoods in comparison to men and formed the poorest and marginalized part of the community. A study shows that among 180,000 people who lost their livelihoods in Louisiana, 103,000 were women (Ginn 2009). 87% unmarried women and 100% married women lost their source of income by cyclone Nargis that hit Ayeyarwaddy Delta in Myanmar in 2008 (British Red Cross on Relief Web 2009). More women died as compared to men in 2003 European heat-wave and in Indonesia and Sri Lanka 2006 tsunami (Araujo et al. 2008).

Natural disasters are also increasing the prevalence of water-borne diseases. This also increases rate of mortality and morbidity and aggravates women's care-giving responsibilities. In addition, post-disaster studies show that women are less likely to be given quality health-care after disasters (World Health Organization (WHO) 2008). Women are, therefore, more likely to contract diseases after natural disasters.

Men own most of the agricultural lands and houses so their losses are recorded, but losses other than these are never considered. However, women lose their kitchen utensils, sewing machines, small animals and any other productive assets they have that make them more dependent on men (Bradshaw and Fordham 2013). Depletion in natural resources increases women's workload with more distance to travel for wood, water and food collection. This leaves women with no time for income-generating activities. Sometimes, women have to sacrifice themselves for the sake of their families with declining quantity and quality of food (Masika 2002).

Many factors have been listed as a cause of women's vulnerability to natural disasters. Lack of resources and poverty contribute to their vulnerability. A study conducted by International Federation of Red Cross and Red Crescent Societies shows that in low-income countries, people are 4 times more prone to dying in natural events as compared to people in high-income countries (World Disasters Report 1993). Since women form the major part of world poor, they are more vulnerable to natural disasters than men. Certain social aspects of a society also play an important role in determining the vulnerability. As per study conducted in Orissa, India about the vulnerability of women to floods show that it is difficult to study various aspects of vulnerability without taking into account the place and its class, gender and ethnicity concepts (Arora-Jonsson 2011). In many areas, the notion of socially constructed 'dependence of women on men', economic disadvantage, gender discrimination in ownership, access and control of land and resources, limited decision-making, lower literacy rates make them susceptible to damage during natural disasters. Cultural and religious restrictions on women's mobility also hamper their timely escape at times of disasters. For example, it was reported that during floods, many women did not leave their houses as it was considered socially and culturally inappropriate and some of the women who tried to escape died because they did not know how to swim (Rohr 2006). In their analysis of up to 141 countries conducted between 1981 and 2002, Neumayer and Plumper found that the extent of socially constructed vulnerability also determines women's vulnerability to disasters as compared to male life expectancy and that women are more likely to die if they are more economically disadvantaged (Neumayer and Plumper 2007). Kafi points out that there are no laws to protect women rights in some countries and even if there are some legal provisions, women are not literate enough to claim their rights and do not have any financial resources. (Kafi et al. 1992). Men are preferred over women in post-disaster treatment resulting in more suffering of food shortages, toilets and bathing facilities and sleeping arrangements for women (Swarup et al. 2011). Similarly in 1991, no official warning to women regarding cyclone in Bangladesh was given whereas men were totally aware as they were informed in public places, but these warnings were seldom communicated on to their families. This indicates social injustice and general gender inequality in society (Rohr 2006). This limits women's coping capacity and decreases their resilience (https://www.karat.org/wp-content/uploads/2012) to the natural disasters.

2.5 Women, Climate Change and Wars

Another consequence that is usually not considered when listing effects of climate change is increase in wars and conflicts all over the world. Climate change is resulting in extinction of species, water resources and prevalence of droughts and famines. Thus, survival instinct of nations forces them to fight against each other to get food, water, and other necessary resources. It is generally said that third world war will be due to the shortage of water. Harald Welzer, the author of the book 'Climate Wars: Why People Will Be Killed in the 21st Century', said 'My belief is that we will see renaissance of violent conflict in the 21st century, and that many of these conflicts will spring from climate change (Illing 2017)'.

Marcus King, a professor at George Washington University's Elliott School of International Affairs who authored the chapter on 'weaponizing' water, said that in coming years, water shortages might also lead to interstate war. Over the issue of damming River Nile, Ethiopia has already been threatened by Egypt with air strikes (Aton and American 2017). Marco Sánchez Cantillo at the UN Food and

Agriculture Organization says that 'There's no doubt that there's a clear interaction between climate change and conflict". He further added that "They work together to accelerate and deepen the severity of hunger". Marco in his report pointed out that the number of undernourished people in the world increased yearly from 2003 to 2016. In 2015, there were 777 million undernourished people, while the number increased to 815 million in 2016. About 489 million undernourished people among these were in those countries which had high conflict rate. The report also blames droughts to be the cause of conflicts and food crisis in Afghanistan, Iraq, Yemen, Sudan, Somalia and Syria. Thus, today about 53.5 million people have no reliable food source (Coghlan 2017).

War on natural resources is already underway in countries like Iraq and Afghanistan according to Pentagon's study of climate change (Military Advisory Board, The CAN Corporation 2007). Gwyn Kirk of Women for Genuine Security has reported that America is fighting war against Iraq to get hold of its oil and use it continuously. All over the world, an increase in greenhouse gas emissions is being observed due to militaristic acquisition and unjust use of natural resources. Hence, climate instability and depletion of resources is increasing leading to more wars and even further climate instability (Roberts 2009). In 2000, under $300 billion were spent by United States military, but in 2008, it spent $700 billion. Greenhouse gas emissions and military spending has surpassed all previous levels (Sharp 2009). During 3-week combat in Iraq, about 40 million gallons of fuel were burnt by army. It means about 2 million gallons were burnt per day, which is an amount equal to total gasoline consumption of all the Allied armies during World War I (Roberts 2009).

The majority of the people affected during war are women and children. This is because they are solely left responsible to feed their families when their husbands, sons or male members of the house are killed during wars. All burden falls on them. They also face sexual violence at the hands of male soldiers. Sometimes, they are forced to leave their houses and migrate to faraway places. So, they suffer from poverty and are left with no other choice than to hold a beggar's bowl. Domestic violence becomes prevalent when normalization of militarism and violence in a society takes place. Thus, whenever situation of war arises, it is women, whose rights are mostly crippled, demeaning the status of women even more (Roberts 2009).

