Gender-differentiated household vulnerability to environmental stressors in the Volta Delta, Ghana

Abstract

This study investigated the relationship between household gender composition and household vulnerability to the economic and environmental impacts of flooding and drought. The study utilised data on 1364 households from the 2016 DECCMA Survey in the Volta Delta of Ghana. There are two dimensions of vulnerability (economic and environmental) each to flooding and drought. Gender is measured by combining sex of household head and adult sex composition of a household. Binary logistic regression models revealed very little differentiation of vulnerability by household gender compositions when other sociodemographic and location characteristics are controlled for. However, male-headed households with female adults were more likely to be vulnerable to economic impacts of flooding and droughts than male-adult only and female-adult only households. Household location and socioeconomic characteristics were also differently associated with economic and environmental dimensions of vulnerability to different hazards. Our findings controvert the blanket feminisation of vulnerability, and we recommend that future research be based on perspectives of gendered household compositions.

Introduction

Environmental change impacts are disproportionately felt by less privileged social groups. Given that social roles, labour and resource allocation are gendered, vulnerability to the impacts of climate extremes are implicitly gendered (Rao, Lawson, Raditloaneng, Solomon, & Angula, 2017). There is the tendency for researchers, policy and development officials to highlight the vulnerability of women to environmental hazards due to their social and reproductive responsibilities (Arora-Jonsson, 2011). Typically, research equates female household headship with poverty and vulnerability (Arora-Jonsson, 2011), perceiving women as a "marginalised group" (Rao et al., 2017). This feminisation of vulnerability, rather than supporting the discourse on gender, may unintendedly obfuscate the real contextual gendered vulnerability (Arora-Jonsson, 2011). The association between female household headship and vulnerability to climate change is variable and empirically contested (Arora-Jonsson, 2011; Shackleton, Cobban, & Cundill, 2014).

While previous research on gender and environmental change have tended to focus mainly on women (Ogra & Badola, 2015) an interesting nuance is the importance of household adult sex composition and family type on vulnerability or adaptive capacity of women (Giri & Darnhofer, 2010). People are not isolated as individuals but as contributors to household income and decision-making as family breadwinners or otherwise (Arora-Jonsson, 2011). This study seeks to investigate the gender-differentiated vulnerabilities to environmental stressors in the Volta Delta from the perspective of household adult composition.

Moreover, studies on household or community vulnerability have measured vulnerability from perspectives of determinants of propensity for harm rather than actual impacts of stressors. At best, they have measured people's perceptions of their vulnerability. While perceptions of vulnerability are very much linked with geophysical characteristics of their location a more direct measurement of vulnerability will be people's stated experience of sensitivity to hazards to which they are exposed.

Again, vulnerability is as multidimensional as livelihoods. Different stressors impact different dimensions of household livelihoods. We consider that gender-differentiated access to economic and environmental capitals mean that different hazards may differentially impact these capitals by gender. We also acknowledge that the presence of alternative–sex adult members in a household may also have an effect on household vulnerability in addition to sex of household head. Thus, household gender composition is hypothesized to impact economic and environmental vulnerabilities to environmental stressors differently.

Gender and vulnerability to environmental change

The extant but scant research show an inconsistent relationship between gender and environmental change vulnerability. Women may experience vulnerability differently from men (Goh, 2012) but women and men do not constitute monolithic units (Arora-Jonsson, 2011; Van Aelst & Holvoet, 2016). Social productions of space (Jabeen, 2014) places women and men in different places with varying levels of exposure to environmental change and have implications for their sensitivity and the capacity to adapt.

Inequalities create spatio-temporally differentiated vulnerabilities in societies. Gender is but one of many axes of inequality that produce vulnerabilities to environmental change (Aberman et al., 2015; Kaijser & Kronsell, 2014; Van Aelst & Holvoet, 2016). However, the differentiations of vulnerability by gender are quite ambiguous (Shackleton et al., 2014). The relationship between gender and vulnerability is mediated by conventional disparities in education, land and productive asset inheritance, and sociocultural roles that preclude participation in mainstream formal occupations (Akampumuza & Matsuda, 2016; Van Aelst & Holvoet, 2016). The intersection between gendered inequalities, poverty and the impacts of climate change presents a complexity that needs to be understood (Ogra & Badola, 2015; Shackleton et al., 2014).

Gender profoundly impacts individual or household access to natural resource, financial, human, social, political and physical assets (Aberman et al., 2015). Traditional gender roles, responsibilities and power relationships have an impact on livelihood security and influence vulnerability of households to environmental stressors (Codjoe, Atidoh, & Burkett, 2011; Fisher & Carr, 2015; Tsikata, 2006; Tsikata & Yaro, 2014). Women's relative lack of access to productive economic assets and their traditional roles of social reproduction increase the economic burdens of the households they head where they, more often than not, are single earners who combine economic and domestic roles (Flatø, Muttarak, & Pelser, 2017; Van Aelst & Holvoet, 2016). Some studies note that female-headed households are more likely to live in poverty than male-headed households (Rademacher-Schulz, Schraven, & Mahama, 2014; Segnestam, 2014). Thus, female-headed households are likely to be vulnerable to economic impacts of climate-related hazards compared with male-headed households (Flatø et al., 2017; Sugden et al., 2014). Again, because they are rarely successors to family land and farms women tend to be excluded from family farming opportunities except through marriage where they can only become farmhands or labourers but are rarely owners (Fisher & Carr, 2015; Luhrs, 2015). Such pervasive patterns of patrilineal inheritance predispose women to relative depravity of financial capital and assets (Luhrs, 2015). This, paradoxical as it may seem, should reduce their vulnerability as their exposure to destructive loss is minimal compared with male owners of vast land and capital resources. This also calls into question which dimension of vulnerability is more differentiated by gender.

The structures which subordinate women to men in households create differential opportunities or challenges where household structures are transformed. For instance, new vulnerabilities may develop where female household heads are widowed, and yet have minimal access to land

and physical capital resources. On the other hand, access to social capital may accrue for such females and their households. Further, household dynamics brought about as a result of migration of household members, particularly male heads or other males, may increase access to financial resources in the form of remittances and greater control by females over household physical and social capital resources (Flatø et al., 2017; Giri & Darnhofer, 2010). Some studies find otherwise though (Sugden et al., 2014). In Ghana for instance, the incidence of poverty for instance is lower among female-headed households (19%) than among male-headed households (26%) (Cooke, Hague, & Mckay, 2016) but this may be due to remittances received from migrant would-have been male household heads. Evidence from nationally representative surveys in Ghana contradict such pervasive conclusions about female versus male household headship and poverty (Owusu-Afriyie & Nketiah-Amponsah, 2014). The incidence of poverty is lower among female-headed households (19%) than among male-headed households (26%) in Ghana (Cooke et al., 2016) but this may be due to remittances received from migrant would-have-been male household heads.

