LIVING WITH A CHANGING CLIMATE: VULNERABILITY AND RESILIENCE VIEWED THROUGH A GENDER LENS

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Abstract **–**This paper uses a desk-based review of academic and grey literature on gender and climate change plus empirical evidence linked to biofuels (advocated as a response to climate change mitigation) and food insecurity to demonstrate the value of gender analysis as an analytical tool for use within sustainability science.

Keywords **– climate change, gender, vulnerability, resilience.**

I. INTRODUCTION

There is a generally agreed global consensus both within the scientific community and amongst the general public that the climate is changing. The extent of these effects and their impacts experienced in the socio-ecological system through changes in weather patterns, such as heightened extremes of temperature and rain fall patterns, remain uncertain. However, there are general fears that a changing climate will have negative impacts on human well-being by increased vulnerability particularly in relation to food security. Research to gain insights into the ecological and social processes of change induced by variations in weather patterns at the local level tend to focus on 'communities' or use the term 'people'. However, social science shows that these entities are not homogeneous but that they show a considerable degree of heterogeneity. Within a 'community' there are multiple identities with combinations of age, class, ethnicity, race, religion, gender etc. which are linked to their assets. These assets play a role in the way individuals are able to respond to the changes in weather patterns. For example, migration may not be a strategy for the elderly or very young, those with limited resources, or those facing cultural or religious restrictions on their mobility (Demetriades and Esplen, 2008).

When designing responses to climate change it should be recognised that climate change may not be the priority of poor communities which may have more pressing local level issues. These priorities can be shaped by the way in which rural communities attach meaning to the environment and climatic events, such as droughts. Rural people will interpret from their own worldview, concerns, culture, and accumulated experience of climate events the information they receive about responses to climate change (Roncoli et al. (2003): 197; cited in Nelson and Stathers (2009):90). Understanding these perspectives can lead to more effective interventions.

Spangenberg in his review of sustainability science considers that 'gender mainstreaming in scientific staff and research topics offers significant potential for enhancing the human knowledge base' (Spangenberg, 2011: p282). Gender mainstreaming can be defined as 'the process of project design, implemen-tation, monitoring and evaluation to ensure that women's and men's concerns have been taken into account' (UNDP, 2010: 23).This paper will show as part of that mainstreaming process how gender analysis can be used as an analytical tool to offer insights into how groups of people experience and respond to climate change. Gender analysis provides an understanding of how communities work from perspective of relations between women and men. In so doing it also challenges assumptions about a community by providing a useful entry point into defining the social composition of a community. Gender analysis identifies impacts linked to roles and responsibilities, which vary with the context, as well as providing insights into coping strategies which are linked to the ecological system from which people draw their livelihoods.

The structure of this paper is as follows: Section II describes the methodology use to write the paper; Section III defines the concepts of gender, vulnerability and resilience used for the analysis responses to climate change which is the subject of the paper; Section IV briefly reviews, from a gender perspective, approaches to addressing climate change; Section V analyses using a feminist political ecology framework, biofuels as climate mitigation strategy and how it links to building resilience; and Section VI, closes the paper with Conclusions.

II. METHODOLOGY

This paper uses a desk-based review of academic and grey literature on gender and climate change as experienced in rural areas. In addition it also draws on empirical evidence that the author has been involved in generating linked to biofuels and food security. The analysis uses a feminist political ecology framework.

There are two broad ways of using the concept of "gender". Firstly as an analytical tool which offers insights into situations around two groups of people who would identify themselves as "women" and "men". Women and men have different roles, responsibilities, rights and obligations which define the relationship between women and men in a household: their gender roles. In this case "gender" is seen as "who does/experiences what and why"; where "why" is explained at the level of assets. Women generally have lower levels of assets (eg, land, finance, information, knowledge, skills and social networks) than men. Secondly it can be used as a concept which focuses on the relational position of women and men. Again "gender" is seen as "who does/experiences what and why" but here "why" is explained in terms of power relations. In most societies, men have more power than women to make decisions about, and exercise control over, not only their own bodies, lives and resources, but also that of other family members. The capacity to choose and to act to make that choice become a concrete reality is agency. This balance of power between men and women defines the

relationship between them and can lead to the exclusion of women in decision making. The effects of differences in power operate at all levels in society: household, community, organisational, national and international.