2.6 Women, Climate Change and Migration

Climate change is also accelerating the process of urbanization as temperatures are rising and lands are becoming less productive and it is predicted that over the next decade, the environmental deterioration is further likely to increase internal and cross-border migration (IOM 2009). In 2008, as many as 20 million people were displaced by climate-related natural disasters as per Norwegian Refugee Council (Elverland 2009) and about 800,000 people were displaced due to cyclone Nargis. Desertification in Mexico's drylands displaced about 600,000–700,000 people annually (Elverland 2009). This is generating pressure on already scarce resources and public services. Outbreak of diseases, increase in cost of food and energy, social and psychological issues and political conflicts are also arising (Guterres 2009). Women are more vulnerable to impacts of wars and natural disasters, hence they are more vulnerable to impacts of migration as well. In the least developed countries, number of deaths of women is greater during migration due to their cultural, social, religious and behavioral restrictions; poor or no access to information at all and poor socio-economic status (United Nations Women Watch 2009). Due to Hurricane Katrina, number of households run by low-income mothers dropped from 18,000 in 2005–3000. This indicates that significant displacement of low-income earning women and their children took place (Ginn 2009). About 1.5 million people went homeless in 2007 due to flooding and rains in 18 African countries. Among these displaced people, about three-quarters were women and children (UNICEF 2008). High ratio of stillbirths, infant deaths, and women deaths are observed in times such as these. Women are left poverty-stricken and helpless.

In another report, it was observed that sometimes, due to lack of financial resources and socially constructed roles and responsibilities, women do not migrate at times of disasters or poor environmental quality, as a result of which they die (Ndaruzaniye 2013).

Migration is usually followed by withdrawal of water from rivers, modification of rivers and changes in land-use leading to the loss of coral reefs and damage to seas. Human settlement in a new area usually accompanies use of that area's natural resources such as water, fuel wood, food resources, etc., by the people which can sometimes be so excessive that it entails loss of biodiversity. For example, in coastal areas, overfishing and improper fishing practices, coastal development, sedimentation, land-based sources of pollution and marine pollution can lead to ocean acidification which can cause degradation of calcifying organisms such as mollusks and coral reefs. Thus, migration entails loss of biodiversity and ecosystems (Elverland 2009; Chronicle 2013).

Migration also affects health. Sometimes, migrants don't get even basic life requirements. As a result, many people die and many fall preys to serious diseases. Women and especially pregnant women, who are more vulnerable to any adversities and malnutrition, are at greater risk to become sick. Stillbirths and maternal mortalities are observed as well.

2.7 Women, Climate Change and Pollution/ Environmental Awareness

Women are usually responsible for disposing off household wastes and managing waste water at household level. Additionally, women are agents of agricultural production. But as pollution is increasing, women are more exposed to agro-chemicals such as pesticides, organic pollutants and infectious agents found in waste. Thus, women are more susceptible to water-borne and air-borne diseases (Ndaruzaniye 2013).

The following Table 1 illustrates climate change knowledge and concerns by gender (2001–2008 pooled sample) as per a study by Aaron M. McCright titled 'The effects of gender on climate change knowledge and concern in the American public (2010)'.

From Table 1, it is observed that more women than men show concern about global warming. More women (59%) than men (54%) believe that global warming is happening now and more women (66%) than men (60%) agree that scientists' belief that global warming is happening is true. Also, more women (64%) than men (56%) agree that global warming is the result of human activities. Thus, even though women show more assessed knowledge about climate change, more men than women exhibit perceived understanding of it.

2.8 Women, Climate Change, Health and Sanitation Issues

Climate change is largely affecting water availability since temperatures are rising leading to increase in evaporation. This results in droughts. Also, glaciers are melting rapidly as a result the areas which depend on glaciers for freshwater are facing water shortage (GRACE Communications Foundation 2018). Water quality is being affected as well as rainfall patterns are being disturbed. As a result of heavy downpours, the amount of runoff into rivers and lakes increases. Pollutants, trash, animal waste, sediments and toxic elements enter the water supplies making the water unusable or unsafe to drink (National Climate Assessment, US Global Change Research Program 2014).

As a consequence of the above mentioned facts, climate change is leading to outbreak of many diseases in women and children. Heat waves, floods, fires, droughts and storms are leading to increased morbidity and mortality and are increasing the risk of contraction of illnesses. It has been observed that climate usually determines the geographical spread of infections while weather determines the time of onset of the disease. Changing climate that is continuously changing the weather patterns is resulting in growth and spread of certain infectious parasites and bacteria. For example, rise in temperature is accelerating the maturation and biting rate of mosquitoes (Chan 2007). Tsetse fly and parasites responsible for malaria are increasing due to increasing warmth and dryness outside malarial zones. Every year, malaria imposes a loss of $12 billion on African economy through medical costs, lost productivity and deaths and is the major killer of African children. Bacterium responsible for cholera is also temperature dependent. With increase in temperature, this epidemic is increasing (Radcliffe Institute 2011). Women are more susceptible to diseases as a result of pollution because of their direct contact with waste materials. For example, women working in agriculture are in direct contact with agro-chemicals, organic pollutants and pesticides which specifically harm pregnant and lactating women. Use of pesticides is increasing due to changes in land use, changes in crop rotations and the introduction

Table 1 Climate change knowledge and concerns by gender (2001–2008 pooled sample) Source: McCright AM (2010) (McCright 2010)

Belief or attitude item/index	Men	Women	Gamma[a]
Assessed climate change knowledge			
% who believe the effects of global warming have already begun to happen	0.54	0.59	0.107***
% who believe pollution from human activities are primary cause of global warming	0.56	0.64	0.168***
% who believe most scientists believe global warming is occurring	0.60	0.66	0.141***
Climate change knowledge index mean	1.73	1.91	0.107***
Perceived understanding			
Perceived understanding of global warming mean	3.04	2.75	−0.336***
Climate change concern			
% who worry about climate change a great deal	0.29	0.35	0.162***
% who believe global warming will threaten their way of life	0.28	0.37	0.198***
% who believe the seriousness of global warming is underestimated in the news	0.28	0.35	0.225***
Climate change concern index mean	1.29	1.55	0.174***

[a]Gamma for the relationship between gender and each item/index

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

of new varieties as a result both of higher and lower rainfall and more extreme temperatures, i.e., climate change. These changes result in different quantity and different types of pests; hence result in increased use of pesticides (Wood 2017). Persistent organic pollutants enter women's body tissues and breast milk which cause reproductive and immunological disorders as these toxins can be passed onto their off springs. Additionally, women are involved in disposal of household wastes in their daily lives. In areas like Sub-Saharan Africa where proper methods of disposal are not present and disposal is done through primitive methods of burning and landfilling, many water-borne and air-borne diseases are prevalent among women (Ndaruzaniye 2013).

Water-borne diseases are one of the major issues of today's world with about 250 million people diagnosed with water-borne diseases in the beginning of twenty-first century. Among these, about 75% were the people living in slum-areas according to UNICEF/WHO in its report of 2000. Majority among these were women hence, it has been recognized that gender and sex are determinants of health status as per WHO in its report of 2002 (Aureli and Brelet 2004). Thus, access to clean water is necessary for maintaining good health especially of pregnant women to protect them from diseases such as hepatitis and sepsis. Clean water is also necessary during birth-giving processes as inadequate drinking water, sanitation facilities and poor cleaning can increase the risk of death of the mother and the child. All over the world, women are responsible for collection and storage of water. Thus, women having to carry heavy pots that may sometimes weigh up to 40 kg on their heads and shoulders suffer from pelvic, pectoral, spinal deformities and arthritic diseases and injuries (Page 1996). This may also result in childbirth problems. Energy consumption during water collection can also affect the people with poor nutritional intake. A data collected from a study conducted in Zimbabwe showed that the task of water collection and carrying required over 30% of average daily per capita calorie intake (Mehretu and Mutambirwa 1992).