While dominant past and contemporary narrative on environmental change vulnerability presents women as victims because they are financially and socially ill-resourced they also acknowledge their capacity and resilience due to their local social and ecological knowledge and roles (Figueiredo & Perkins, 2013).

Different types of capital include natural, physical, human, social, financial and political capital. Access to any of these assets or the lack of it may determine households' vulnerability or their liability for loss or damage (Goh, 2012; Segnestam, 2014). Ownership of land and other physical assets (including agricultural livelihood inputs) tend to make men more vulnerable on the exposure front whereas their deprivation of political and social assets mean that women have limited capacity to cope, adapt or respond when systems are affected by environmental hazards. Different types of environmental change hazards may augur differently for access to different types of capital.

In times of hazards, men lose more as they own much of the farmlands and housing structures. Women however may still bear the brunt of the loss. Their responsibility for social reproduction where they primarily care for other household members including the aged and children depreciates their access to household social capital (Moser & Stein, 2015). Also, combining productive, reproductive and community roles may increase women's exposure and deepen their vulnerability to environmental hazards (Jabeen, 2014).

Women normatively have relatively limited access to financial capital stemming from asset acquisition and inheritance systems. Their extended social capital arising from their connections in two families (procreative and nuclear) however affords them better coping options than men. Similarly, where ecological crises trigger livelihood transformations women, per their socioecological knowledge, are better poised to diversify livelihoods in many situations towards commerce and trade in household consumables and food items. They also are better-suited to benefit from self-help groups that tend to reduce their vulnerabilities in times of stress (Sultana, 2014).

This position holds true only on the basis of two assumptions. First is that women are, by default, caregivers of young or much older household members. The second basis for such proposition will be that women are not themselves household heads who may benefit from the services of other adult economically active household members. These in the Ghanaian context may not necessarily be so as there are records of the ingenuity and autonomy of Ghanaian women (Abdul-Korah, 2011; Awumbila & Ardayfio-Schandorf, 2008; Odotei, 2002). In Ghana, women are among land owners and there are more women business owners than men in all the ten regions (Oduro & Ackah, 2017; Oduro, Baah-Boateng, & Boakye-Yiadom, 2011). Whereas formal financial assets (bank or financial institutional savings or assets) are more likely to be owned by men informal assets are likely to be owned by women in Ghana (Oduro et al., 2011).

In their study among rural households in the Afram Plains of Ghana, Codjoe at al. (2011) identify that different household responsibilities for male and female household members endeared them towards specific adaptation strategies to reduce their vulnerabilities. For instance, in adapting to the impacts of droughts in the Afram Plains of Ghana, male farmers tend to prefer strategies that protect or mitigate against monetary and farm asset loss while women are more inclined towards provision of resources to improve access to water (Codjoe et al., 2011). Fisher & Carr also identify among Eastern Ugandan farming communities that female household heads were less likely than male household heads to adopt newly developed maize varieties due to credit resource and information constraints as well as being labour-constrained (Fisher & Carr, 2015).

Taking the above into consideration, it may be misleading to conclude based on broad comparisons that one category is more vulnerable than the other, more so without a framework for contextual gender and power analysis (Djoudi et al., 2016). A more refined approach will be to incorporate basic household composition dynamics to offer a nuanced perspective to understanding gender dynamics in the broader society.

Measuring Gendered Household Dynamics

It is not uncommon for survey-based studies to distinguish between gendered household dynamics by referring to the sex of the household head. A lot of studies of household vulnerability make reference to sex of household head to distinguish between their gendered influences (Akampumuza & Matsuda, 2016; Andersen, Verner, & Wiebelt, 2016; Codjoe, 2010; Opiyo, Wasonga, & Nyangito, 2014). Household-level analyses based on female-headed versus male-headed households may very often produce misleading results (Doss, 2014;

Shackleton et al., 2014; Van Aelst & Holvoet, 2016). While in many settings the household head may be the key asset owner and main stakeholder in decision-making reference to household head alone is bridled with significant shortfalls, much less the sex of the head as an indicator of household vulnerability. First of all, it discounts essential income contributions by other household members and their roles in intra-household decision-making. Also, traditional norm and culture accord much recognition to the oldest household members who may automatically be referred to as household heads though intra-household decision-making negotiations and economic upkeep may not necessarily be their concern.

To surpass such impasse, recent researchers have taken into account the essential contributions of other household members while distinguishing between sex of household heads (Andersen et al., 2016; Codjoe & Afuduo, 2015; Flatø et al., 2017; Segnestam, 2009, 2014; Shackleton et al., 2014). More nuanced work further distinguish the presence of other adult household members by age and gender too (Shackleton et al., 2014). Similarly, others studies on gendered vulnerabilities explore the intersectionality between gender and other individual characteristics (Djoudi et al., 2016; Wrigley-Asante, Owusu, Egyir, & Owiyo, 2017) such as age (Fisher & Carr, 2015), marital status, household type or family (Van Aelst & Holvoet, 2016) and inequalities in poverty (Andersen et al., 2016; Fisher & Carr, 2015; Flatø et al., 2017).

Data & Methods

The study draws on data from the first phase of the DEltas, vulnerability and Climate Change: Migration and Adaptation (DECCMA) Project 2016 Survey in the Volta Delta of Ghana. The survey collected data from 1364 households selected through a stratified random sampling approach from 50 Enumeration Areas (EAs) in nine districts across the Greater Accra and Volta Regions in South Eastern Ghana. EAs were stratified according to levels of biophysical vulnerability to environmental change including temperature, liability to flooding and erosion and land cover.