The concept of gender as related to power rejects the notion of the household as a unified entity pooling resources and whose preferences can be expressed in terms of a single utility function. Instead, the household is seen a place of negotiation, in which women and men define their roles and relations (mediated by informal and formal institutions), in a context where there is both conflict and cooperation over labour allocation and the distribution of resources, with important implications for individual outcomes. Conflicts of interests and differences in priorities can exist between female and male members of the same household (Social Development Department, 2005). Therefore, it would be incorrect to assume that when aggregate household income rises, all household members' wellbeing improves equally.

Nevertheless when used as an analytical tool gender does provide an understanding of how communities work from the perspective of relations between women and men. It challenges our assumptions about a community and helps to identify constraints in participation in projects (see Section IV). The first step is to identify impacts linked to roles and responsibilities. For example, in most communities cash crops are men's primary responsibility and subsistence crops for the household food security are women's primary responsibility. It is generally assumed that household fuel provision is a woman's task but if the distance for collection increases then men take over the task (Cooke et al., 2008).

For rural people their daily survival tasks are full of existing problems which they try to overcome with their available assets. These problems are exacerbated by climate change. For example, reliance on rain-fed agriculture always makes households' food security vulnerable to the weather. Limited preservation techniques and lack of food storage facilities also threatens food security. Periods of diminished and/or heavy rain fall predicted to increase due to a changing climate can lead to reduced harvests escalating the threat to food security.

Gender analysis provides insights into coping strategies adopted as short-term responses to the impacts of climate change, such as reducing consumption. These strategies differ between women and men. Cultural practice generally allows men to migrate more easily than women. Men have a better level of and control over assets which gives them more options. Women's vulnerability increases when the natural resource base is threatened by extreme weather events since they use this resource for goods and services to meet household needs and for income generating activities. Women draw on common property resources for meeting household needs because of their limited control over private resources (Rocheleau et al., 1996).

Cultural perceptions of gender roles also play a part in strategies to respond to the hazards, such as floods, linked to a changing climate. We expect men to be proactive but in disasters men's roles and responsibilities can expose them to dangers which can result in their untimely death and leave their wives as head of the household. Widowhood is one of the easiest routes into poverty (Naryan, 1999). On the other hand, more women are victims of flooding than men often due to cultural barriers which prevent women from learning to swim and place restrictions on their movement outside of the home (UNDP, 2010). This creates a new category of households: man-headed households with no adult women about which we have little understanding.

Actors (such as governments, practitioners, development agencies and NGOs) involved in responses to mitigating the potential adverse impacts of climate extremes on individuals and communities have begun to classify groups in terms of their vulnerability and talking increasing their resilience to these impacts (IPCC 2012). There is no universally agreed definition of vulnerability. Some researchers focus on impacts on people and the natural environment related to hazards; some focus on differentiated loss within communities and coping strategies; while others combine the two. The latter approach provides the most holistic insights, which is captured in the definition by Cardona:

> *Vulnerability is an intrinsic predisposition to be affected by or to be susceptible to damage; that means vulnerability represents the system or the community's physical, economic, social or political susceptibility to damage as the result of a hazardous event of natural or anthropogenic origin.*
> (Cardona (2004) cited in Birkmann, 2006: 12).

From this definition it can be concluded that vulnerability is not equated with poverty. Nevertheless, poor people in a particular community are disproportionately affected by disasters and least able to respond to rebuilding their lives after disasters[1]. Who within a community is vulnerable is also shaped by social characteristics such as gender, caste, and ethnicity (Shepherd et al., 2013).

Vulnerability can be considered to exhibit the following characteristics (Vogel and O'Brien (2004) cited in Birkmann (2006): 13):

- *multi-dimensional and differential* (varies across physical space and among and within social groups)
- *scale dependent* (with regard to time, space and units of analysis such as individual, household, region, system)
- *dynamic* (the characteristics and driving forces of vulnerability change over time).

I would posit that gender analysis alone while providing useful insights is not enough to create a holistic understanding of the dynamics in rural areas of vulnerability due to climate change. Both women and men draw on the natural resource base for their products and affect the natural environment (here I will use the term 'ecosystem[2]' to avoid the multiple interpretations given to the word 'environment') both of which are vulnerable to climate change. One of the strengths of Cardona's definition is that it is applicable to both social and ecological systems. However, gender analysis focus on the social while a more holistic understanding of vulnerability requires also an understanding of ecosystems and the services they provide to rural dwellers.

