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Climate Change and Population

A REVIEW OF THE LITERATURE

Population Action
INTERNATIONAL
HEALTHY FAMILIES HEALTHY PLANET

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Executive Summary

There is a sizeable body of literature that explores the connections between population and climate change and family planning as a link between the two. Overall, family planning has been proposed as both a means of preventing further climate change by slowing population growth, and thereby reducing consumption, and as a tool to equip vulnerable individuals, households, communities, and countries to better manage the challenges of a warming world. This review summarizes the academic literature, conference papers, and UN reports from the last decade, exploring the background of these two perspectives, with an emphasis on family planning as a strategy of climate change adaptation, particularly for women.

In the first section, the backgrounds of climate change mitigation and adaptation, in relation to population and family planning, are described. Effective climate change adaptation is especially critical for vulnerable groups, such as women, who suffer disproportionately from the negative impacts of weather fluctuations. Following this, climate change vulnerability is deconstructed as a function of socioeconomic conditions and gender roles to elucidate which conditions and background characteristics need to be addressed to enhance adaptability and resilience. Various adaptation strategies are explored in the context of, and compared to, family planning as a strategy. And lastly, the review investigates how family planning can empower women to overcome the obstacles that hinder their adaptability and resilience.

In addition to reviewing the state of the literature on population and climate change, this review illustrates the multi-faceted benefits of family planning and the mechanisms through which improved reproductive health works to better individual, household, and national-level well-being, all of which, in turn, are linked to higher adaptive capacity to climate change.

Introduction

The relationship between population dynamics, particularly fertility, and climate change have been investigated from a variety of angles. The two most often examined perspectives are: 1) How do population dynamics mitigate or exacerbate climate change; and 2) How do population and fertility affect climate change adaptation, which is defined by the UN Framework Convention on Climate Change (UNFCC) as adjustments made in response to "actual or expected climatic stimuli… which moderates harm or exploits beneficial opportunities." In general, population most often is examined from the mitigation perspective for its potential to slow down climate change. Specifically, many studies examine how more moderate population growth potentially may decrease greenhouse gas (GHG) emissions and, conversely, how unchecked population growth can intensify climate change and environmental degradation. This body of literature emphasizes that family planning provision, in addition to being a basic human right, would also have the added benefit of decreasing population growth and reducing the magnitude of climate change. The process of mitigating climate change through slowing population growth often is examined as a cost benefit analysis: namely, how cost effective are family planning investments as a strategy for averting carbon emissions? Although this approach sheds some insight into how population growth and climate change may be linked, there also are shortcomings to viewing climate change mitigation as a strictly linear function of population, considering the many other demographic and economic implications of changes in fertility and population structure.

In contrast to climate change mitigation through family planning and slowed population growth, a second, emerging component of population, as related to climate change, is the framing of family planning as a strategy for increasing national, community-level, and individual adaptive capacity and resilience. While adaptation refers to the adjustments made in response to climate shocks, resilience is "the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to, and recover… in a timely and efficient manner." (UNISDR). It is crucial to understand the determinants of climate change resilience to empower developing countries and their most vulnerable citizens, often women and children, with the means to cope with climate change-related events. As stated in the declaration from the 1992 UN Conference on Environment and Development (the "Rio Declaration"), it is important to balance developing countries' development needs with environmental protection to protect the human right to a healthy and productive life. Developing countries also require special consideration because they shoulder a disproportionate burden of climate change impacts but historically have contributed the least to carbon emissions (Stephenson et al. 2010).

Several studies have investigated how rights-based, voluntary family planning can be harnessed as a tool for improving national level and individual level "assets, capacity, flexibility, and mobility" (Engelman 2009), thereby improving resilience and adaptive capacity, especially among women. Additional strategies for increasing climate change resilience are mentioned in the literature, such as education, social networking, and community participation, and also can be tied back to family planning, which can be seen as an overarching means of empowering women and communities, creating an environment where these other strategies can become a reality. Although this approach to population, family planning, and climate change is investigated less frequently in the literature, a growing body of work, such as that conducted by Futures Group, Population Action International, the African Institute for Development Policy (AFIDEP) and the Environment and Development Society of Ethiopia (LEM Ethiopia), has examined how family planning can empower women and communities, reshaping their climate change adaptation and improving resilience.