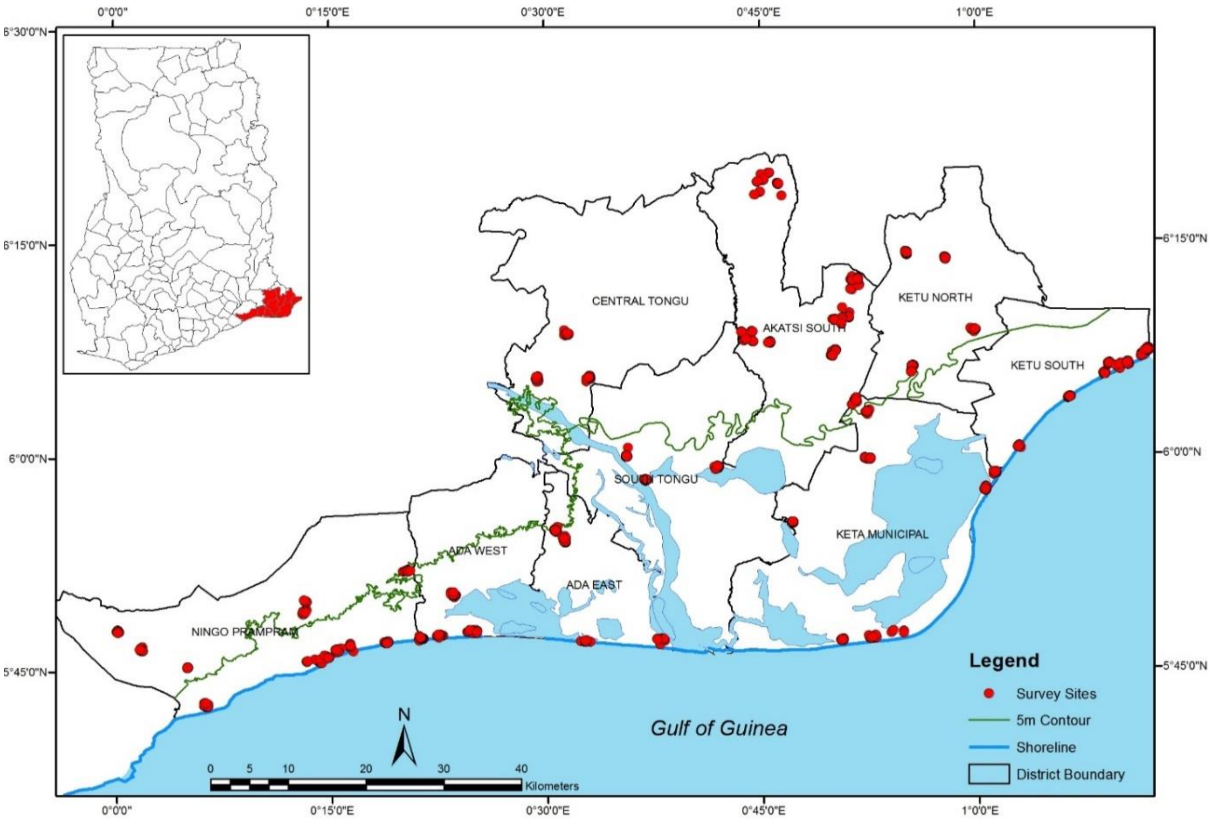
Key variables: Vulnerability is an outcome of exposure and sensitivity of households to two main biophysical hazards: flooding and drought. Sensitivity was measured by reported impacts of these hazards on household capital. Capital assets were grouped into environmental and economic capitals. Environmental capital included housing, drinking water and food security. Economic capital included economic security and crop or livestock security.

Gendered structure of households is differentiated beyond binary categorisation as male-headed versus female-headed households. To capture the inherent heterogeneity, particularly among female headed households, we categorised households by four gender categories à la Shackleton et al. (2014). There are four categories of households which we label as Type I representing male headed households with female adults; Type II representing female headed households without male adults; Type III representing female-headed households with adult male members and Type IV male adult(s) only households.

Analysis: We use descriptive statistics to show the distribution and bivariate associations between gendered household headship and household vulnerability to flooding and drought in the delta area. Logistic regression models assess the role of gendered household headship and adult sex composition on the sensitivity of households to flooding, drought and salinization. We control for socioeconomic, demographic and environmental characteristics of households.

Study Setting: The Volta Delta area consists of nine districts across two administrative regions in south-eastern Ghana with a population of about 900,000. These are Ningo-Prampram, Ada West, and Ada East in Greater Accra Region and South Tongu, Central Tongu, Keta, Ketu South, Ketu North and Akatsi South in the Volta Region. The delta area is largely rural.