In recent years, a direct link between climate change and HIV prevalence has been found. According to experts, in the areas where droughts are frequent, HIV cases are more prevalent as the people living in these areas suffer from malnutrition and develop poor immune systems making them more susceptible to HIV AIDS. One example is of Lesotho which has faced one of the worst droughts recorded in history and thus, has highest rate of HIV in whole of Southern Africa (Isgrig 2017). According to reports, 80% of the HIV-infected women live in Sub-Saharan Africa which makes water collection even more difficult. Consequently, young girls are charged with responsibility of collecting water and taking care of the elders at the expense of their own health, education and time (Bridget Mahoney 2016). In communities with lack of access to safe water, trachoma, a bacterial eye infection is common, with mainly children and women infected from it (The Gender and Water Development Report 2003a). As per a resource, women form 70% of the world's total trachoma-blinded people (Bridget Mahoney 2016). Malaria, a water-related disease, is very common in Africa. Pregnant women are more susceptible to contracting this disease. These women easily develop anemia and their infants are more likely to be born with low birth-weight and weak immune systems (Africa Women's Initiative 2003).

In Karakalpakstan, Uzbekistan, NGOs that were working there found close relation of women's health issues to the environmental degradation. Greater rates of maternal mortality, miscarriages, stillbirths, and anemia were observed due to the environmental degradation. Children greatly suffered from skin diseases, respiratory diseases and diarrhea (Women's Environment and Development Organization 2018).

Sanitation issues are also faced by women. About one-third schools globally lack access to sanitation which is an obstacle in the way of their education and women spend about 266 million hours a day finding a washroom to go to (Bridget Mahoney 2016).

In many rural and socio-economically disadvantaged areas, where underground water is contaminated with arsenic, several health problems arise among women such as lesions, dark spots on hands and feet, hardening of skin, loss of feeling and swollen limbs. This has been observed in Bangladesh where large number of women is affected (UNICEF 2018).

As mentioned above, natural disasters and migration also lead to many water-borne diseases.

2.9 Women, Climate Change and Loss of Education/ Disempowerment

Effect of climate change on agriculture and water resources is increasing women workload; hence keeping them away from schools to work in fields, fetch water. Also due to lack of washrooms, sanitation facilities and sanitary napkin disposals, many girls during puberty tend to leave schools (Bridget Mahoney 2016). During natural disasters, women also drop out of schools to help their families for migration. Moreover, when male members of family die during natural disasters or wars, women are left poverty-stricken because either they are illiterate or social restraints do not allow them to move from one place to another to earn a living (Ariyabandu 2000). Similarly in case of disasters, women have to drop out of their schools or jobs. During natural disasters, loss is determined only by number of households destroyed but equipment such as kitchen utensils, sewing machines, etc., which women use to run cottage industries are never considered. Thus, women are left disempowered. A case study made by Bhutta in Jhang, Punjab, Pakistan showed

that during floods, schools were washed away and students had no choice but to support their families in agriculture or household chores, etc. (Bhutta 1999).

2.10 Women, Climate Change and Loss of Security

Climate change is not only affecting the health and education of women, but also security and resilience of women is being harmed. Due to the environmental degradation, women have to search faraway fields and places to collect fuel and water. As a result, they fall victim to sexual harassment and assault (United Nations Women Watch 2009). Because of the absence of restrooms in or near their homes and because of the lack of privacy as public restrooms are usually located alongside roads, women tend to wait till night. This increases the risk of sexual harassment, assault and animal attacks (Bridget Mahoney 2016). Women in three villages in Nepal have reported that they were not involved in tube well designing procedures and that they waited till night to undertake activities such as washing clothes and bathing (Regmi and Fawcett 1999). During wars and migration, women also face sexual harassment at the hands of male soldiers. Domestic violence is also common during periods of wars (Roberts 2009). Not involving women in empowering activities and not giving them equal social status is itself enough to cripple the resilience of women.

2.11 Women, Climate Change, Social and Psychological Issues

Social effects of climate change are seldom given any attention. However, they are very much there and affecting large number of women. Women, having to spend a lot of time on collection of fuel and water and carrying out their domestic responsibilities, have very little time to socially interact with other people. Therefore, their social relations are crippled (Ecosystems and Human Well-being 2005). Climate change producing temperature fluctuations, water-borne and air-borne diseases is leading to infertility in women (Barreca 2015), which is an obstacle in a way of their marriages. As already mentioned, in areas of arsenic contamination, arsenic poisoning in women causes skin lesions. As a result, these women are shunned and excluded and chances of their marriage are greatly reduced. Additionally, unmarried women are generally more vulnerable to poverty and social exclusion (Elverland 2009). More than 1.2 million refugees migrated from Iraq to Syria due to US occupation of Iraq. Among these, the girls and women who were responsible for supporting their families, having no other option, turned to prostitution (Zoepf 2007).

Women and children also severely suffer from post-traumatic stress disorder (PTSD) as a result of wars and natural disasters (Bradshaw and Fordham 2013). A survey conducted in Nicaragua about impacts of Hurricane Mitch showed that among 74% of the people that were emotionally affected were women (CIET-CCER 1999a, b).

An increase in forced and early marriages has been observed post-disaster in Haiti, Pakistan and many other countries that were affected by Indian Ocean tsunami (Bradshaw and Fordham 2013). It has been found that many girls are forced to marry at an early age after disasters to lessen the burden as parents are not in a position to secure and support their daughters. Thus, they are either sold or forced to marry. Bhutta, during his case study in Pakistan, found that many houses were washed away by floods which reduced the chances of marriages of girls. Additionally, being financially corrupt, parents had to sell their daughters' dowries and jewelry further leading to delay in marriages. Since, delay in marriages is considered taboo in the society; these unmarried girls were left with feelings of self-pity and worthlessness (Bhutta 1999).

2.12 Climate Change and Violation of Human Rights

Basic human rights include rights to food, health, basic education and shelter. However, due to climate change, these rights of many people are being crippled (Kyung 2008). Global warming is leading to malnutrition, hunger, exposure to disease and depletion of water resources throughout the world. Loss of livelihoods and limitations to adequate housing are also being observed due to migration and permanent displacement. Moreover, rights to social life and security are also being harmed. Since, women are major sufferers of all these issues, it is concluded that basic human rights of women are being violated due to climate change. Hence, climate change is not just a physical issue, but is also becoming social and moral issue as well.