Climate Change Mitigation

Background

In several papers focusing on climate change mitigation (Wheeler and Hammer 2010, Skeer 2002, Wire 2009) the cost effectiveness of family planning (FP) is framed in comparison to other traditional technological strategies. In their 2010 study, Wheeler and Hammer estimate the cost of carbon emission aversion through family planning and find this strategy more cost effective than technical solutions, such as carbon efficiency, low carbon energy, and forestry/agriculture, at $4.50/ton of averted carbon emissions for FP spending. At the country level, 40 out of 88 developing countries have FP costs below the forestry/agriculture strategy (set at $5/ton of averted carbon) and 70 have costs below the strategy of low carbon energy (set at $20/ton of averted carbon). These results were calculated from methods that deliberately biased the cost of FP and abatement costs (cost of carbon avoided) upward to obtain a conservative estimate.

Another paper published by the London School of Economics (Wire 2009) has similar findings regarding the mitigation potential of FP. In this study, Wire calculates that if the unmet need for FP estimated by the UNFPA was met, the reduction in person years lived would reduce emissions by 34 gigatonnes.

Moreover, given the cost of FP reported by UNFPA and UNSD reported carbon emissions per capita, FP is more cost effective than most technology-related strategies, including wind power, solar power, hybrid vehicles, at $7/tonne of CO_2 averted, versus $13-$131/tonne of CO_2 (Wire 2009).

Taking into account limitations of scale, Wire concludes that a 34 Gt reduction of CO_2 would cost over $1 trillion with low carbon technologies, compared to $220 billion with basic FP.

Lastly, Skeer's work asserts that extending voluntary FP, as outlined at the 1994 International Conference on Population and Development in Cairo, would avert 10 billion tonnes of GHG by 2050. The program of action composed during the Cairo conference emphasized the necessity of providing comprehensive reproductive health care to women as a human right and to enhance individual health and well-being. By Skeer's calculation, investing in FP as prescribed by Cairo is equivalent to mitigating carbon emissions at the cost of $10.5/ averted tonne, much more cost effective than low-carbon technology methods. Both Skeer and Wire emphasize that declines in fertility can be effected through voluntary means, as evidenced by the more than 200 million women with unmet need worldwide who desire FP and are not currently using it.

Limitations

Although FP is a cost-effective mitigation strategy, there are several shortcomings to viewing population and climate change within an exclusively linear framework, as the nuanced, non-linear relationships between other population processes and climate change are not accounted for. For example, Skeer acknowledges that one limitation in his methodology is that the unplanned births averted with increased prevalence of family planning may occur among lower income communities, which are responsible for lower per capita emissions than the average individual. Thus, assigning the average per capita emissions to these averted births may overstate the impact of each averted birth. A reduction in the population also may lead to less resource stress and increase the overall consumption of the remaining population. Conversely, as countries improve economically, their future consumption per capita may increase, and using current estimations of GHG averted per birth may understate the impact of reducing population. Deforestation is also both a stressor of climate change and a ramification of population growth and Skeer's calculations do not account for the fact that population growth increases overall GHG emissions and simultaneously chips away at the carbon sink provided by forests. In these ways, Skeer acknowledges that a simple multiplicative model for estimating carbon emissions reduction as a function of population has limitations.

Furthermore, in addition to increases in the magnitude of the population, the changes in age-sex composition associated with rapid population growth, as well as population processes such as urbanization and migration, and subsequent changes in household size or consumption patterns, also may serve to worsen carbon emissions and climate change. O'Neill et al. argue that slowing population growth could lead to 16-29% of the reduction in emissions necessary to achieve by 2050 to prevent catastrophic climate change (O'Neill 2010). However, models making such calculations need to account for the relationships between population, economics and technology. Using survey data from 34 countries, O'Neill et al. calibrate the Population Environment Technology (PET) model with parameters such as demand, labor supply, and wealth, and project population growth in several scenarios. The PET model accounts for indirect relationships between age structure and labor supply, population growth and economic growth, urbanization and labor productivity, changing

household sizes, and spending behavior as functions of age structure. For example, population aging results from decreased fertility and slower population growth and can reduce emissions by up to 20% in industrialized countries through lowered labor productivity, an older labor force, and slower economic growth (O'Neill et al. 2010). Rapid population growth can also perpetuate urbanization in less developed areas and possibly lead to a 25% increase in emissions beyond the projected increase due solely to a larger population for similar reasons, such as increased labor productivity and slower economic growth (O'Neill et al. 2010). As countries become more developed however, urban dwellers tend to emit less carbon per capita than non-urban dwellers (O'Neill et al. 2010).