Figure 1. Map showing the study area, survey sites and district boundaries



Source: Authors

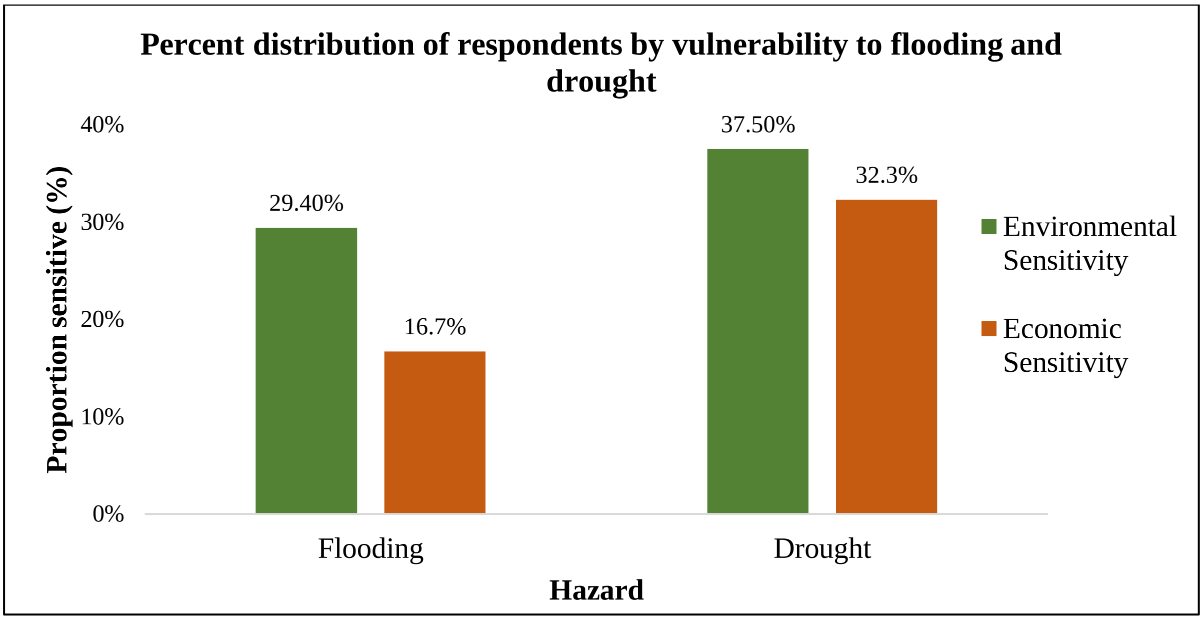
Results

Univariate results: There are more male than female household heads in the delta area. However, the proportion of female headed households, which is two-thirds of households, is higher than the national average of about 34.7% from the 2010 Population and Housing Census (Ghana Statistical Service, 2013). The most common type of household is Type I. Corroborating findings from Latin America (Andersen et al., 2016), the more common type of female-headed households are Type II (Table 1). The least common household type is Type III where female heads have other adult male members. Adult male members usually are household heads. Rarely, infirmed older male adults may be dependent members of female headed households where they mainly receive care.

<<Table 1 about here>>

The distributions of respondents by their vulnerability to flooding and drought, measured by their economic and environmental sensitivity, are displayed in Figure 2 below. The green bars represent the proportion environmentally sensitive to a hazard while the brown bars represent economic sensitivity.

Figure 2. Graph showing the proportions of households with (i) economic and (ii) environmental sensitivity to flooding and drought in the Volta Delta



Results generally indicate that households in the study area identify as being less sensitive to economic impacts of hazards compared to the environmental impacts. In all, households are most sensitive to droughts. Economic and environmental sensitivity to is more common for drought than for flooding. Of all the 1,364 respondents about 16.7% indicated that their exposure to the flood had negatively impacted their economic security or crop/livestock security. The remaining 83.3% had either not experienced flooding or not had their economic livelihoods affected by flooding.

A little under a third (29.4%) of households were sensitive to environmental impacts of flooding. These may have had their drinking water or food security or housing affected by the impacts of drought. About 32.3% of households were impacted in their economic security and the security of their crops/ livestock by droughts. About two-fourths (37.5%) of households noted that they were sensitive to environmental impacts of drought.

Multivariate results

The outcomes are inconsistent for household gender categories for different households. However, male headed households with female adults are consistently more likely to be sensitive, compared with female-adult only households, to environmental stressors.

Economic Vulnerability to Flooding

Model 1 of Table 1 shows no significant difference between male-headed households with female adults and any of the female-headed household types. The difference however, is between male-headed households with female adults and male-adult only households. The latter are less likely to be sensitive to economic impacts of flooding. Model 2 presents a different relationship between household gender structure and vulnerability. The statistic power between household gender structure and economic sensitivity to flooding is lost. This is a significantly important result which presents evidence that the difference attributed to gender may be explained by some extraneous variables. Where other household sociodemographic, economic and location characteristics are controlled for there seems to be no significant difference between households by gender category. As expected, non-agricultural households are .51 times as likely as agricultural households to be economically sensitive to flooding.

<<Table 2 about here>>

Environmental vulnerability to Flooding

A similar pattern for economic sensitivity to flooding is observed for environmental sensitivity to flooding. Only male-adult only households show some difference from male-headed households with female adults but that relationship exists only to the extent that gender category and geophysical characteristics of households are considered. In the model which includes other sociodemographic and economic characteristics of households, this association is lost between gender and sensitivity to flooding.

Higher dependency ratios are associated with lower likelihood of environmentally sensitive households. In rural areas, though children do not contribute to household incomes they tend to contribute essentially to upkeep of households by engaging in house chores. Households whose main source of drinking water is sachet or bottled water may have less problems accessing water in times of flooding. They are about 0.58 times as likely as households whose main source of drinking water is unimproved open sources. Households whose heads are formerly married are twice as likely as households whose heads were never married to be sensitive to environmental impacts of flooding.

<<Table 3 about here>>

Economic vulnerability to drought

With high explanatory power (Nagelkerke R^2=.023), Model 3.1 shows a strong association between the types of household gender and economic sensitivity to the impacts of drought. Compared with male-headed households with female adults, all the other household types are less likely to be sensitive to economic impacts of droughts.

Further in Model 2 where household sociodemographic and economic characteristics are controlled for, together with geophysical characteristics, female-adult only households are the only category significantly less likely than male-headed households with female adults to be sensitive to economic impacts of droughts. Female headed households tend to be more diversified than male-headed households even where women are present (Andersen et al., 2016). In male-headed households, women may be farmhands on farmlands usually owned by their partners. In female-adult only households where access to land resources is limited women are able to engage in diversified labour or commercial activities. In the Volta Delta area where women may not necessarily be farmers, they engage in and control trading activities including sale of food items (Ayivor, 2001). Droughts may rarely present economic stress to such female-adult only households. Thus, we fail to accept the hypothesis that female-headed households are more likely than male-headed households to be sensitive to economic impacts of droughts.

Neither proximity to river nor proximity to lagoon has a significant association with sensitivity to economic impact of drought. However, households that are resident in Keta and Ketu North are three and four times respectively as likely as households in Ningo-Prampram to be sensitive to economic impacts of drought. Households in Ada West were 0.29 times as likely as those in Ningo-Prampram to be sensitive to economic impacts of droughts. Households in Akatsi South are 17 times more likely than households in Ningo-Prampram to be economically sensitive to droughts. Akatsi South is largely a rural district with over 67% of its population living in rural areas. All six EAs in the Akatsi South involved in the DECCMA Survey were rural localities where the main livelihood is rain-fed farming. Most households had farms even if that was not the main occupation. Irrigation facilities were absent and the main sources of water were ponds or intermittent small rivers and streams. A common plight of households in the district was the reduced rainfall.

A unit increase in mean household age was associated with an infinitesimal (.005) reduction in the odds of economic sensitivity to droughts. While generally the odds of economic sensitivity increase with household size, 4-6 member households are 1.48 times more likely than single-member households to be sensitive to economic impacts of drought. Non-poor households are 0.57 times as likely as very poor households to be sensitive to economic impacts of droughts. Perhaps, non-poor households may have diverse livelihood options that are not rain-fed nor affected by droughts. Migrant households are twice as likely as non-migrant households to be sensitive to economic impacts of droughts. Migrant remittances are supposed to improve household welfare and reduce effects of adverse economic impacts from droughts. However, remittances can only serve to replenish what economic capital has been lost. The situation is more likely that households economically sensitive to drought impacts are more likely to have sent migrant members as a way of livelihood diversification.