An analysis of the dynamics at play due to climate change can be made using political ecology. Political ecology is the study of

[1] Although there is some evidence to suggest that this many not always be the case: the reverse may be true in some communities. (Béné, Devereux, and Sabates-Wheeler (2012) cited in Béné et al., (2012): 10).

[2] An ecosystem can be defined as a dynamic complex of plant, animal, and microorganism communities and their non-living environment interacting as a functional unit (Millennium Ecosystem Assessment, 2003). The concept of an ecosystem is an approach used in biological and environmental sciences used to provide a better understanding of the nature of life on our planet. Closely linked with the concept of an ecosystem is the concept of biodiversity which relates to the diversity within species and between species. This diversity can be considered a characteristic of a particular ecosystem.

the relationships between political, economic and social factors with environmental issues and changes. The approach also fits well with analysing vulnerability since vulnerability is considered scale dependent. Political ecology uses the concept of 'scale' however, not in a Euclidian sense but in an actor-network theory sense of relational spheres of influence, power and connectivity (Henderson et al., 2002). In other words it as a social construct which leads some researchers to consider that levels of scales are not static but are dynamic and contested through interactions among multiple actors with different –and often competing or conflicting –values and interests ((Brown and Purcell, 2005); (Neumann, 2009) cited in Özerol, 2013: 28). Interactions between multiple actors are not necessarily taking between equals and so the question becomes: whose values and interests dominate? Who has the power to decide?

The issue of power is central to analysis using a political ecology framework with researchers using a concept of power rooted in Foucault:

> "…. *the ability of an actor to control their own interaction with the environment and the interaction of other actors with the environment*" (Bryant and Bailey 1997: 37)

Foucault considers power relationships exist between individuals or groups in which power manifests itself through political, economic, discursive or coercive means to determine the choices, ways of acting and outcomes of the one over whom power is exercised (Foucault, 1983). Since power relations are also at the centre of gender relations a more powerful analysis of the dynamics of vulnerability linked to climate change can be gained by incorporating gender analysis into a political ecology framework. In other words political ecology evolves into feminist political ecology (Rocheleau et al., 1996).

Feminist political ecology aims at analysing gendered experiences of and responses to environmental and political – economic change that brings with it changing livelihoods, ecosystems, property regimes and social relations (Hovorka, 2006). Central to this perspective is an emphasis on uneven access to, distribution and control of resources by gender, as well as other social characteristics such as, caste, class and ethnicity. As a consequence attention can be drawn to local agency and creativity, demonstrating the ways in which women (in particular) are (re)defining their situations, often in light of or in relation to significant constraints (Rocheleau et al., 1996: 289) to which can also be added the changes and challenges brought about by or in response to climate change impacts. So taking a gender perspective underlines the assertion that women are vulnerable not because of natural weakness (i.e., because of their sex/physical bodies), but rather because of the socially and culturally constructed roles ascribed to them as women (i.e., because of their gender) (Tacoli et al., 2014).

Vulnerability is not a desirable state either for people or ecosystems. Understanding vulnerability can be seen as a step towards moving away from this state to one which an ecosystem, an individual, a household and a community are able to survive shocks and significant disturbances, such as floods – there may be a temporary disruption in functioning but after a period of time these functions return. This way of thinking has led to the emergence of the concept of 'resilience':

> '*the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a potentially hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions*' (Lavell et al., 2012).

Resilience is influenced by the degree to which the social system is capable of organising itself to increasing its capacity for learning from past disasters for better future protection and reduce its vulnerability to risks (Yamin et al., 2005). Resilience needs to exist at different scales: individual, household, community, region, and system. These scales are inter-connected.

Responses to climate change include ensuring that people and their communities, well as the ecosystems they depend on, are resilient to the threats the changed weather patterns bring (Tompkins and Adger, 2004). Where resilience needs building first requires an understanding of why people and ecosystems are not resilient. Building resilience also requires individuals to be able to exercise their agency and here again power plays a role in determining who decides and who is able to act according to their preferences (Béné et al., 2012). From a gender perspective, this is usually men.

III. RESULTS

A justification for taking a gender perspective on climate change is that it is considered that the impacts of variations in weather patterns will have a disproportionately greater effect on women than men, since women are often poorer and less educated than men and often excluded from political and household decision-making processes that affect their lives. Climate change is considered to increase inequalities, including those based on gender (Dankelman, 2002).