Although mitigation of climate change through slower population growth has been touted as a cost effective strategy, there is skepticism among donors and government planners about its effectiveness in the short term, which is preventing FP from becoming a serious climate change funding priority (Alber 2009, Mutunga and Hardee 2009, Bryant 2009). Changes in fertility trends take time to realize and climate change responses tend to favor "urgent action, single sector moves" (Mutunga and Hardee 2009), instead of longer term measures that address deeper societal issues. The role of developing countries in mitigating climate change is also questioned in light of the fact that developing countries' consumption of natural resources and GHG emissions have been negligible compared to those of the industrialized world (Mutunga and Hardee 2009, Moreland and Smith 2012, Stephenson et al. 2010). Per capita consumption in the developing world continues to be many orders of magnitude lower than the pattern of consumption in high income nations (Klingholz and Topfer 2012). Moreover, in the 1992 Rio Declaration, as well as in the UN Millennium Declaration, the right to develop is expressed as a right of all humans, countries, and generations. Thus, not only have developing countries emitted less carbon than developed countries, but they also have the right to *increase* their energy consumption to fight poverty and improve the well-being of their citizens.

Furthermore, while considering development and climate change, Guillebaud asserts that it is crucial to consider all the determinants of environmental impact when formulating strategies to combat climate change, including: 1) efficiency of technology; 2) affluence/effluence per capita; and 3) population (Guillebaud 2008). Guillebaud further explains that minimizing population growth through voluntary, rights-based ethical means is imperative, since energy consumption is necessary to alleviate poverty in lower income communities and countries. In some situations, such as for least developed countries, decreasing energy consumption and per capita affluence/effluence would actually lead to undesirable outcomes. Thus, where energy consumption cannot be compromised, another factor in the balance, such as population, can be addressed instead.

The right to develop sustainably is echoed in Rybski et al.'s 2011 study that investigates development and CO_2 emissions as described by a "positive, time dependent correlation between the Human Development Index (HDI) and per capita CO_2 emissions from fossil fuel combustion" (Rybski et al. 2011). With this concept, the authors predict that the cumulative CO_2 emissions necessary for the development of 104 developing countries represents only 20-30% of previously calculated CO_2 budgets, which would help to limit global warming to <2°C. Thus, Rybski et al. stress that keeping emissions below the desired target in less developed countries will not interfere with their development, considering the emissions necessary to achieve a desirable HDI (above 0.8). Moreover, Rybski et al. reiterate that while developing countries should participate in climate change response through voluntary family planning, they will still be able to develop appropriately in order to reduce poverty and improve human well-being.

Climate Change Adaptation

In contrast to climate change mitigation, a growing body of literature proposes that in the face of the inevitable challenges of climate change from previous GHG emissions and environmental degradation, there are strategies that can equip individuals, households, and communities to be adaptive and resilient in the face of these challenges. This section of the paper will examine the existing landscape of climate change adaptation literature, focusing on how family planning fits in as a crucial tool to facilitate empowerment and improved climate change resilience.

It is important to consider how gender impacts climate change vulnerability to fully appreciate the background behind many of the strategies proposed in the literature. Vulnerability to climate change is characterized as "characteristics of a community…that make it susceptible to the damaging effects of a hazard" (UNISDR). For example, many studies assert that women are more vulnerable to climate change for social, economic, labor, and health-related reasons (Alber 2009, Callister 2008, Crossette 2011), and improving women's resilience to climate change will require first addressing the inequities and gender-related conditions that caused the vulnerability in the first place. These vulnerabilities thus provide the context for developing strategies to increase adaptive capacity. In particular, several papers examine where women, with their gender-related barriers to adaptation, fit in with these strategies and what women's roles can be in increasing adaptive capacity, both for themselves and for their communities. Family planning is one such strategy to improve resilience and also can help women to engage in other strategies, such as education and community participation, allowing them to realize influential leadership roles in climate change adaptation and become a bigger part of climate change response.

Gender and Climate Change Vulnerability

With regards to women and climate change vulnerability, studies consistently find that women face particular challenges and suffer disproportionately due to their social and economic roles (Alber 2009, Juran 2012), their lack of access to information (Page and Larsen 2010), and their experiences in climate change-related disaster aftermath (Leni 2008).

Gender- related vulnerability is summarized comprehensively in a 2009 UNFPA paper by Alber, who focuses on women's disproportionate vulnerability to climate change and argues that environmental and climate-related decision making needs to include a gender lens. Alber explains that the stress of climate shocks force tradeoffs upon people that "reinforce and perpetuate wider inequalities based on income, gender, and other disparities" (Alber 2009). In this way, systemic cultural patterns and social roles put women at increased vulnerability to the impact of climate change. An investigation of women in post-tsunami Tamil Nadu, India, reinforces Alber's argument that climate change impacts rarely manifest equally across a population, but instead can be related to social constructs, such as religion, caste, socioeconomic status, and gender (Juran 2012). Since women are faced with pre-existing inequalities during normal times, these inequalities are magnified in times of disaster (Juran 2012). And because women are not adequately represented at the policy, decision making, and leadership levels, disaster-related information and warnings often are broadcast in public spaces less frequented by women, hindering women's access to climate change information (Page and Larsen 2010).