The odds of economic sensitivity to drought is lower among non-agricultural households (0.28) and households whose heads are economically inactive (0.22) than in agricultural households. Agricultural activities are predominantly rain-fed in the Volta Delta, except in parts of Keta and Ada East where there is irrigation. Thus, droughts are very likely to cause economic distress to farming households than other household types.

<<Table 4 about here>>

Environmental vulnerability to drought

Gendered household categorisation shows some significant association with sensitivity to the environmental effects of droughts. In Model 1, female-headed households and male-adult only households are significantly less likely than male-headed households with adult females to be sensitive to environmental impacts of droughts. The association is lost with female headed households when geophysical and location characteristics are controlled for. In the final model with sociodemographic and economic characteristics there is no significant difference between male-headed with female adults and other household types. Again in this first model, the household sex ratio is not statistically associated with sensitivity to the environmental effects of droughts.

<<Table 5 about here>>

Synthesis Discussion on Gender and Vulnerability to Flooding

This paper aimed to analyse gendered household differences in vulnerability to flooding and drought in the Volta Delta. Gender was measured by a combination of sex of household head and presence of adult members of an alternative sex that that of head. The study found that when other household sociodemographic and economic characteristics are considered then gender shows modest or no significant association with vulnerability. That statistical differences disappear when other household sociodemographic and economic variables are controlled for indicate that gendered traits may characterise other important background characteristics. The apparent effect of gender on household vulnerability may be remotely influenced by wealth, occupation, education and household size and composition.

Male headed households tend to be more vulnerable than female headed households as there is less reinforcement of unjust gender relations in households with female adults only. Households in Ghana are by default male-headed. The absence of a male head should imply combined burdens of social reproduction and economic productivity for female heads. However, where the absence is due to labour migration of male heads the economic burden on female heads is expectedly reduced through the sending of remittances. Juxtaposed to findings by Carr among households in a rural area in Ghana (Carr, 2005), the presence of a male household head did not necessarily augment women's incomes in times of environmental stress. Rather, there was a tendency for males to hoard and spend their incomes on alcohol and their personal effects leaving the women with the responsibility of household subsistence. Similar to findings from a research among Nepalese women whose husbands had out-migrated, women with no adult males in their households tend to be more active in community forestry than if otherwise. In that setting male out-migration presented a "window of opportunity" for female participation in environmental decision-making.

In addition to the above, other adult members of a household contribute significantly to social reproduction and economic productivity of households. Gendered intra-household power dynamics may explain why male-adult only and female-adult only household have less economic sensitivity to flooding and drought respectively than male-headed households with female adults. Intra-household discord in preferences and resource utilisation that exist in male-headed households with female adults may adversely impact household vulnerability to flooding and drought.

Conclusion

This study shows that vulnerability to environmental stressors is as a result of a wide array of differentials which include livelihood types, wealth, household size and composition as well as geophysical location. Gender may be remotely associated, to varying extents, with vulnerability to environmental change. This reflects a complex intersectionality which requires multidimensional analytical frameworks of the relationship between gender and environmental change. In all, vulnerabilities may be differentiated by household gender composition rather than sex of household head. However, to explain how gender affects vulnerability requires differentiating dimensions of vulnerability and types of hazard for a better understanding of the gender and vulnerability nexus. We caution against the blanket feminisation of vulnerability and recommend that future research approach similar studies from the perspective of gendered household compositions.

References

Abdul-Korah, G. B. (2011). “Now If You Have Only Sons You Are Dead”: Migration, Gender, and Family Economy in Twentieth Century Northwestern Ghana. *Journal of Asian and African Studies*, *46*(4), 390–403. http://doi.org/10.1177/0021909611400016

Aberman, N.-L., Ali, S., Behrman, J. A., Bryan, E., Davis, P., Donnelly, A., … Roncoli, C. (2015). Climate, change adaptation assets and group-based approaches: Gendered perceptions from Bangladesh, Ethiopia, Mali, and Kenya, (January), 28. http://doi.org/10.2139/ssrn.2564556

Akampumuza, P., & Matsuda, H. (2016). Weather Shocks and Urban Livelihood Strategies: The Gender Dimension of Household Vulnerability in the Kumi District Of Uganda. *The Journal of Development Studies*, *53*(6), 1–18. http://doi.org/10.1080/00220388.2016.1214723

Andersen, L. E., Verner, D., & Wiebelt, M. (2016). Gender and Climate Change in Latin America: An Analysis of Vulnerability, Adaptation and Resilience Based on Household Surveys. *Journal of International Development*, 1–20. http://doi.org/10.1002/jid

Arora-Jonsson, S. (2011). Virtue and vulnerability: Discourses on women, gender and climate change. *Global Environmental Change*, *21*(2), 744–751. http://doi.org/10.1016/j.gloenvcha.2011.01.005

Awumbila, M., & Ardayfio-Schandorf, E. (2008). Gendered poverty, migration and livelihood strategies of female porters in Accra, Ghana. *Norsk Geografisk Tidsskrift - Norwegian Journal of Geography*, *62*, 171–179. http://doi.org/10.1080/00291950802335772

Ayivor, S. (2001). *Patterns of land tenure in Anloga, Ghana*. (Adarkwah Antwi, Ed.). London: RICS Foundation.

Carr, E. R. (2005). Placing the environment in migration: Environment, economy, and power in Ghana's Central Region. *Environment and Planning A*, *37*(5), 925–946. http://doi.org/10.1068/a3754

Codjoe, S. N. A. (2010). Population and food crop production in male- and female-headed households in Ghana. *International Journal of Development Issues*, *9*(1), 68–85. http://doi.org/10.1108/14468951011033815

Codjoe, S. N. A., & Afuduo, S. (2015). Geophysical, socio-demographic characteristics and perception of flood vulnerability in Accra, Ghana. *Natural Hazards*, *77*(2), 787–804. http://doi.org/10.1007/s11069-015-1624-y

Codjoe, S. N. A., Atidoh, L. K., & Burkett, V. (2011). Gender and occupational perspectives on adaptation to climate extremes in the Afram Plains of Ghana. *Climatic Change*, *110*(1–2), 431–454. http://doi.org/10.1007/s10584-011-0237-z