Most of the research on gendered impacts has focused on sectors that are obviously climate-sensitive (food security and agriculture, forestry, and water) while there is a wide knowledge gap concerning those sectors where the gendered impacts of climate change are less tangible (eg in transport and infrastructure, energy access, housing, and formal and informal employment) (Otzelberger, 2011).

In climate change interventions which have taken gender into account use of the definition of concept which focuses on roles and assets. There can be a tendency for 'gender' to be used synonymously with 'women'. Women are seen as a homogenous group either as 'passive victims' or as 'virtuous' people having a closer relationship with the environment than men. There is a strong critique of this narrow approach which argues that you cannot build climate resilience unless you transform gender relations and reduce inequalities (Tacoli et al., 2014) in other words women's agency needs to be built.

Nevertheless, in interventions aimed at reducing vulnerability and building resilience within households there are arguments for focusing on women. Women and men often have different priorities that translate into different patterns of household expenditures and investments. For instance, resources controlled by women tend to be invested more heavily in children (at the margin) than resources controlled by men (World Bank, 2001: 70). There is a large body of evidence to show that "the greater the degree of control exercised by women over the family income, the greater the proportion of income spent on food" (Rahman Osmani, 2010). Enabling women to generate income has implications for the family's well-being (by which here is meant their physical and mental state). Women's power to influence resource allocation and investment decisions within the home is limited which in turn reduces their capacity to generate income - whether in self-employed activities or in wage employment. In other words, gender power relations determine women's vulnerability and resilience.

Approaches to addressing the impacts of climate change fall

into two areas: adaptation and mitigation. There are arguments that at least at the micro-level these approaches are linked and re-enforcing. For example, women and men involved in renewable energy projects can increase their income which allows them to adopt adaptation measures and hence builds their resistance to a changing climate (Bäthge, 2010). The remainder of this section gives a brief overview, from a gender perspective, of adaptation and mitigation approaches to climate change.

A. Adaptation to Climate Change

Adaptation to climate change can be defined as the capacity of human and natural systems to adapt to and cope with changes that occur in response to climatic stimuli, such as changes in rain fall patterns. The capacity of people to act depends on factors such as wealth, technology, education, information, skills, infrastructure, access to resources, and management capabilities (IPCC, 2001). Women are generally disadvantaged in terms of their assets compared to men from the same socio-economic group. Therefore we can assume that capacity to respond to climate change will be gendered. There is a danger that adaptation projects at the community level can inadvertently exclusively address men's concerns. This has been the experience with the UNDP-GEF Community Based Adaptation Programme unless gender is mainstreamed at the beginning of the project cycle (UNDP, 2010).

The impacts of climate change are predicted to affect communities across a number of dimensions including: health, agriculture, water, and non-farm employment. It is also predicted that there will be an increased number of natural disasters, such as floods. Households will respond to events by adopting coping strategies which are gendered. This means that interventions to support households must also be gender responsive to these coping strategies. The remainder of this section will briefly review the four dimensions of rural life referred to at the start of this paragraph plus climate-related disasters in terms of impacts and coping strategies.

Health: Some of the predicted health effects include: increase in water borne diseases are expected, potentially higher rates of malnutrition due to food shortages, and increases in heat-related mortality and morbidity (Brody et al., 2008). Energy access can help with water purification, increasing food yields and providing better processing and storage, and cooling to reduce heat stress. Women's time poverty can increase with increased levels of sickness in their households. Fuel wood collection may become increasingly more difficult if there is damage to biomass sources due to changes in rain fall patterns and temperatures. This can increase the time women take in collecting fuelwood and worsen their time poverty. Increasing energy availability, including fuelwood supply or higher efficiency stoves, would be appropriate interventions.

Food Security: Rural women and men play complementary roles in guaranteeing food security (FAO 2003). Women often grow vegetable gardens for the households own consumption and for local markets, as well as being responsible for raising small livestock. Men are generally responsible for cash cropping and larger livestock. Extreme weather events linked to climate can lead to crop failure and animals dying. Energy interventions can include water pumping for irrigation and animal drinking supplies. Mechanisation of grain milling and electricity for refrigeration can help improve food quality and contribute to storage of food. These types of interventions can increase a family's food security as well as potentially generating a surplus to sell which increases household income and reduces vulnerability.