Women experience higher fatality rates during disasters, especially during floods and heat waves, causing a disproportionate depressive effect on female life expectancy (Alber 2009). Disproportionate mortality was a major inequality of the 2004 Asian tsunami, in which between 50-80% more men survived than women (Callister 2008, Leni 2008). Callister reasons that women were more vulnerable during the tsunami because they were bound by social roles and behavioral expectations. For example, when evacuating, women were expected to carry children and tasked with protecting the elderly, sometimes at the expense of their own safety. They were also bound by social expectations, such as wearing long, flowing clothing that impeded swimming or the ability to climb trees. Callister also explains that women are more likely to face poverty, a major determinant of vulnerability to extreme weather.

In addition to social and behavioral constraints, economic status is further explored as a predictor and determinant of vulnerability. Firstly, women spend much more time doing unpaid work than men, at an average of 36 hours a week versus 3.5 done by men in rural India (Alber 2009). Much of this time is centered around gathering natural resources, such as fuel and water, which will become increasingly scarce with climate change, expanding women's time spent on unpaid work to the detriment of tasks that could increase autonomy or agency, such as paid work and education. Moreover, Alber argues that the lack of access to economic opportunities and fiscal instrumentals, such as markets, credit, land ownership, stocks, bonds, and savings, all serve to exacerbate women's economic vulnerabilities, both in the face and aftermath of climate-related disasters and events. In the 2011 report on the *State of the World Population*, Crossette affirms that women, poor people, and marginalized populations are particularly at risk for climate change adverse outcomes. Women are at greater risk due not only to their gender, but also because they are more likely to belong to other vulnerable groups, such as marginalized populations and poor communities (Crossette 2011). Women are more likely to experience greater poverty, enjoy less economic productivity, and generally are in charge of food production and agriculture, which suffers greatly from climate change-related extreme weather (Crossette 2011). Their lack of access to capital and lower incomes also provide little or no access to the safety nets and services necessary when adapting to changing situations. Furthermore, women also are generally less mobile, which makes relocation during emergencies difficult, especially since women are tasked with managing the domestic domain (Crossette 2011). In rural areas with shrinking economic opportunities, men may move to cities, leaving women to stay behind in areas prone to flooding, environmental degradation, and desertification (Crossette 2011, Engleman 2009).

Women also face disproportionate burdens and morbidities in the aftermath of disasters and climate change-related events (Leni 2008, Callister 2008). A study of qualitative data from disaster survivors and NGO workers demonstrates a "systematic pattern of violations of women's human rights" in post-disaster situations in India, Sri Lanka, and Indonesia (Leni 2008). Analyzing these findings, Leni finds that women's reproductive health needs and sanitation requirements were overlooked; pregnant women were not provided health care, resulting in miscarriage and premature birth; post-partum and breastfeeding mothers were not accommodated; and

women were often given one adult portion of food and supplies to share among their children. Additionally, women were not involved in supply procurement or allocation, so basic hygiene supplies were inaccessible or in short supply. These results are consistent with the conclusions of several other studies (Alber 2009, Callister 2008, Juran 2012) regarding women's gendered disadvantage in the aftermath of crises due to lack of access to reproductive health care and vulnerability to sexual violence and harassment in shelter/refugee settings. Furthermore, women often were not recognized as the head of the household and had difficulty providing documentation to secure access to food, health care, and social services in the aftermath of disaster (Callister 2008), and inheritance to land, even if their families had died (Leni 2008). Thus, although women make up a larger proportion of disaster victims, they have less of a voice in disaster risk reduction and designing post-disaster infrastructure and decision making, leading to overlooked health issues, unsafe conditions, and human rights violations in disaster aftermath.

Combating Vulnerability:
Women and Adaptation Strategies

Although the marked hardships of women in climate change-related situations are well established, there are many different proposed strategies for addressing these vulnerabilities at the individual, household, and community levels, including reproductive health, education, environmental stewardship, eradication of poverty, and social networking. Because women and their primary charges, children and the elderly, are among the most vulnerable to climate change, improving their resilience goes far in improving how communities and populations fare during climate change overall.

Many of the proposed strategies in the literature also center on the prevailing notion that women must play a bigger role in climate change response and adaptation and seek to understand how women can shape and fit into climate change solutions.