Cooke, E., Hague, S., & Mckay, A. (2016). *The Ghana Poverty and Inequality Report: Using the 6th Ghana Living Standards Survey*. Retrieved from https://www.unicef.org/ghana/Ghana_Poverty_and_Inequality_Analysis_FINAL_Match_2016(1).pdf

Djoudi, H., Locatelli, B., Vaast, C., Asher, K., Brockhaus, M., & Basnett Sijapati, B. (2016). Beyond dichotomies: Gender and intersecting inequalities in climate change studies. *Ambio*, *45*(s3), 248–262. http://doi.org/10.1007/s13280-016-0825-2

Doss, C. (2014). Collecting sex disaggregated data to improve development policies. *Journal of African Economies*, *23*(1 SUPPL1), 62–86. http://doi.org/10.1093/jae/ejt023

Figueiredo, P., & Perkins, P. E. (2013). Women and water management in times of climate change:participatory and inclusive processes. *Journal of Cleaner Production*, *60*, 188–194. http://doi.org/10.1016/j.jclepro.2012.02.025

Fisher, M., & Carr, E. R. (2015). The influence of gendered roles and responsibilities on the adoption of technologies that mitigate drought risk: The case of drought-tolerant maize seed in eastern Uganda. *Global Environmental Change*, *35*, 82–92. http://doi.org/10.1016/j.gloenvcha.2015.08.009

Flatø, M., Muttarak, R., & Pelser, A. (2017). Women, Weather, and Woes: The Triangular Dynamics of Female-Headed Households, Economic Vulnerability, and Climate Variability in South Africa. *World Development*, *90*(179552), 41–62. http://doi.org/10.1016/j.worlddev.2016.08.015

Ghana Statistical Service. (2013). *2010 Population & Housing Census*. *Ghana Statistical Service*. Accra.

Giri, K., & Darnhofer, I. (2010). Outmigrating men: A window of opportunity for women's participation in community forestry? *Scandinavian Journal of Forest Research*, *25*(sup9), 55–61. http://doi.org/10.1080/02827581.2010.506769

Goh, A. (2012). *A literature review of the gender-differentiated impacts of climate change on women's and men's assets and well-being in developing countries* (No. 106). *CAPRi*. Washington, D.C. Retrieved from http://www.indiaenvironmentportal.org.in/files/file/a literature review of the gender-differentiated impacts of climate change.pdf

Jabeen, H. (2014). Adapting the built environment: the role of gender in shaping vulnerability and resilience to climate extremes in Dhaka. *Environment and Urbanization*, *26*(1), 147–165. http://doi.org/10.1177/0956247813517851

Kaijser, A., & Kronsell, A. (2014). Climate change through the lens of intersectionality. *Environmental Politics*, *23*(3), 417–433. http://doi.org/10.1080/09644016.2013.835203

Luhrs, D. E. (2015). Consider the daughters, they are important to family farms and rural communities too: family-farm succession. *Gender, Place & Culture*, *524*(October), 1–15. http://doi.org/10.1080/0966369X.2015.1090405

Moser, C. O., & Stein, A. (2015). Challenging stereotypes about gendered vulnerability to climate change. In *Gender, Asset Accumulation and Just Cities: Pathways to Transformation* (pp. 181–196). Routledge. Retrieved from http://scholar.google.com/scholar?hl=en&q=moser%3B+stein%3B+challenging+stereotypes&btnG=&as_sdt=1%2C5&as_sdtp=#1

Odotei, I. K. (2002). *Sea Power, Money Power: Ghanaian Migrant Fisherman and Women in the Republic of Benin*. Institute of African Studies, University of Ghana. Retrieved from http://www.africabib.org/rec.php?RID=W00089315

Oduro, A. D., & Ackah, C. G. (2017). Closing the Gender Gaps in Ghana. In Ernst Aryeetey & Ravi Kanbur (Eds.), *The Economy of Ghana Sixty Years After Independence* (1st ed., pp. 317–332). Oxford University Press. Retrieved from https://books.google.com.gh/books?hl=en&lr=&id=Sw7xDQAAQBAJ&oi=fnd&pg=PA317&dq=oduro,+ackah%3B+gender&ots=fGl2w_6inP&sig=qJBWgw7MeRdfK5FBd2DT5RpNfI4&redir_esc=y#v=onepage&q=oduro%2C ackah%3B gender&f=false

Oduro, A. D., Baah-Boateng, W., & Boakye-Yiadom, L. (2011). *Measuring the gender asset gap in Ghana*. Woeli Publishing Services, publ. for the Department of Economics, University of Ghana.

Ogra, M. V, & Badola, R. (2015). Gender and Climate Change in the Indian Himalayas : Global Threats , Local Vulnerabilities , and Livelihood Diversification at the Nanda Devi Biosphere Reserve Gender and Climate Change in the Indian Himalayas : Global Threats ,. *Earth System Dynamics*, *6*(August), 505–523.

Opiyo, F., Wasonga, O. V, & Nyangito, M. M. (2014). Measuring household vulnerability to climate-induced stresses in pastoral rangelands of Kenya: Implications for resilience programming. *Pastoralism: Research, Policy and Practice*, *4*(10). http://doi.org/10.1186/s13570-014-0010-9

Owusu-Afriyie, J., & Nketiah-Amponsah, E. (2014). An Individual Level Test of the " Feminization of Poverty " Hypothesis Evidence from Ghana. *Journal of Developing Societies*, *30*(1), 25–43. http://doi.org/10.1177/0169796X13516351

Rademacher-Schulz, C., Schraven, B., & Mahama, E. S. (2014). Time matters: shifting seasonal migration in Northern Ghana in response to rainfall variability and food insecurity. *Climate and Development*, *6*(1), 46–52. http://doi.org/10.1080/17565529.2013.830955

Rao, N., Lawson, E. T., Raditloaneng, W. N., Solomon, D., & Angula, M. N. (2017). Gendered vulnerabilities to climate change : insights from the semi-arid regions of Africa and Asia Gendered vulnerabilities to climate change : insights from the semi-arid regions of Africa and. *Climate and Development*, *0*(0), 1–13. http://doi.org/10.1080/17565529.2017.1372266

Segnestam, L. (2009). Division of Capitals—What Role Does It Play for Gender-Differentiated Vulnerability to Drought in Nicaragua? *Community Development*. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/15575330903001562

Segnestam, L. (2014). *Drought and Gender Differentiated Vulnerability in Nicaragua, 1970-2010*. Stockholm University.