2.13 Women, Climate Change and World Economy

Climate change is leading to decline in the world economy. It has been estimated that if climate change remains unmitigated, the world economy will suffer the loss of 23% by 2100 (Burke et al. 2015). Another study suggests that its mitigation will cost $44 trillion by 2060 (Channel 2015). Cost of mitigation and adaptation efforts will be somewhere between $249 billion and $1371 billion annually till 2030 (Human Development Report 2011). According to World Bank report, till 2050, temperature of the earth will be 2 °C warmer while the cost on the adaptation side would be between $75 billion and $100 billion from 2010 to 2050 (World Bank 2010). Global climate finance was increased by 18% in the year 2014 and about $ 391 billion was the cost spent on low-carbon and climate-resilient growth (Buchner 2015). Many climate funding agencies are working at

present including 50 international public funds, 45 carbon markets and 6000 private equity funds are providing climate change finance (Flynn 2011).

In such matters of finance, women are never taken into consideration. In 2011–2012, $469 million which formed only 2% of total bilateral aid was given to women's economic empowerment initiatives. Only 14 out of 193 finance ministers globally were women in 2015 and the representation of women in climate funds governing bodies was just 22%. The 2012 Climate Development assessment report showed that only five out of 3864 projects considered gender in their documents. In the year 2015, in national parliaments, women held only 21% seats globally while in Latin America and Caribbean, the women held 25% seats. In Arab parliament, they held less than 14% seats. However, it has been found that in countries where women lack access to credit, number of malnourished children are 85% higher (Global Greengrant Funds (GGF) and International Network of Women and the Alliance of Funds (INWF) 2015; Aguilar and Granat 2015; UNDP 2015). Thus, in only two countries, women in parliament match their share in population (UNDP 2014). The McKinsey Global Institute has estimated the impact of closing gender gap on economy in labor markets in 95 countries. It has been found that the national GDPs of each country would increase by 9% and global GDP would increase by $428 trillion or 26% if gender gaps are closed (McKinsey Global Institute 2015). As per FAO, the number of malnourished people could be decreased by 12–17% if women are given access to resources, i.e., both credit and land (Food and Agriculture Organization (FAO) 2011).

3 Ecofeminism for Mitigation of Climate Change Effects on Women

Ecofeminism is a slowly emerging concept in human society that links ecology to feminism and encourages women's role in protecting the environment (Ling 2014). Climate change is not 'gender-insensitive' issue and women are as important in dealing with this issue as men. Thus, women should be taken into equal consideration in combating climate change and following steps should be undertaken.

- Gender analysis considers daily life roles of men and women, overlap and conflict of interests, social structure, age, wealth and ethnicity, socio-economic and technological factors, access to and usage of resources, distribution of labor, time and payments, gender-wise vulnerability and hazards, gender budgeting, gender-wise impact, gender equality audit and establishment of gender-sensitive benchmarks (Annecke 2010; The Gender and Water Development Report 2003b).
- Four effective actions are observed, i.e., mitigation (women involvement to control greenhouse concentration); adaptation (reducing women's vulnerability to climate risk) (www.careclimatechange.org/adaptation) by adjustments in women's behavior, providing resources and technology (UNFCCC 2007; Change 2007); financial mechanisms [gender-sensitive policies and investments for women (Women 2008; Aguilar 2009)] and technological developments [providing women an access to knowledge, information and technologies relevant to their needs (Women 2008; Aguilar 2009)].
- Ownership of land, access to agricultural and other natural resources and technology to women has increased agricultural yield from 2.4 to 4% in some countries (Food and Agriculture Organization (FAO) 2011), (UNICEF 1998) and in Nigeria, Tanzania and Uganda, 2.8, 8.1 and 10.3%, respectively (Mukasa and Salami 2016). In Pakistan, ownership of waste-land by women allowed them to make watercourse to bring water from river to the village and about 10,400 trees for fuel and 8700 trees for fruits were planted and vegetables were sown (Noreen 1991). Hundreds of hours annually would be devoted to economically benefitting activities if women are given access to clean water and other resources (Swarup 2011).
- Women are stewards of natural resources and possess indigenous knowledge about wildlife and food, medicinal plants and domestic animals, reproduction of plants and animals, ecosystems, geographic ranges of species, disaster management by mobilization of community for better risk-assessment and management (Permanent Forum on Indigenous Issues Seventh session 2008; http://content.undp.org/go/cms-service/download/asset/?asset_id=1854911; Carvajal-Escobar 2008; Van Meygaarden 2008). Research on women of Ganga river basin in Bangladesh, India and Nepal led to learning of many new adaptation strategies such as flood or drought resistant crops, or varieties of rice that can sustain floods by growing above water-level (Mitchell et al. 2007). In Mali, women have developed a new crop, the shea nut trees that can sustain adverse weather conditions as they can be used for fire-wood and nuts can be used for making butter, food products and beauty creams (Mitchell 2007; Perakis 2009; UNIDO 2011).
- Women involvement in energy and water-related matters concludes effective management, production and utilization than men's (www.energia.org/pubs/papers/karlsson-csdbook_lores.pdf). Examples include Tanzania, where wells dug were more sustainable (Fisher 2006) and India where 62% more drinking water projects were developed when women were involved (Bridget Mahoney 2016).
- Women empowerment provides them the environment that supports their needs, demands, choices and aspirations (www.careclimatechange.org/adaptation). Women

and young girls should be given gender-awareness, modern education, modern methods and technology, risk-assessment, leadership and management, self-protection, health. This has resulted in improved crop varieties, livestock management and pest control techniques in Uganda, Kenya and Tanzania (Food and Agriculture Organization (FAO) 2011). In La Masica, Honduras, after hurricane Mitch, no fatalities were observed due to quick evacuation and post-disaster reconstruction, as a disaster agency provided gender-sensitive training regarding disaster management involving both men and women (Aguilar 2018).