Several papers identify female education as a predictor of climate-related disaster preparedness and find that a better educated population is better equipped to face the challenges of climate-related crises. In one study, education is found to be a significant predictor of HDI, which is negatively linked to disaster-related mortality (Lutz and Striessnig 2011). In this study, the authors use three models to show that HDI and climate change disaster death counts are negatively related and that education is the sole consistently significant predictor of HDI (Lutz and Striessnig 2011). By extension of these two findings, the proportion of educated women can be used as a proxy for education to predict a relationship with disaster-related death counts (Lutz and Striessnig 2011). Another investigation by the Berlin Institute for Population and Development also concludes that education can help to push least developed countries out of poverty, equipping them to develop and adapt to climate- related challenges, such as food crises or distribution conflicts, in an environmentally sustainable way (Klingholz and Topfer 2012). Similarly, Stephenson et al. stress the importance of female education in improving developing country resilience, as well as developing a skilled labor force in countries with young age structures to utilize the power of the demographic dividend (Stephenson et al. 2010) and foster development. Furthermore, a separate study at the household level of low income communities in South America by Wamsler et al. found that formal education is a significant predictor of the adaptive capacity of people and a particularly strong predictor for women (Wamsler et al. 2012).

While progress in female education is indicated as a possible strategy to improve adaptive capacity, at the same time it is consistently noted that women must play a more active role in climate change response and capacity building, especially since they shoulder a disproportionate burden during climate shocks and often are excluded from leadership roles (Glazebrook 2011, Figueirdo et al. 2012, Engelman 2010). For instance, a study of the effect of extreme weather on female subsistence farmers in Ghana demonstrated that women have a wealth of local agricultural knowledge, which is instrumental for informing climate change responses (Glazebrook 2011), but were absent at the decision making level. On a community level, Figueirdo et al.'s work in Kenya, Mozambique and South Africa found that women possess knowledge of social technologies necessary for adapting to water stress but were unable to effectively participate in water management governance bodies due to their limited social roles (Figueirdo et al. 2012). Because women represent a larger proportion of farmers in the developing world and manage a "broad range of consumption and production decisions" (Engelman 2010) that impact GHG emissions, they have the knowledge and interest to act as environmental stewards in their communities by practicing farming and forestry that reduces atmospheric carbon (Carvajal-Escobar et al. 2008, Engelman 2010, Glazebrook 2011, Dankelman 2002). Women also are especially effective players in community organizing (Carvajal-Escobar et al. 2008) and have a history of environmental activism in the developing world (Dankelman 2002). It also is suggested that women generally manage risk more conservatively (Alber 2009, Engelman 2010) and are more amenable to making adaptive lifestyle changes (Alber 2009).

Besides women's strategic position as community and environmental leaders, and their wealth of local environmental knowledge, women also are better able to identify and address the specific hardships of post-disaster situations.

For example, Leni found that basic sanitary supplies and requirements were lacking in South Asian and Southeast Asian refugee camps because women were not involved in supply procurement and allocation (Leni 2008). Callister's analysis of South and Southeast Asian survivors of the 2004 tsunami found that women in post- disaster situations were able to mobilize to form groups and address community needs with innovative solutions (Callister 2008).

Although improving the education of women, harnessing women's environmental knowledge, and tapping into women's leadership potential may increase the climate change resilience of individuals and communities, it is necessary to overcome the economic, social, and institutional barriers that have prevented women from realizing their full adaptive capacity.

By addressing equity on many different levels, improved FP and reproductive health provision can help to overcome the lack of equity for women and the constraints of gender roles and family responsibilities that leave women less agency, time, and freedom to alleviate their economic burdens, achieve education, and participate in community-based adaptation strategies (Callister 2008, Engelman 2010, Carvajal-Escobar et al. 2008, Thurairajah et al. 2008).

Studies consistently suggest that empowering women to overcome restrictive gender roles would improve both individual and community adaptive capacity (Dhungel and Ojha 2012, Figueirdo et al. 2012, Mula et al. 2012, Thurairajah et al. 2008), whether through education, economic stability, increased community environmental stewardship/leadership, or social networking.

Family planning and improved reproductive health can play a key role in re-shaping the landscape of women's roles in the domestic and community spheres and also empower women to better realize social and economic agency and self-determination (Thurairajah et al. 2008).

Climate Change Resilience:
Empowering Women Through Family Planning

Household and Individual Level Approaches

Family planning can make great strides in helping women overcome vulnerabilities to climate change and can also empower women to engage in strategies for increasing adaptive capacity. At the household level, a smaller family, with children well-spaced in age, is more mobile and flexible during periods of instability, may be better economically disposed, and is generally a predictor for better education and health outcomes for children, who also are extremely vulnerable to adverse outcomes related to climate change (Stephenson et al. 2010, Hardee et al. 2009).