Shackleton, S., Cobban, L., & Cundill, G. (2014). A gendered perspective of vulnerability to multiple stressors, including climate change, in the rural Eastern Cape, South Africa. *Agenda*, *28*(3), 73–89. http://doi.org/10.1080/10130950.2014.932560

Sugden, F., Maskey, N., Clement, F., Ramesh, V., Philip, A., & Rai, A. (2014). Agrarian stress and climate change in the Eastern Gangetic Plains: Gendered vulnerability in a stratified social formation. *Global Environmental Change-Human and Policy Dimensions*, *29*, 258–269. http://doi.org/10.1016/j.gloenvcha.2014.10.008

Sultana, F. (2014). Gendering Climate Change: Geographical Insights. *The Professional Geographer*, *66*(3), 1–10. http://doi.org/10.1080/00330124.2013.821730

Tsikata, D. (2006). *Living in the Shadow of the Large Dams: Long Term Responses of Downstream and Lakeside Communities of Ghana's Volta River Project*. Retrieved from http://library.wur.nl/WebQuery/clc/1824720

Tsikata, D., & Yaro, J. A. (2014). When a Good Business Model is Not Enough: Land Transactions and Gendered Livelihood Prospects in Rural Ghana. *Feminist Economics*, *20*(1), 202–226. http://doi.org/10.1080/13545701.2013.866261

Van Aelst, K., & Holvoet, N. (2016). Intersections of Gender and Marital Status in Accessing Climate Change Adaptation: Evidence from Rural Tanzania. *World Development*, *79*, 40–50. http://doi.org/10.1016/j.worlddev.2015.11.003

Wrigley-Asante, C., Owusu, K., Egyir, I. S., & Owiyo, T. M. (2017). Gender dimensions of climate change adaptation practices: the experiences of smallholder crop farmers in the transition zone of Ghana. *African Geographical Review*, *6812*(August), 1–14. http://doi.org/10.1080/19376812.2017.1340168

Table 1. Frequency distributions of households by gender categories

Sex of Household Head	Frequency	Percentage
Female-headed	553	40.5
Male-headed	811	59.5
Household Type		
Male-headed with female adult (Type I)	605	44.4
Female adult(s) only (Type II)	371	27.2
Female-headed with male adult (Type III)	182	13.3
Male adult(s) only (Type IV)	206	15.1
Total	**1364**	**100.0**

Table 2. Binary logistic regression models to determine the effects of household gender category on economic Sensitivity to Flooding in the Volta Delta

	Model 1			**Model 2**		
Nagelkerke R^2	**.014**			**.205**		
Independent variables	**Odds Ratio**	**Standard error**	**p-value**	**Odds Ratio**	**Standard error**	**p-value**
Household Gender						
Females only	.779	.216	.247	.806	.283	.446
Female head with Male adult	.889	.221	.594	1.086	.269	.758
Male only	.441	.302	.007	.986	.437	.975
Male head with female adult *ref*						
Household Sex Ratio	1.861	.413	.133	1.325	.450	.532
Household mean years of education				.947	.031	.080
Household dependency ratio				.663	.426	.334
Household mean age				.992	.008	.316
Household size						
1 (ref)						
2-3				1.189	.371	.641
4-6				1.483	.448	.379
7+				1.303	.516	.608
Wealth level						
Poor (ref)						
Middle				1.063	.171	.720
Rich				.983	.291	.953
District of residence						
Ningo-Prampram *ref*						
Ada West				1.102	.444	.828
Ada East				.763	.511	.596

Keta		1.784	.480	.228
Ketu South		1.255	.477	.634
Ketu North		2.048	.485	.140
Akatsi South		2.138	.466	.103
South Tongu		.644	.654	.500
Central Tongu		.455	.628	.209
Main source of drinking water				
Open source				
Pipe/borehole		.820	.215	.354
Sachet/Other		.486	.352	.040
Type of toilet facility				
No toilet				
Pit latrine		.714	.209	.107
KVIP		1.203	.222	.404
Flush toilet		.458	.561	.164
Religion				
Traditional (ref)				
Christian		.783	.207	.236
Other		.426	.438	.052
Migrant status				
Non-migrant (ref)		1.305	.175	.129
Migrant				
Tenancy				
Non-owner(ref)				
Owner		.649	.299	.149
Mobile phone ownership				
Non-owner (ref)				
Owner		1.161	.313	.633
Household head's characteristics				
Occupation				
Agric				
Non-agric		.509	.190	.000
No occupation		.798	.354	.525
Marital status				
Never married (ref)				
Currently married		1.949	.406	.101
Formerly married		1.872	.424	.140
Geophysical variables				
Distance to shoreline				
<1km *ref*				
1km+		1.836	.255	.017
Distance to river				
<10km *ref*				.042
10km-30km		.420	.352	.014
30km+		.560	.368	.115
Distance to lagoon				
<5km				

5km+		.206	.283	.000
Constant		.668	.968	.677

Table 3. Binary logistic regression models to determine the effects of household gender category on Environmental Sensitivity to Flooding in the Volta Delta

	Model 1			**Model 3**		
Nagelkerke R^2	**.013**			**.216**		
Independent variables	**Odds Ratio**	**Standard error**	**p-value**	**Odds Ratio**	**Standard error**	**p-value**
Household Gender						
Females only	1.050	.174	.781	1.077	.231	.747
Female head with Male adult	1.202	.179	.306	1.065	.220	.774
Male only	.476	.248	.003	.886	.372	.744
Male head with female adult *ref*						
Household Sex Ratio	1.579	.334	.171	1.167	.377	.682
District of residence						
Ningo-Prampram *ref*						
Ada West				2.522	.308	.003
Ada East				1.196	.384	.640
Keta				2.040	.361	.049
Ketu South				1.263	.338	.489
Ketu North				1.860	.389	.110
Akatsi South				2.091	.371	.047
South Tongu				.486	.541	.183
Central Tongu				.309	.539	.029
Household mean years of education				.957	.025	.076
Household dependency ratio				.317	.360	.001
Household mean age				.988	.006	.068
Household size						
1 *ref*						
2-3				1.380	.297	.279
4-6				1.891	.361	.078
7+				2.241	.418	.053
Main source of drinking water						
Open source *ref*						
Pipe/borehole				.876	.189	.482
Sachet/Other				.582	.264	.041
Type of toilet facility						
No toilet *ref*						
Pit latrine				.699	.178	.044
KVIP				.946	.191	.770
Flush toilet				.691	.327	.259
Wealth level						
Very poor *ref*						
Poor				.916	.142	.536