- In rural areas, public baths should be made nearby their houses where women can freely bathe and wash clothes at any time of the day. This will improve their health and sanitation and provide more time for participation in more productive and tangible outcomes.
- Gender friendly laws should be made and strictly implemented specially for compulsory education to girls, responsibility of single-mothers and unmarried girls in poor areas on government, domestic violence, compensations to women running cottage factories in disaster situations. Women and men should be held equally responsible for collection of fuel and water.
- Basically, it is short-comings in human society social structure that hampers women empowerment. Our centuries old cultural, religious and social biases put constraints on women from participating in educational and leadership activities. Thus, before implementation of all the above mentioned steps, changes should be brought in social structure of society. For this, men also need to be educated for recognizing the rights of women. Men should be trained to support women rather than demoralize them. These men can themselves become gender trainers. The concept of 'gender equality' should be emphasized. Religious personalities or scholars should come forward to remove any religious misconceptions that limit the freedom of women. An awareness regarding importance of women's involvement should be given to everyone especially people living in backward areas to break free from 'cultural shackles'. As Angela Davis has put it: 'We have to talk about liberating minds as well as liberating society'.
- Women should be involved in national policies, action plans and other measures for sustainable development at all levels. Efforts for women empowerment should be done at local, national, international levels. Also, donor governments and civil society can play an important role. At local level, local governments should make sure to address women's issues and try to curb them with the aid of national government. It should ensure women's security. At national level, finance for mitigation and combating the environmental issues should be distributed. It should have control of all health, educational, legal issues of women and should make guidelines for protection of women against climate change. At international levels, projects with NGOs or companies of other countries should be designed to benefit women and fulfill their needs and requirements. Women should also be involved in these processes. Donor governments are major contributors to women empowerment through their technical and financial support. Gender equality should be ensured in all the bilateral environmental and development initiatives. Civil society can also play their part by ensuring that legal laws are properly implemented and that rights of women are being fulfilled.
- At present many international and well-known programs are underway to promote women empowerment in the field of climate change. These include: United Nations Development Programme (UNDP), United States Agency for International Development (USAID), United Nations Charter and the Universal Declaration of Human Rights, UN Women Watch, Food and Agricultural Organization (FAO), Women's Environment and Development Organization (WEDO), Millennium Development Goals 2000, World Health Organization (WHO), Beijing Platform of Action (1995), Financing for Gender Equality and the Empowerment of Women at 52nd session of the Commission on the Status of Women, Swedish International Development Agency (SIDA), CARE, IPCC (Intergovernmental Panel on Climate Change), United Nations Framework Convention on Climate Change (UNFCCC), The International Union for Conservation of Nature (IUCN), Aurat Foundation in Pakistan.

4 Conclusions

Women are most vulnerable to climate change based on their dependence on natural resources, daily life roles, and socio-economic status. Two-third of the global female labor force is employed in agriculture producing almost 45–80% of the food of developing countries and spending up to 5 h a day in collecting fuel and water at the expense of education and health. In natural disasters, women death rate is observed 14 times greater than men with harm to up to 70% during floods and rains and hurricanes resulting in high percentage of post-trauma disorders as a result of wars, disasters and migration. Despite of women deep involvement in energy and the environmental activities, world has not yet fully recognized the extent of the difficulty faced by women due to climate change and women are still left out in its mitigation. Women representation is almost negligible in finance ministries (7%) and funded projects (0.1%) globally; 2% of total bilateral aid for women's economic empowerment initiatives; ownership of 10–20% of the land and 5% of

agricultural extension services worldwide. Due to climate change, women are major sufferers of health issues including lesions on skin, eye infections, and respiratory diseases, loss of feeling and swollen limbs, arthritis, spinal deformities, infertility, stillbirths, maternal deaths and water-borne diseases. 80% of the HIV infected people in Sub-Saharan Africa are women and women also form 70% of the world's total trachoma-blinded people. Climate change is posing serious social issues such as delay in marriages, forced marriages, lack of security and privacy and sexual violence. It is also reported that local GDP of each country and global GDPs would increase by 9 and 26%, respectively, if gender gaps are closed. As per FAO, the number of malnourished people could be decreased by 12–17% if women are given access to resources, i.e., both credit and land. Projects become six to seven times more effective if women are involved in planning and finance mechanisms To combat climate change alongside men, it is concluded that there is a pressing need to include women in climate change combating policies at local, national and international level such as analyzing women's vulnerability to climate change, involving women to reduce greenhouse gas emissions, increasing their adaptive capacity, involving women in all finance policies regarding climate change, giving women an access to modern technology and education and ensuring their participation in all decision-making processes as there can be no economic development and social well-being without women.

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References

Africa Women's Initiative (2003) Health care issues

Aguilar L (2009) Training manual on gender and climate change. Rep. IUCN, UNDP, global gender and climate alliance. Web. http://data.iucn.org/dbtw-wpd/edocs/2009-012.pdf. Accessed 30 July 2018

Aguilar L (2018) Climate change and disaster mitigation: gender makes the difference. International Union for Conservation of Nature, Switzerland

Aguilar L, Granat et al (2015) Roots for the future: the landscape and the way forward on gender and climate change (Washington D.C.: International Union for Conservation of Nature and Global Gender and Climate Alliance, 2015). https://portals.iucn.org/library/sites/library/files/documents/2015-039.pdf. Accessed 30 July 2018

Annecke W (2010) Gender and climate change adaptation. https://idl-bnc-idrc.dspacedirect.org/bitstream/handle/10625/46073/132561.pdf. Accessed 30 July 2018

APWLD (2005) "Why are women more vulnerable during disasters?" Asia Pacific Forum on Women, Law and Development, NGO in Consultative Status at UN ECOSOC

Araujo A, Quesada-Aguilar L, Pearl R (2008) Gender equality and adaptation. Women's Environment and Development Organization (WEDO)/World Conservation Union (IUCN), Gland

Ariyabandu MM (2000) Impact of Hazards on Women and Children Situation in South Asia, pp 1–10. www.gdnonline.org/resources/ariyabandu_paper.doc. Accessed 30 July 2018

Arora-Jonsson S (2011) Virtue and vulnerability: discourses on women, gender and climate change. Glob Environ Change. 21(2):744–751

Aton A, Scientific American (2017) Once again, climate change cited as trigger for conflict. https://www.scientificamerican.com/article/once-again-climate-change-cited-as-trigger-for-war/. Accessed 30 July 2018

Aureli A, Brelet C (2004) Water and ethics, women and water: an ethical issue Series on water and ethics, Essay 4. UNESCO, Paris, pp 1–38 **(ISBN 92-9220-019-4)**

Barreca A et al (2015) Climate changes hotter weather could reduce human fertility. http://theconversation.com/climate-changes-hotter-weather-could-reduce-human-fertility-50273. Accessed 30 July 2018

Bern C, Sniezek J, Mathbor GM, Siddiqi MS, Ronsmans C, Chowdhury AMR, Choudhury AE, Islam K, Bennish M, Noji E, Glass Rl (1993) Risk factors for mortality in the Bangladesh cyclone of 1991. Bull World Health Org 71(1):73–78. http://whqlibdoc.who.int/bulletin/1993/Vol71-No1/bulletin_1993_71(1)_73-78.pdf

Bhutta AH (1999) The response of riverine communities to disasters. A case study of a Pakistan Village Mamola, with special reference to changes in livelihood patterns and community based rehabilitation. Unpublished report, ITDG

Bradshaw S, Fordham M (2013) Women, girls and disasters. A review for DFID. http://gcrsp.eu/assets/uploads/women-girls-disasters.pdf. Accessed 30 July 2018

Bridget Mahoney (2016) 22 Facts about women and water. https://womenthrive.org/22-facts-about-women-water/. Accessed 30 July 2018