Although family planning often is overlooked as a means of improving climate change adaptation, communities frequently recognize its power to improve resilience.

A qualitative study conducted in Ethiopia by Population Action International indicated that people perceived family planning as a key tool for strengthening climate change adaptation (Hardee et al. 2009). Because of the particular needs of women and children, study subjects noted that the number of children in a household was a crucial predictor of the household's capacity to support itself during economic and environmental hardships (Hardee et al. 2009). In particular, participants stated that smaller families were best positioned to overcome climate change-related challenges, as they were better able to plan and save and, when necessary, migrate, and their children were more likely to survive in transit (Hardee et al. 2009). Since women are also tasked with carrying children and protecting the elderly when evacuating, having fewer charges, or children well-spaced in age who could look after each other, would enhance the safety of both women and their dependents (Alber 2009, Callister 2008, Page and Larsen 2010). Pregnant women are also particularly vulnerable during disasters, as well as in the aftermath in shelters and refugee camps, due to inadequate health care and nutrition (Leni 2008), and expanded FP access would help to reduce the incidence of unwanted pregnancies during particularly difficult circumstances. For these reasons, the most effective climate change adaptation strategies should address "people's expressed needs for expanded access to reproductive health and FP services" (Hardee et al. 2009).

On the individual level, FP improves maternal health outcomes and equips women to adequately space and limit their child bearing to minimize high-risk births. It follows then that women who have fewer children likely spend less time recuperating from the physical demands of childbearing and less time and labor caring for large families with many young children who require substantial attention and resources. Since "reproductive and family roles can limit women's participation in economic, civic and political life"(Engelman 2009), women with more control over their reproduction will not only be in better health and have a lighter domestic workload, but also may have access to more opportunities to pursue interests and activities outside of the domestic sphere. A study of women's participation in community climate change responses found that women with reduced domestic obligations were more likely to be involved in climate change response activities (Mula et al. 2010). The authors conclude that interventions to reduce women's domestic workloads would improve female participation in community adaptation programs and thereby improve the quality of such programs via the utilization of women's specialized environmental knowledge, the consideration of more risk averse approaches, and the inclusion of first-hand insight into the needs of women, children, and the elderly (Mula et al. 2010 and Crossette 2011). Additionally, with better management over their reproductive futures and the subsequent time spent on child care, women can expend more time pursuing education or improving their economic status through wage earning labor, overcoming two important predictors for climate change vulnerability and resilience (Alber 2009, Wheeler 2010, Crossette 2011). With increased economic independence, women have the agency to make more of the crucial production and consumer decisions that impact the ability of their families to cope during disasters or other climate shocks (Thurairajah et al. 2008). Moreover, women who are able to expand their activities outside of the domestic environment will also be exposed to more public messages, such as disaster warnings and evacuation orders, and can prepare themselves and their families accordingly (Page and Larsen 2010).

Speaking more generally, several studies find that improved climate change adaptability can come from a perception of self-efficacy (Muttarak et al. 2012) and having control over one's familial, socioeconomic, and psychological spheres (Mula et al. 2010, Thurairajah et al. 2008, Dhungel and Ojha 2012). For example, in a deconstruction of disaster resilience, Thurairajah et al. find that having a say in household decisions, including reproductive health decisions, empowers women during disaster recovery (Thurairajah et al. 2008). By extension, since FP helps women plan and manage their home life and economic agency, it also can be perceived as a strategy for better disaster resilience and climate change adaptability.

Thus FP acts as a powerful tool for improved climate change adaptation at the household and individual levels through several pathways.

First, it helps women and families determine their ideal family size, which allows them to plan for emergencies, create safety nets, and evacuate and migrate more safely and easily (Alber 2009, Stephenson et al. 2010, Hardee et al. 2009). Second, since FP improves maternal health outcomes by decreasing inadequately spaced, high-risk births and can decrease domestic workloads (Engelman 2010). Through better management of their own health and lives, women increase their own resilience to environmental and climate change shocks, as well as the resilience of their communities. Women are able to realize improved resilience by being in better health and being more likely to pursue other adaptive strategies, such as education, wage earning labor, or participation in climate change response efforts and environmental stewardship. Thus, with FP, both individuals and households are more resilient to environmental fluctuations and climate change events and women may advance their economic and social standing and feelings of self-efficacy and empowerment, all of which can improve adaptability to climate change as well as the quality of climate change responses.