Water: The supply of water for household use is generally the responsibility of women and girls. If decreased rainfall results in rural women and girls having to walk further to fetch water increases their time poverty as well as increasing the chances of their exposure to violence and sexual harassment. In urban areas interruptions in water supplies can result in women queuing for long hours. Improvements in water supply infrastructure which includes a reliable energy supply can reduce the problems women face.

Non-Farm Employment: Since rural women's livelihoods are drawn primarily from natural resources their cash income is also affected reducing the option to reduce their vulnerability for example to purchase of fuels to substitute for collected fuelwood. In urban areas the informal sector is place of refuge in times of crisis (Heltberg et al., 2012), and it is not unreasonable to assume that this would also be a coping strategy in response to climate impacts. Therefore, this sector could be expected to expand in response to climate change events, for example, if rural victims of drought or flooding move to urban areas. Enterprises based around food processing or selling prepared food are popular options, particularly for women, since they can be carried out using household equipment thus requiring little or no investment to start-up.

Climate-related disasters: Climate-related disasters such as prolonged droughts and floods can lead to destruction of livelihoods. As a coping strategy men are able to migrate to urban areas and they generally have a better level of assets than women to find new income sources. Women are either displaced to live in refugee camps or they stay put, the consequence of both options is often increased vulnerability. When men migrate to cities women are left with increased tasks. Degradation of natural resources by droughts and floods can result in women spending more time searching for clean water and fuel which could be useful entry points for energy interventions to support vulnerable people. Women may not be able to participate in initiatives to revitalise communities since their duties to re-building the family home have to take priority (Demetriades and Esplen, 2008).

For displaced women living in camps the provision of energy carriers is often a forgotten commodity, unlike water and shelter, for relief agencies to provide. Women are forced to search in unfamiliar surroundings for fuel wood where they can be subject to sexual harassment (Kasirye et al., 2009). When men and boys in their household respond by stepping-in and collecting fuelwood they in turn can also be subject to physical assaults.

B. Climate Change Mitigation

Mitigation of climate change impacts refers to human interventions to reduce the sources or enhance the 'sinks' of greenhouse gases. Mitigation interventions encompass a range of different approaches which can be grouped into three categories (i) using fossil fuels more efficiently for transport, industrial processes or electricity generation as well as improving the insulation of buildings; (ii) switching to renewable sources of energy; and (iii) using forests and other sinks to remove greater amounts of carbon dioxide from the atmosphere. Mitigation initiatives fall under the umbrella known as 'low carbon development'. These initiatives have tended to be market- or technology-based, the latter focusing on large-scale systems. While policy makers consider these initiatives gender-neutral in their implementation and beneficiaries, women can be considered disadvantaged because their assets, knowledge and skills to participate are generally less than those of men.

There is not an extensive literature on the technical aspects of climate change mitigation and gender. Most of the existing literature relates to access to climate finance and women's voice in climate negotiations. However, three mitigation issues linked to

women's involvement are beginning to receive more attention: biofuels, black carbon from soot and carbon sequestration in forests. This section briefly reviews the second and third of these issues while biofuels is discussed in the next section.

Black carbon has been identified as a possible significant contributor to climate change, with estimates suggesting that this source can contribute as much as 18 per cent of warming (Global Humanitarian Forum, 2009). Wood stoves have been identified as a major source of black carbon. However, there is scientific uncertainty about whether black carbon emissions from the use of biomass in cookstoves has a net warming effect on the global climate (Ramanathan and Carmichael (2008) cited in Adams (2011):14). Therefore, care needs to be taken in the formulation of interventions so as not to 'demonise' women as creators of climate change. There is a very clear knowledge gap in our "understanding and quantification of the net climate impact of cookstove emissions" (Global Alliance for Clean Cookstoves, 2011: 44). There also needs to be a nuancing of statements related to the impact of emissions from cookstoves and the link with climate impacts since the level and type of emissions vary greatly between cookstove types (Adams, 2011). The perspective for addressing black carbon in relation to stoves has focused on the improvement in women's health and time saving that reducing this and other forms of indoor pollution can bring within any reduction in impacts on global warming being seen as secondary benefit. Nevertheless stoves are a gender issue: men make the decisions about the acquisition of new household equipment including for the kitchen (Clancy et al., 2012). Also when taking a gender approach to analysis rather than looking at women in isolation has shown that since families often spend some time in the kitchen men can also negatively affected by smoke in the kitchen when they have pulmonary diseases (World Bank, 2012).