British Red Cross on Relief Web (2009) Myanmar cyclone Nargis: one year on enormous challenges to recovery remain. 30 April. http://www.reliefweb.int/rw/rwb.nsf/db900SID/OYAH-7RMLTW?OpenDocument. Accessed 30 July 2018

Buchner B et al (2015) Global landscape of climate finance 2015. Venice climate policy initiative (CPI). http://climatepolicyinitiative.org/wp-content/uploads/2015/11/Global-Landscape-of-Climate-Finance-2015.pdf. Accessed 30 July 2018

Burke M, Hsiang SM, Miguel E (2015) Global non-linear effect of temperature on economic production. Nature 527:235–239

Burkett et al. VR (2008) Climate change impacts on coastal biodiversity. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.461.6066&rep=rep1&type=pdf. Accessed 30 July 2018

CARE International Climate Change Brief: Adaptation, Gender and Women's Empowerment. 21st December 2015. www.careclimatechange.org/adaptation. Accessed 30 July 2018

Carvajal-Escobar Y et al (2008) Women's role in adapting to climate change and variability. Adv Geosci 14:277–280. https://www.adv-geosci.net/14/277/2008/adgeo-14-277-2008.pdf. Accessed 30 July 2018

Chan M (2007) Climate change and health: preparing for unprecedented challenges. Keynote statement at the U.S. National Institutes of Health, Maryland, USA. http://www.who.int/dg/speeches/2007/20071211_maryland/en/index.html?langu

age **(Director General of the World Health Organization)**. Accessed 30 July 2018
Chan HTH (2018) Climate change and biodiversity loss. https://chge.hsph.harvard.edu/climate-change-and-biodiversity-loss **(School of Public Health, Center for Health and Global Environment)**. Accessed 30 July 2018
Change I.P.O.C. (2007) IPCC fourth assessment report: climate change 2007; 'climate change 2007: working group II: impacts, adaptation and vulnerability
Channel J et al (2015) Energy darwinism II. Why a low carbon future doesn't have to cost the earth. Citi GPS: Global Perspectives and Solutions http://www.ourenergypolicy.org/energy-darwinism-ii-why-a-low-carbon-future-doesnt-have-to-cost-the-earth. Accessed 30 July 2018
CIET-CCER (1999a) Social audit for the emergency and reconstruction: phase 1—April 1999, Managua, Nicaragua: Civil Coordinator for Emergency and Reconstruction/CIET International/Cargui Press. http://www.ciet.org/en/project/nicaragua-social-audit-of-the-emergency-response-and-reconstruc/first-two-phases-of-the-social-audit-on-reconstruction-after-hurricane-mitch-1999/. Accessed 30 July 2018
CIET-CCER (1999b) Auditoria Social Para la Emergencia y la Reconstruction: Fase 2- Noviembre, Managua, Nicaragua: Civil Coordinator for Emergency and Reconstruction/CIET International/Cargui Press. http://www.ciet.org/en/project/nicaragua-social-audit-of-the-emergency-response-and-reconstruc/first-two-phases-of-the-social-audit-on-reconstruction-after-hurricane-mitch-1999/. Accessed 30 July 2018
Climate change: Women in developing countries, the hardest hit; project 'connect! South East West Women for development building support in New Member States for Gender-sensitive and responsive European Development cooperation'. https://www.karat.org/wp-content/uploads/2012/02/Brief-on-Gender-and-climate-change.pdf. Accessed 30 July 2018
Coghlan A (2017) World hunger is on the rise again due to climate change and war. https://www.newscientist.com/article/2147570-world-hunger-is-on-the-rise-again-due-to-climate-change-and-war/ **(Daily News)**. Accessed 30 July 2018
Ecosystems and Human Well-being (2005) Biodiversity synthesis. Millennium ecosystem assessment. http://www.maweb.org/documents/document.354.aspx.pdf21. Accessed 30 July 2018
El-Keblawy A (2014) Impact of climate change on biodiversity loss and extinction of endemic plants of arid land mountains. https://www.omicsonline.org/open-access/impact-of-climate-change-on-biodiversity-loss-and-extinction-of-endemic-plants-of-arid-land-mountains-2332-2543.1000120.php?aid=23166. Accessed 30 July 2018
Elverland S (2009) 20 million climate displaced in 2008. Norwegian Refugee Council. http://www.nrc.no/?did=9407544. Accessed 30 July 2018
ENERGIA (International Network on Gender and Sustainable Energy), 2007. Where energy is women's business: national and regional reports from Africa, Asia, Latin America and the Pacific. http://www.energia.org/pubs/papers/karlsson-csdbook_lores.pdf. Accessed 30 July 2018
FAO (2013) Gender equality and food security: women's empowerment as a tool against hunger, pp 45–46. http://www.fao.org/wairdocs/ar259e/ar259e.pdf. Accessed 30 July 2018
FAO (2018) Women and Food Security. FAO FOCUS http://www.fao.org/publications/en/. Accessed 30 July 2018
Fisher J (2006) For her it's the big issue: putting women at the center of water supply, sanitation and hygiene. Evidence report. Water Supply and Sanitation Collaborative Council, Geneva
Fletschner D (2009) Rural women's access to credit: market imperfections and intrahousehold dynamics. World Dev 37(3):618–631. https://pdfs.semanticscholar.org/c1f2/611a2b709c89bb63b45cc426341b51124a87.pdf
Flynn C (2011) Blending climate finance through national climate funds: a guidebook for the design and establishments of national funds to achieve climate change priorities. New York. http://www.undp.org/content/dam/undp/library/Environment%20and%20Energy/Climate%20Change/Capacity%20Development/Blending_Climate_Finance_Through_National_Climate_Funds.pdf. Accessed 30 July 2018
Food and Agriculture Organization (FAO) (2011) The state of food and agriculture: closing the gender gap for development. Rome. http://www.fao.org/docrep/013/i2050e/i2050e.pdf. Accessed 30 July 2018
Ginn D et al. (2009) Looking both ways: women's lives at the crossroads of reproductive justice and climate justice. Asian Communities for Reproductive Justice. p 5
Global Greengrant Funds (GGF) and International Network of Women and the Alliance of Funds (INWF) (2015) Climate justice and women's rights: A guide to supporting grassroots women's action. http://www.womenandclimate.org/wp-content/uploads/2015/03/Climate-Justice-and-Womens-Rights-Guide1.pdf. Accessed 30 July 2018
GRACE Communications Foundation (2018) The impact of climate change on water resources. http://www.gracelinks.org/2380/the-impact-of-climate-change-on-water-resources. Accessed 30 July 2018
Guterres A (2009) UNHCR; climate change, natural disasters and human displacement: a UNHCR perspective, 5658. http://www.unhcr.org/protection/environment/4901e81a4/unhcr-policy-paper-climate-change-natural-disasters-human-displacement.html. Accessed 30 July 2018
Habtezion S (2016) Gender and climate change, overview of linkages between gender and climate change, policy brief 1, p 3 **(United Nations Development Programme (UNDP))**
Habtezion S (2016) Gender and climate change; gender, climate change and food security, policy brief 3, pp 1–7, http://wedo.org/wp-content/uploads/2017/04/UNDP-Gender-CC-and-Food-Security-Policy-Brief-3-WEB.pdf **(UNDP)**. Accessed 30 July 2018
Holmes J, Under-Secretary-General for Humanitarian Affairs and Emergency Relief Coordinator (2008) Opening remarks at the Dubai International humanitarian aid and development conference and exhibition "DIHAD 2008 Conference". http://www.reliefweb.int/rw/rwb.nsf/db900sid/YSAR-7DHL88?OpenDocument. Accessed 30 July 2018
Illing S (2017) How climate change could lead to more wars in the 21st century. https://www.vox.com/world/2017/11/14/16589878/global-climate-change-conflict-environment. Accessed 30 July 2018
IOM (2009) Migration, climate change and the environment. Policy brief. https://www.iom.int/jahia/webdav/shared/shared/mainsite/activities/env_degradation/compendium_climate_change.pdf. Accessed 30 July 2018
Isgrig H (2017) Food security: the link between HIV and climate change. https://crowd360.org/linking-climate-change-hiv/. Accessed 30 July 2018
Jayaweera I (2010) Livelihood and diversification in rural coastal communities. dependence on ecosystems services and possibilities for sustainable enterprising in Zanzibar, Tanzania, p 3. http://www.diva-portal.org/smash/get/diva2:350389/FULLTEXT01.pdf. Accessed 30 July 2018
Kafi SA, Disaster and Destitute Women (1992) Twelve case studies, BDPC 1992, Dhaka
Kyung W-K (2008) Climate change, migration and human rights. Keynote address at conference on climate change and migration: addressing vulnerabilities and harnessing opportunities. Geneva. http://www.unhchr.ch/huricane/huricane.nsf/view01/