Non-poor		.856	.232	.501
Religion				
Traditional *ref*				
Christian		1.176	.185	.379
Other		.630	.363	.204
Migrant status				
Non-migrant *ref*				
Migrant		1.103	.147	.504
Tenancy				
Non-owner *ref*				
Owner		.920	.211	.694
Mobile phone ownership				
Non-owner *ref*				
Owner		1.742	.292	.057
Household head's characteristics				
Occupation				
Agric *ref*				
Non-agric		.733	.159	.051
No occupation		1.078	.289	.796
Marital status				
Never married *ref*				
Currently married		1.683	.295	.078
Formerly married		2.139	.313	.015
Geophysical variables				
Distance to shoreline				
<1km *ref*				
1km+		.780	.200	.215
Distance to river				
<10km *ref*				
10km-30km		.397	.293	.002
30km+		.430	.309	.006
Distance to lagoon				
<5km *ref*				
5km+		.315	.228	.000
Constant		**1.223**	**.774**	**.795**

Table 4. Binary logistic regression models to determine the effects of household gender category on **Economic Sensitivity to Drought** in the Volta Delta

	Model 1			Model 2		
Nagelkerke R^2	**.023**			**.501**		
Independent variables	**Odds Ratio**	**Standard error**	**p-value**	**Odds Ratio**	**Standard error**	**p-value**
Household Gender						
Females only	.591	.174	.003	.452	.281	.005
Female head w/ Male adult	.562	.188	.002	.667	.272	.136
Male only	.561	.236	.015	1.077	.437	.866
Male head w/ female adult *ref*						
Household Sex Ratio	1.087	.333	.803	.759	.455	.544
Household mean years of education				1.000	.989	.029
Household dependency ratio				.589	.207	.420
Household mean age				.995	.457	.007
Household size						
1 *ref*						
2-3				1.192	.340	.607
4-6				2.479	.418	.030
7+				2.280	.482	.087
Wealth level						
Very poor *ref*						
Poor				.852	.167	.337
Non-poor				.575	.267	.038
District of residence						
Ningo-Prampram *ref*						
Ada West				.289	.430	.004
Ada East				1.081	.429	.856
Keta				3.295	.400	.003
Ketu South				1.045	.382	.907
Ketu North				4.905	.398	.000
Akatsi South				18.122	.416	.000
South Tongu				2.451	.564	.112
Central Tongu				2.072	.489	.136
Main source of drinking water						
Open source				.869	.210	.503
Pipe/borehole				.793	.301	.441
Sachet/Other *ref*						
Type of toilet facility						
No toilet				.995	.202	.980

Pit latrine		.655	.222	.057
KVIP		.835	.383	.637
Flush toilet				
Religion				
Traditional *ref*				
Christian		.740	.204	.140
Other		.945	.352	.873
Migrant status				
Non-migrant *ref*				
Migrant		2.282	.171	.000
Tenancy				
Non-owner *ref*				
Owner		1.001	.249	.998
Mobile phone ownership				
Non-owner *ref*				
Owner		.714	.303	.268
Household head's characteristics				
Occupation				
Agric		.282	.178	.000
Non-agric		.217	.354	.000
No occupation				
Marital status				
Never married (ref)				
Currently married		1.082	.341	.818
Formerly married		1.738	.358	.123
Geophysical variables				
Distance to shoreline				
<1km *ref*				
1km+		1.516	.245	.090
Distance to river				
<10km *ref*				
10km-30km		1.102	.339	.775
30km+		.866	.352	.682
Distance to lagoon				
<5km				
5km+		1.518	.265	.116
Constant		**.452**	**.864**	**.358**

Table 5. Binary logistic regression models to determine the effects of household gender category on **Environmental Sensitivity to Drought** in the Volta Delta

	Model 1			Model 2		
Nagelkerke R^2	**.008**			**.348**		
Independent variables	**Odds Ratio**	**Standard error**	**p-value**	**Odds Ratio**	**Standard error**	**p-value**
Household Gender						
Females only	.936	.164	.687	1.019	.235	.935
Female head with Male adult	.700	.179	.046	.911	.233	.689
Male only	.604	.226	.026	1.033	.377	.931
Male head with female adult			.046			
Household Sex Ratio	1.239	.315	.497	.990	.388	.980
Household mean years of education				1.016	.025	.516
Household dependency ratio				.592	.349	.133
Household mean age				.997	.006	.644
Household size						
1 (ref)						
2-3				1.436	.286	.205
4-6				2.529	.353	.008
7+				2.469	.412	.028
District of residence						
Ningo-Prampram *ref*						
Ada West				.366	.370	.007
Ada East				1.311	.385	.482
Keta				4.141	.355	.000
Ketu South				1.787	.318	.067
Ketu North				6.905	.360	.000
Akatsi South				14.670	.368	.000
South Tongu				4.476	.512	.003
Central Tongu				2.548	.452	.038
Main source of drinking water						
Open source						
Pipe/borehole				.810	.186	.257
Sachet/Other				.935	.240	.778
Type of toilet facility						
No toilet						
Pit latrine				.905	.179	.576
KVIP				.676	.194	.044
Flush toilet				.887	.295	.684

Wealth level				
Very poor (ref)				
Poor		.831	.145	.201
Non-poor		.640	.225	.047
Religion				
Traditional (ref)				
Christian		1.042	.181	.821
Other		.711	.322	.290
Migrant status				
Non-migrant (ref)				
Migrant		1.654	.148	.001
Tenancy				
Non-owner(ref)				
Owner		1.033	.207	.875
Mobile phone ownership				
Non-owner (ref)				
Owner		.776	.264	.337
Household head's characteristics				
Occupation				
Agric				
Non-agric		.447	.162	.000
No occupation		.812	.285	.465
Marital status				
Never married (ref)				
Currently married		1.042	.282	.884
Formerly married		1.164	.298	.611
Geophysical variables				
Distance to shoreline				
<1km *ref*				
1km+		.943	.206	.775
Distance to river				
<10km *ref*				
10km-30km		1.703	.304	.080
30km+		1.239	.320	.502
Distance to lagoon				
<5km				
5km+		1.440	.231	.115
Constant		.212	.749	.038