The gender aspects of carbon sequestration in forests are linked to women's perceived role as caring for natural forests due to their drawing significantly on these sources for supplying much needed household goods and services, such as fuelwood and medicines (Bäthge, 2010). Under the Kyoto Protocol, Reducing Emissions from Deforestation and Forest Degradation (REDD+)[3] has been developed as a financing mechanism to encourage a two pronged approach to reducing atmospheric carbon: addressing deforestation and encourage tree planting. For women when addressing deforestation involves payment for forest protection they run the risk of exclusion not only from the payments but also physical exclusion from forests.

Tree planting by women can also be problematical from a cultural perspective and from a practical perspective. In some cultures, women do not plant trees. In Kakamega area of Kenya despite there being a fuelwood shortage, women would not plant trees since they did not own the land, their husbands did. Under traditional law, this also gave men the ownership rights over the trees (Bradley, 1991). It should not be assumed that women have time to participate in such activities as tree planting. In northern Thailand, while it appeared that both the women and men in a community supported the idea of planting trees for fuelwood, the saplings were never planted. The reasons were that women were busy planting food crops at the time the saplings should have been planted. The men did not see this as their tasks since the trees would benefit women (Wilde and Vainio-Mattila, 1995).

IV. DISCUSSION

Biofuels are promoted as a mitigation measure for reducing carbon dioxide emissions through two routes: (i) displacement of fossil fuels and (ii) growing feedstocks absorbs carbon dioxide (CO2). There is a considerable debate as to whether or not the latter does reduce atmospheric carbon. Reduction estimates vary according to the type of feedstock, cultivation methods, conversion technologies, energy efficiency assumptions and disparities regarding reductions associated with co-products (Doornbosch and Steenblik, 2007).

There have been other criticisms about biofuel programmes ranging from ecological threats (see for example Stromberg et al., 2010) to human rights abuses (see for example Marin-Burgos, 2014). From a gender perspective the literature voices particular concerns about women being disadvantaged by biofuels in their communities. These issues include loss of ecosystem services, which women rely on for their household goods and services such as food, fuel, building materials, and medicines, due to 'waste' land being used to grow biofuels (Kartha and Larson 2000) (see below). In northern India, it is estimated that nearly half of the income of poor women depends on resources from common land compared to only one eighth of poor men's incomes (Reddy et al., 1997). The poorer the household, the higher the contribution common land makes to meeting household needs ((Gundimeda, 2005) quoted in (Rossi and Lambrou, 2008): 6). Women's rights can be overridden, for example, where the male head of household signs deals with contractors for growing biofuel crops on the land traditionally farmed by women for subsistence crops to feed their families (Vermeulen and Cotula, 2010). Growing sufficient quantities of nutritious food plays an important part of ensuring households are not vulnerable to the impacts of climate change. Poor nutrition is a significant factor in ill-health which is considered to be the most overwhelming reason why households move into poverty (CPRC, 2008).

There is rather limited independent empirical evidence about gender issues specifically related to biofuels. The available literature tends to draw on the experiences of women and men in general agricultural production and by extension drawing conclusions about the likely effects of biofuel production (Clancy, 2012). Concerns are expressed that women are excluded from decision making about whether to grow biofuel crops and how they should be produced, as well as not having sufficient level of assets (e.g. land, knowledge, skills, and finance) to participate in biofuels production (Rossi and Lambrou, 2008). Participation in biofuels production does allow for income generation which is part of assets building to increase resilience. Unequal participation contributes to perpetuating or exacerbating inequalities in levels of resilience.

Of the empirical evidence that is available, there are gender differences in willingness to participate in biofuel projects and hence how benefits accrue (Clancy, 2012). The distribution of intra-household income is important if women are responsible for household food security. The evidence shows that where specific measures are made to include women, such as reserved tasks as found in the Indian Biofuels Programme (Government of India, 2009), women are able to participate not only in production but also in governance structures. In a focus group interview in Hassan (Karnataka, India), women indicated that they would use their extra income from bio-fuel crops for buying food (Narayanaswamy, 2009).