BA5B630BFFAD7FC1C12573F600386398?opendocument **(Deputy Hugh Commissioner for Human Rights, OHCHR)**. Accessed 30 July 2018

Lambrou Y et al (2006) Energy and gender in rural sustainable development. FAO, Rome. http://www.fao.org/tempref/docrep/fao/010/ai021e/ai021e00.pdf. Accessed 30 July 2018

Ling C (2014) Ecological criticism based on social gender: the basic principles of ecofeminism. p 71. http://www.cscanada.net/index.php/hess/article/viewFile/4895/pdf_62. Accessed 30 July 2018

Masika R (2002) Gender, development and climate change. Oxford: Oxfam. http://eige.europa.eu/resources/bk-gender-development-climate-change-010102-en.pdf. Accessed 30 July 2018

McCright AM (2010) The effects of gender on climate change knowledge and concern in the American public

McKinsey Global Institute (2015) The power of parity: How advancing women's equality can add $12 trillion to global growth. McKinsey and Company, New York

Mehretu A, Mutambirwa C (1992) Gender differences in time and energy costs of distance for regular domestic chores in rural Zimbabwe: a case study of the Chiduku communal area. World Dev 20(11):1675–1683. https://scholars.opb.msu.edu/en/publications/gender-differences-in-time-and-energy-costs-of-distance-for-regul-2. Accessed 30 July 2018

Military Advisory Board, The CAN Corporation (2007) National security and the threat of climate change. https://www.cna.org/cna_files/pdf/national%20security%20and%20the%20threat%20of%20climate%20change.pdf. Accessed 30 July 2018

Mitchell et al. (2007) op. cit **(Adapted from)**

Mitchell T, Tanner T, Lussier K (2007) 'We Know What We Need!' South Asian Women Speak Out on Climate Change Adaptation. Action aid International and the Institute of Development Studies Mitchell et al. 2007:6. http://www.ids.ac.uk/publication/we-know-what-we-need-south-asian-women-speak-out-on-climate-change-adaptation. Accessed 30 July 2018

Mukasa A, Salami A (2016) Gender equality in agriculture: What are really the benefits for Sub-Saharan Africa? Chief economist complex, AEB 7, no. 3. https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/AEB_Vol_7_Issue_3_Gender_equality_in_agriculture.pdf. Accessed 30 July 2018

National Climate Assessment, US Global Change Research Program, (2014) Water supply. https://nca2014.globalchange.gov/highlights/report-findings/water-supply#intro-section-2. Accessed 30 July 2018

Ndaruzaniye V (2013) The impact of climate change on women in the African societies. Time for Plan B: positive effects of gender sensitive and environmental policies

Neumayer E, Plumper T (2007) The gendered nature of natural disasters: the impact of catastrophic events on the gender gap in life expectancy, 1981–2002. Ann Assoc Am Geogr 97(3):551–566

Noreen S (1991) Women and Water; Aurat Publication and Information Service Foundation, Lahore. http://jdhr.org/publications/media-and-development/WOMEN%20AND%20WATER.pdf. Accessed 30 July 2018

Page Ben (1996) Taking the strain-the ergonomics of water carrying. Waterlines 14(3):29–31

Parker H, Oates N, Mason N, Calow R (2016) Gender, agriculture and water insecurity; ODI insights, policy brief March 2016. https://www.odi.org/sites/odi.org.uk/files/resource-documents/10533.pdf. Accessed 30 July 2018

Perakis SM (2009) Improving the quality of women's gold in Mali, West Africa: The case of shea. https://ageconsearch.umn.edu/bitstream/51703/2/PerakisPlanB.pdf. Accessed 30 July 2018

Permanent Forum on Indigenous Issues Seventh session (2008) Issue paper on indigenous people and climate change. (E/C.19/2008/CRP27). New York

Radcliffe Institute (2011) Panel of scientists at the conference on "something in the air" at the Radcliffe Institute. Panelists included David Battisti, University of Washington; Kerry Emanuel, MIT; Daniel Schrag, Harvard University; Carl Wunsch, MIT, and Maria Zuber, MIT

Regmi SC, Fawcett B (1999) Integrating gender needs into drinking water projects in Nepal. Gender Dev 7(3):2. https://www.tandfonline.com/doi/abs/10.1080/741923243

Resource Guide on Gender and Climate Change http://content.undp.org/go/cms-service/download/asset/?asset_id=1854911. Accessed 30 July 2018

Roberts M (2009) War, climate change, and women. Race Poverty Environ 16(2):39–41

Rohr U (2006) 'Gender and climate change—a forgotten issue?' Tiempo: Climate Change Newsletter, p 59

Sandys E (2005) Women and water. United Nations Division for the Advancement of Women, Department of Economic and Social Affairs

Shah A (2014) Climate change affects biodiversity. http://www.globalissues.org/article/172/climate-change-affects-biodiversity. Accessed 30 July 2018

