Universe International Journal of Interdisciplinary Research
(Peer Reviewed Refereed Journal)
© UIJIR | ISSN (O) – 2582-6417
FEB. 2022 | Vol. 2 Issue 9
www.uijir.com

COMMUNITY-BASED DISASTER RISK MANAGEMENT: AN ANALYSIS OF URBAN DISASTER VULNERABILITY IN CACHAR DISTRICT- ASSAM

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DOI No. – **08.2020-25662434**

Abstract

The weakest link in risk management is the community (local people) who are affected by disasters. Despite technological advances, proper implementation of Disaster Management strategies is found to be poor. This aspect can be attributed to the fact that people at risk are neither involved nor their awareness levels are channelized. Before the formulation of Disaster Management policies, it is mandatory to understand the requirements of the community, their adaptability, their preparedness and vulnerability in the eventuality of disaster. This validates the need and importance of Community Based Disaster Risk Management (CBDRM). This paper is an attempt to analyse the vulnerability of the urban population of Silchar Town in Assam, India concerning four hazards viz. earthquake, flood, urban flood and fire. An organised involvement of the urban community of the town is employed to assess the vulnerability towards the considered hazards. The study is the first of its kind purely based on the CBDRM model wherein the vulnerability assessment is truly based on people's perspectives. Although previous studies reported in Silchar Atlas are institutional, the present study can be corroborated with the existing ones to bridge the gap in existing DM plans and policies at the district level.

Keywords*: community, disaster, risk, management, vulnerability*

INTRODUCTION

Disaster occurrences have a detrimental impact on the human system. Every year disaster events injure and kill hundreds of thousands of people resulting in an economical loss worth billions (GECHS, 2008). Physical and socio-economic resilience causes variable disaster impacts from nation to nation. Developed countries face extreme economic loss due to disasters while developing countries face intense human casualties (Rahman, 2010). Developing countries are disaster hotspots. Disasters in such countries are associated with threats for the poor and have the potential to terminate development gains and accumulated wealth (World Bank, 2005). The CRED (2014) reveals that the occurrence of disaster events are frequent. Statistics reveal that the period 1900-1940 witnessed mere 100 disasters per decade while over 2,080 extreme events during the period 1990-2000. Hydrometeorological disasters are on the rise while several geophysical disasters are fairly steady (IPCC, 2007; UNISDR, 2009a). The CRED (2014) report revealed that every year 373 country-level disaster events occur on an average, resulting in the death of over 100,000 people, with an economic loss of 156 billion US dollars approximately. In 2013, the worst affected region was Asia with 88% fatality approximately due to the occurrence of various disasters as against a decadal average of 62%. As per analyses, 80% of human casualties are due to climate change. As per the report of IPCC fourth assessment climate change is likely to magnify the frequency and occurrence of storms, floods, heatwaves, droughts etc.

The significance of the local community is immense towards preparedness, mitigation, preparedness, early warning and emergency response for early recovery. The role of the local

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FEB. 2022 | Vol. 2 Issue 9
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community is decisive in diminishing vulnerability and building up resilience in the eventuality of disaster as has been accepted by Disaster Management practitioners. Gaillard (2010) emphasises community participation at the local level for risk management. Community-Based Disaster Risk Reduction helps to tackle unforeseen disaster eventualities by the empowerment of local people. The Community Based Disaster Risk Management purely rely on the resources of local people while handling the extreme event. There exists a requirement for an alternative Disaster Risk Reduction (DRR) approach compared to the traditional approach as the existing top-down approach of disaster relief cannot provide redressal to local needs and vulnerabilities (Shaw, 2012b). Resilient communities can be built up when community levels are given proper attention, but in reality, they are relatively neglected (Berkes and Ross, 2013). CBDRM strategy can be implemented efficiently which endorses both combined bottom-up and top-down efforts to strengthen people's capacity to handle disaster impacts towards building resilient communities by reducing inherent vulnerabilities (JANI, 2011). CBDRM emphasizes systematic community involvement to manage as well as reduce disaster risk (Maskrey, 2011). In the late 1990s, CBDRM was visualised as an alternative approach to traditional DRR (Izumi and Shaw, 2012) and was first used by NGOs of developing nations. CBDRM quickly gained popularity due to its success in elevating risk awareness, building local resources and capacities; and addressing existing vulnerabilities (Izumi and Shaw, 2012). The CBDRM approach further gained popularity in the Hyogo Framework for Action (HFA) in 2005 and subsequently in Sendai Framework for Disaster Risk Reduction (SFDRR) in 2015. Presently all Disaster Risk Management (DRM) programmes are integrated with CBDRM components (Maskrey, 2011) wherein members of at-risk communities are the main actors in the process of risk management (JANI, 2011).

Having understood the importance of the CBDRM model, the paper is an attempt to analyse the vulnerability of an urban population of Silchar Town in Assam, India concerning four hazards viz. earthquake, flood, urban flood and fire. An organised involvement of the urban community of the town is employed to assess the vulnerability towards the considered hazards. The study is the first of its kind purely based on the CBDRM model wherein the vulnerability assessment is truly based on people's perspectives. Although previous studies reported in Silchar Atlas are institutional, the present study can be corroborated with the existing ones to bridge the gap in existing DM plans and policies at the district level.

STUDY AREA

The history of Silchar Town reveals it being affected by natural disasters such as cyclones, earthquakes and riverine floods due to its geographical disposition. Moreover, it is also susceptible to artificial hazards like urban floods, fire, road accidents owing to unplanned urbanization, insufficient public infrastructure, improper solid waste management, poor risk governance by local authorities, high population density to name a few. All the above factors make the town exposed to various kinds of hazards. Consequently, there exists a need to properly manage disaster risks to protect life, livelihood and property.