Evidence for National and Global Level Interventions

The potential impact of family planning as a tool for climate change adaptation also has been demonstrated on the national level.

Voluntary family planning can help to slow national population growth, which can improve countries' capacity to manage climate change-related challenges. When countries prioritize meeting women's reproductive health needs, this can reduce poverty, protect natural resources, reduce inequality, and encourage social development, all of which can enable countries to better cope with the challenges of climate change (Mutunga, Zulu, De Souza 2012). Demographic transitions affected by family planning and fertility, such as changes in age composition, also are related not only to a country's consumption but also its adaptive capacity (Lutz and Striessnig 2011).

Rapid population growth also threatens Millennium Development Goals, which undermines progress in education, poverty, maternal and child health, and HIV, compromising societies' "assets, capacity and flexibility" that would enable them to withstand and adapt to climate change without significant loss of life, health and well-being (Engelman 2009). National-level advances in reproductive health also can work toward increasing HDI through improved life expectancy via decreased maternal and infant mortality, which increases a country's measure of development and improves climate change resilience in several frameworks (Lutz and Striessnig 2011). A study of climate change and women's health also shows that overall, better health care significantly helps populations adapt to climate change, particularly women in low income countries, where as few as 25% of women regularly visit health care providers (Duncan 2006). A lack of adequate reproductive health care in Malawi, in particular, has been particularly problematic for climate change adaptation (Suarez et al. 2008). At a time when demand for disaster relief and climate change response is increasing, the capacity to respond is decreasing, due to an eroded human resource base, most likely attributable to HIV-related mortality and morbidities (Suarez et al. 2008). These studies further illustrate on a national level how crucial reproductive health care, and health care in general, is in the face of a climate change.

In a review of population dynamics and climate change, Stephenson et al. argue that rapid population growth "endangers human development, provision of basic services and poverty eradication," and "weakens the capacity of poor communities to adapt to change" (Stephenson et al. 2010). Stephenson et al. assert that lack of access to family planning and the resulting unstable population growth will exacerbate climate change vulnerabilities and put already vulnerable groups at greater disadvantages. Additionally, population growth can cause resource stress and forced migration, pushing communities to environmentally marginal areas and further encouraging environmentally unsustainable practices (Stephenson et al. 2010). For example, in Ethiopia, soil degradation and low agricultural productivity caused people to migrate to agriculturally peripheral locations and exploit new resources in an unsustainable way, perpetuating the cycle of environmental degradation (Stephenson et al. 2010). Therefore, increased investment in rights-based reproductive health is necessary because FP is a profoundly unique intervention that can help achieve both development and climate change goals by reducing poverty and maternal/child mortality, promoting women's education and empowerment, and increasing environmental sustainability to cope with resource stress and disaster.

Crossette makes a similar argument for slowing population growth in the 2011 UN *State of the World Population*. This

report asserts that on a national level a poor country with a rapidly growing population may have less capacity to adapt to climate change (Crossette 2011). For instance, during rapid population growth in developing countries, migration from low lying coastal areas to urban areas will be problematic because urban areas may not have adequate services, housing, or labor opportunities to accommodate an influx of new residents (Crossette 2011). The climate change-related Horn of Africa famine is cited as another example of how addressing climate change needs to involve integrated responses that tackle both rapid population growth and the subsequent reduction in arable land, both of which stress resources and inhibit climate change resilience (Crossette 2011).

The interrelationship between population, reproductive health, and adaptive capacity is important to consider for national-level strategies.

Although the literature repeatedly makes connections between expanded FP/reproductive health care and improved climate change resilience, few national agendas have prioritized FP as a climate change adaptation strategy. For example, an examination of 41 National Programmes of Action (NAPAs) from developing countries showed that these countries prioritized "urgent action, single sector moves" (Hardee and Mutunga 2009) and did not include family planning or reproductive health in their national plans despite making repeated connections between environmental concerns and population (Hardee and Mutunga 2009). NAPAs were established as a part of Marrakech Accords in 2001 to assist countries with a high vulnerability to climate change and low adaptive capacity with planning and procuring funding. While 37 out of the 41 NAPAs said population growth exacerbates vulnerability and hinders optimal adaptation to climate change via food and resource insecurity, natural resource degradation, human health, and migration/urbanization, only six NAPAs mention reproductive health or FP and link it to an adaptation strategy (Hardee and Mutunga 2009). Two countries identify a reproductive health project as a priority adaptation strategy (Uganda and Sao Tome Principe), while no countries had allocated funding for reproductive health (Hardee and Mutunga 2009). At the same time, a vast majority of the 40 countries have an unmet need for planning of over 20% (Hardee and Mutunga 2009).