Nevertheless, women appear to be prepared to participate on more adverse terms of incorporation than men. Men do not participate when they consider the rates of remuneration are too low. For example, women are participating in jatropha cultivation in Zimbabwe while men are opting out. The women value the

[3] REDD+ has evolved from REDD. The latter placed a monetary value on forests based on their ability to store carbon to which has now been added the storage or removal of carbon from the atmosphere by conserving forests or planting new ones (Aboud, 2011).

access to the oil and by-products whereas the men consider growing maize likely to yield a higher return than jatropha (Karlsson and Banda, 2009). There are examples of women improving their skills levels and hence income and status within the family. In Ghana, a biofuel project ensured that women also were able to access the better remunerated jobs such as tractor drivers by offering them training As a result these women have become the main income earner for their family, with a monthly income of 150 cedi (approximately €77) (Baxter, 2010). For men, the motivation for participation is influenced by the levels of income to be earned and opportunities for access to new knowledge and skills as well as credit. These opportunities would ordinarily be difficult for smallholders. For women who have more restricted options for income generation compared to men, participation in biofuels production presents an opportunity to earn cash income close to home that makes inclusion, even on adverse terms, attractive. Women also value other benefits, such as access to the by-products from the crops.

If a portion of biofuels can be retained in rural areas they can also support the improvement in food security by providing the energy to improving crop processing and storage (which also helps with resilience to variations in weather patterns). Increased supply of clean energy can make a contribution to ending women's time poverty and reducing drudgery which does create an opportunity for women to engage in income generating activities and in so doing potentially reduce household vulnerability (Clancy et al., 2012).

While household food security can be benefit from participation in biofuel programmes by farmers benefiting from increased yields due to improvements in farming practice, there are threats to household food security when land designated as 'waste' or 'not in productive use' is allocated for biofuel crops. This is not the classification given to this land by rural people. Instead it provides an important source of food and other goods and services for the vulnerable and at times of vulnerability for a larger portion of the rural population. This land also has its own ecosystem which has evolved its own level of resilience. Changing the biodiversity composition of that ecosystem to one of less diversity has a knock-on effect which influences the availability and quality of a whole range of goods and services. Ecosystems are particularly vulnerable to biofuel crops grown as mono-crops under large plantation schemes. Women recognise this threat and resist the use of this land (Hospes and Clancy, 2011).

V. CONCLUSIONS

The paper has used feminist political ecology approach to analyse vulnerability and resilience to climate change taking biofuels as an example of a mitigation intervention. The value of such an approach is that it links the policies at the national level with processes and outcomes at the local level. It also focuses on power relations between women and men which influence agency to choose and act upon particularly strategies to reduce vulnerability and build resilience to the impacts of weather related events such as droughts and flooding. These events are predicted to increase and become more extreme with climate change.

Much of the literature examining the social impacts of climate change adopts the position that women are more vulnerable than men which calls for policy interventions to focus on women. However, a gender analysis can show that policy measures cannot treat one sex in isolation from the other, in some circumstances cultural norms can make men more vulnerable than women. On the other hand, women are often portrayed as 'victims' of climate change which ignores their agency to be part of the solution of building resilience. However, as gender analysis shows this can be mediated by gender power relations which exist at all levels.

As the paper shows interventions tend to focus on adaptation rather than mitigation. For women this focus results in interventions related to their household tasks and does little to change the power relations at least at the level of the household (Terry, 2009). Mitigation options, such as running energy service companies to install biogas systems or supply offer opportunities for income generation. However, for many women there are a number of barriers to be overcome to respond to these opportunities and mitigation interventions need to identify these and provide solutions to overcome them.

Gender analysis can also help identify constraints in participation in projects. For women, time poverty can be particularly problematic. As part of daily life women already long hours which can be made even longer as a result of natural disasters which have negative impacts on the natural resource base requiring longer searches for fuel and water.

Attention has been given to ensuring women's as well as men's needs are taken into account. In terms of women's participation in policy development and implementation, this seems to be reduced to a numbers game (eg percentage of women participating or as beneficiaries), rather than ensuring that women have the appropriate knowledge and skills to participate (Otzelberger, 2011) and that men are sensitised to support their participation (Clancy et al., 2012).

A significant contribution of this paper is that has provided evidence to support Spangenberg assertion in his review of sustainability science considers that 'gender mainstreaming in scientific staff and research topics offers significant potential for enhancing the human knowledge base' (Spangenberg 2011). When combined with political ecology, gender analysis can provide a comprehensive understanding of the complex structures and causes of present vulnerability and when linked to climate change, how vulnerability and the likely responses of women and men may evolve within a particular eco-system (natural and agricultural).

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