Shams S (2017) Water scarcity in Pakistan—a bigger threat than terrorism. http://p.dw.com/p/2X71E. Accessed 30 July 2018

Sharp T (2009) Growth in U.S. defense spending over the last decade. Centers for arms control and non-proliferation. http://www.armscontrolcenter.org. Accessed 30 July 2018

SOFA Team, Cheryl Doss, FAO, Agricultural Development Economics Division; (2015) The role of women in agriculture: ESA working paper no. 11-02. http://www.fao.org/docrep/013/am307e/am307e00.pdf. Accessed 30 July 2018

Soroptimist International of the Americas (2008) Reaching out to women when disaster strikes. White paper: disaster relief. Soroptimist International of the Americas, Philadelphia, PA. http://staging.soroptimist.org/whitepapers/wp_disaster.html. Accessed 30 July 2018

Soroptimist International of the Americas (2008) Op.cit

Steady FC (2014) Women, climate change and liberation in Africa, pp 312–333. https://www.jstor.org/stable/43496976?seq=1#page_scan_tab_contents. Accessed 30 July 2018

Swarup et al. (2011) op. cit

Swarup A, Dankelman I, Ahluwalia K, Hawrylyshyn K (2011) Weathering the storm: adolescent girls and climate change, plan UK, London. http://research3.fit.edu/sealevelriselibrary/documents/doc_mgr/412/Swarup_et_al._2011._Adolescent_Girls_&_CC.pdf. Accessed 30 July 2018

The Gender and Water Development Report 2003 (2003) Gender perspectives on policies in the water sector (Loughborough, UK, Water, Engineering and Development Center, Gender and Water Alliance, 2003)

The Gender and Water Development Report 2003 (2003) Gender Perspectives on Policies in the Water Sector (Loughborough, UK, Water, Engineering and Development Center, Gender and Water Alliance, 2003). http://www.genderandwateralliance.org/reports/GWA%20Annual%20Report.pdf. Accessed 30 July 2018

UN Chief Executives Board (CEB) (2007) Coordinated UN system action on climate change. United Nations. http://www.uneca.org/eca_programmes/sdd/events/climate/CEB-Climate.pdf. Accessed 30 July 2018

UN Chronicle (2013) Impacts of climate change on coral reefs and the marine environment. https://unchronicle.un.org/article/impacts-climate-change-coral-reefs-and-marine-environment **(Vol. L No. 1 2013)**. Accessed 30 July 2018

UNDP, Human Development Report 2011 (2011) Sustainability and equity: a better future for all. New York. http://hdr.undp.org/sites/default/files/reports/271/hdr_2011_en_complete.pdf. Accessed 30 July 2018

UN Food and Agriculture Organization (1995) A synthesis report of Africa region: women, agriculture and rural development
UN Women, Asia and the Pacific (2015) Women play crucial role in marine environments and fisheries economies. http://asiapacific.unwomen.org/en/news-and-events/stories/2015/09/women-play-a-crucial-role-in-marine-environments-and-fisheries-economies. Accessed 30 July 2018
UNDP (2014) Human Development Report 2014 http://hdr.undp.org/sites/default/files/hdr14-report-en-1.pdf. Accessed 30 July 2018
UNDP (2015) Human Development Report 2014. http://hdr.undp.org/sites/default/files/hdr14-report-en-1.pdf. Accessed 30 July 2018
UNFCCC (2007) Report on conference on climate change, COP13, Bali, Indonesia. http://unfccc.int/meetings/cop_13/items/4049.php. Accessed 30 July 2018
UNICEF (1998) Empowering the people to improve sanitation. Water front, No. 12. http://www.unicef.org/crc/crc.htm. Accessed 30 July 2018
UNICEF (2008) Our climate, our future, our responsibility. p 22
UNICEF (2018) Arsenic mitigation in Bangladesh. Rep.UNICEF. Web. http://www.unicef.org/bangladesh/Arsenic.pdf. Accessed 30 July 2018
UNIDO (2011) The Mali women-empowerment through beauty. https://reliefweb.int/report/mali/mali-women-%E2%80%93-empowerment-through-beauty. Accessed 30 July 2018
United Nations (2015) Implementation of the international strategy for disaster reduction: report of the secretary-general. p 2 **(document A/70/282)**
United Nations Statistics Division (2010) The world's women 2010: trends and statistics, 2010
United Nations Women Watch (2009) Women, gender equality and climate change. http://www.un.org/womenwatch/feature/climate_change/downloads/Women_and_Climate_Change_Factsheet.pdf. Accessed 30 July 2018
Van Meygaarden, J (2008) Gender justice in times of a changing climate. Gender CC, 2008. www.gendercc.net/policy/conferences/cop14.htm. Accessed 30 July 2018
WEDO (2018) Gender and Biodiversity. http://wedo.org/wp-content/uploads/Gender_and_Biodiversity_WEDO.pdf. Accessed 30 July 2018
Williams P (1993) Women, children and forest resources in Africa. In: Steady F (ed) Women and children first: environment, poverty and sustainable development. Schenkman Books, Rochester
Women UN (2008) Gender perspectives on climate change. Issues paper for interactive expert Panel on Emerging Issues, trends and new approaches to issues affecting the situation of women or equality between women and men. 52nd session of the Commission on the Status of Women; (2008). http://www.un.org/womenwatch/daw/csw/csw52/issuespapers/Gender%20and%20climate%20change%20paper%20final.pdf. Accessed 30 July 2018
Women's Environment and Development Organization (2018) Women respond to a shrinking Aral Sea. http://www.wedo.org/ehealth/respond.html. Accessed 30 July 2018
Women's Environment and Development Organization (WEDO) (2018) Gender, climate change and water connections
Wood H (2017) The effects of climate change on urban pests. https://www.rentokil.com/blog/climate-change-and-urban-pests/#.WyztTjczbIU. Accessed 30 July 2018
World Bank (2010) The cost to developing countries of adapting to climate change: new methods and estimates. Consultation Draft, 2010. http://siteresources.worldbank.org/EXTCC/Resources/EACC-june2010.pdf. Accessed 30 July 2018
World Disasters Report 1993 (1993) International federation of red cross and red crescent societies, p 4. http://www.ifrc.org/en/publications-and-reports/world-disasters-report/wdr1993-1999/. Accessed 30 July 2018
World Health Organization (WHO) (2008) Gender inequities in environmental health. 25th Session of the European and Health Committee. (EUR/5067874/151). http://www.euro.who.int/Document/EEHC/25th_EEHC_Milan_edoc15.pdf. Accessed 30 July 2018
Yoon S (1993) Water for Life. In: Steady F (ed) Women and children first: environment, poverty and sustainable development. Schenkman Books, Rochester
Zoepf K (2007) Desperate Iraqi refugees turn to sex trade in Syria. New York Times. http://www.nytimes.com/. Accessed 30 July 2018

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