Another review of the 40 NAPAs of the least developed countries by Bryant et al. also finds that population growth is problematic for adapting to stresses brought on by climate change (Bryant et al. 2009). Family planning and, hence, slower population growth, would help a country adapt by addressing degradation of natural resources, demand for natural resources, and vulnerability to weather-related disasters (Bryant et al. 2009) with a rights based approach to improving human well-being. More recent climate change adaptation strategies, National Adaptation Programs (NAPs), are developing plans that are increasingly in line with other development strategies, such as reproductive health and education, to better link short term adaption needs with longer term development that will enhance individuals' and communities' adaptive abilities.

On the national scale, several studies show that slower population growth better equips countries to adapt to specific climate change-related challenges, such as water stress, food insecurity, and rapid urbanization (Moreland and Smith 2012, Malone et al. 2011). In a study conducted by Moreland and Smith, future food insecurity is predicted as a function of population and climate change using a model consisting of three parameters: 1) future population calculated using projections; 2) food requirements necessary to maintain health; and 3) food consumption, as determined by economics (using GLOBE model, which accounts for within and between country interaction) (Moreland and Smith 2012). This model was tested and piloted in Ethiopia and was able to quantify how instrumental family planning could be in adapting to food stress. Results demonstrated that in the context of climate change, food security under low population growth was markedly less problematic compared with food security in a scenario of high population growth (Moreland and Smith 2012). The model takes into account interactions between the three variables, such as the relationships between food consumption/requirements and population age/sex composition, food supplies and pricing (Moreland and Smith 2012). Since slower population growth not only changes the size of the population, but can also change age structure, it is important to consider these interrelationships and how one variable may interact with another. The limitation of this macro approach by Moreland and Smith is that it does not account for inequalities of distribution within a country and only measures the adequacy of a diet through calorie counts (Moreland and Smith 2012). Thus, this model is a helpful starting point when discussing family planning as an adaptive strategy for climate change-related food stress and can act as an "evidence-based advocacy tool"(Moreland and Smith 2012) that highlights family planning as a potential adaptation strategy in a world of climate change.

A similar approach using family planning, population projections, and climate change models was used by Malone et al. in a study of seven different developing countries. For this study, Malone et al. run two climate change models with two different population projection scenarios (medium variant UN population and universal access to FP) and find that the measure of resilience to climate change was consistently higher under the UAFP projection, by between 2-10% (Malone et al. 2011). Although environmental capacity was projected to decline for all countries, the predicted decline was less under the UAFP scenario (Malone et al. 2011). Additionally, while most of the seven countries were projected to improve in health and human/civic resource resilience, all countries improved more under the UAFP scenario (Malone et al. 2011). These findings consistently support the benefits of FP toward climate change resilience; however, there were several shortcomings to the models used. Limitations were discussed by the authors and included a lack of interaction variables in resilience modeling, as well as a lack of consideration for relationships between context variables such as population, labor productivity, and life expectancy (Malone et al. 2011). Overall, however, this study's results are consistent with the general premise, evidenced in the rest of the literature, that expanded access to family planning is associated with marked advances in national-level climate change resilience.

Conclusions: Future Studies

The literature demonstrates consistently that family planning can be an effective tool for empowering women, communities, and countries to cope with the stresses of climate change. Although there is wide ranging consensus on this concept, this principle likely would benefit from further rigorous modeling and testing to expand the evidence base supporting the connection and to impart a more quantifiable sense of the potential increases in climate change resilience realized from family planning.

A wider evidence base from well-designed studies could go far in convincing donors, government leaders, and climate change response personnel to invest more seriously in family planning and to allow climate change funds to be partially allocated to family planning. More work, like the climate change resilience modeling conducted by Moreland and Smith at Futures Group, and Malone et al. with Population Action International, would be helpful to solidify the concept of climate change resilience as a personal, household, and national characteristic and also would help to measure the strength of family planning as a predictor.

Mixed methods approaches also would be valuable to capture the nuanced perceptions and beliefs of individuals and communities regarding family planning and climate change. For example, further qualitative studies, like that conducted in Ethiopia by Hardee et al. in 2009, of other countries impacted by climate change also could be instrumental.

Lastly, observational studies of the influence of interventions, such as the Ethiopian Model Farmers project conducted by LEM Ethiopia, also could provide evidence for the effect of family planning and reproductive health on social and economic well-being as related to climate change. In sum, family planning deserves more research, recognition, and funding as a powerful, unique, and cost effective intervention that can improve lives on many levels, particularly in the context of climate change.

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