Silchar is located in the southern part of Assam. It is bounded by Himalayan Frontal Thrust and Naga Thrust in the North and East. These thrusts contribute to making the Assam earthquake-prone. Silchar Town lies in Zone V, the zone of the highest seismicity. Silchar has a history of being inflicted by earthquakes and most of them had a magnitude of 7 and above with as high as 8.7 in

1950. The epicentre of these quakes was in the vicinity of Assam, causing direct or indirect damage to the town. Silchar Town is also affected by urban floods due and riverine floods. The intricate topography of the river system makes it suspectable to flood. Unplanned urbanization and poor solid waste management lead to urban floods in the rainy season paralyzing the life of people in the town. As the town has undergone rapid and unplanned urbanization especially in the last two decades, consequently, the disaster risks have been elevated both to natural and artificial hazards.

METHODOLOGY

Participatory research techniques are employed for CBDRM that stress people's participation in providing detailed information about their knowledge within their domain (Chambers, 1994a; Pain and Francis, 2003). These techniques enable the researcher to learn as well generate research data via a guided process (Mercer *et al.*, 2008). The present work follows a participatory research technique to generate data. Vulnerability analysis in this study involves vulnerability assessment, indexing and mapping.

Data is gathered based on peoples' responses as per framed questions on different aspects of disaster vulnerability. Focus Group Discussion and Guided Personal Interview are employed to record the responses of the people of Silchar Town. Participants opine as an individual, member of a family, resident of award of Silchar Municipal area or its immediate periphery defining the community under study.

UNIVERSE OF THE STUDY

The people of Silchar Town who reside within the purview of the geographical and administrative map of Cachar form the universe of the present study. People of various profiles who live within the jurisdiction of Silchar Municipality and 1 km of the immediate suburban area form the universe of the study.

SAMPLE FRAME AND SAMPLE DESIGN

Community in the present context refer to people of Silchar Town who reside in 28 municipal wards and its immediate periphery is considered as dummy ward 29. A total population of 2,00,000 are considered with about 1,80,000 people residing in 28 municipal wards and the remaining 20,000 in dummy ward 29 which is corroborated as per Government Census Data 2010 and Electoral Voter List 2015-17. The aforesaid configuration forms the sample frame of the present work. The study is undertaken using stratified random sampling technique under probability sampling, Every strata or sub-group i.e. municipal wards of Silchar Town are considered to have an equal probability of being selected randomly.

Rahi (2017) in his paper highlights the thumb-rule for sample size determination applied by authors Krejcie and Morgan (1970). According to them, for a population of 10,00,000, the required sample size is 384. Also, it is calculated that in the present case, for a population of 18,00,000 units, the sample size necessarily does not exceed 384 as obtained from Eqn. 1

$$s = \frac{X^2NP(1-P)}{d^2(N-1) + X^2P(1-P)}$$

where s denote required sample size, X^2 represent table value of Chi-square for 1 degree of freedom at the desired confidence level, N is the population size, P refer to population proportion

(assumed to be 0.50) and d is the degree of accuracy expressed as a proportion (0.05).
Cochran proposed a sampling formula for infinite population given by Eqn. 2

$$n_o = \frac{z^2 p(1-p)}{e^2} \qquad (2)$$

where, n_o is the sample size, Z is a two-tailed area under the normal curve where α = 0.05 and z value is 1.96, e is acceptable sampling error, p is the proportion of the population with the desired attribute (assumed to be 0.5) with an acceptable sampling error of 6.5%. This gives the acceptable sample size which is approximately 267 (Rahi, 2017).

Using Eqn. (3.2), the sample size is found to be 385 using with z value 1.96, e as acceptable sampling error, p being a proportion of the population with the desired attribute (assumed to be 0.5) with an acceptable sampling error of 5% for an infinite population. Further, the modified Cochran formula for the finite population is given by Eqn. 3

$$n = \frac{n_o}{1 + \frac{(n_o - 1)}{N}} \qquad (3)$$

where n_o is Cochran sample size recommendation, N is the population size, n is the new adjusted sample size. Based on the modified Cochran formula, the sample size of the present study is found to be 387 for a finite population count of 2,00,000. Considering universe to be constituted of 2,00,000 people, 1500 people from the study area are chosen by stratified random sampling method who participate in Focus Group Discussion or Personal Interview representing as an individual, member of a family, ward and the Silchar Town per se defining the urban community.

The vulnerability of the people of Silchar Town is classified into three categories - social, economic and physical vulnerability. For a given hazard, total vulnerability is calculated as the total of social, economic and physical vulnerability given by Eqn. 20 to Eqn. 23. The construct of social vulnerability is defined by pertinent items of a questionnaire that are labelled as variables in experiments and are listed in Section A and Section B (Appendix A). Q2, Q3, Q4, Q5 and Q6 of Section A of questionnaire and Q1, Q2, Q3, Q4, Q5 and Q6 of Section B of questionnaire measure social vulnerability. Social vulnerability is calculated in the study from the result of statistical experiments and formulation applied on variables labelled as *Age1, Gender1, Marital1*, *LangKB11*, *LangKH1, LangKE1*, *LangKA1OT1*, *Edu1*, *Tfamily1*, *Fmmbrs1*, *Nowmn1*, *Nochld1*, *Noagd1*, *Bdiffrabl1e* and *Noedu1* (Appendix B) given by Eqn. 4. Economic vulnerability represented by Eqn. 5 is measured from pertinent questions in Sections A, B and C of the questionnaire. Economic vulnerability determiners correspond to Q7 of Section A; Q8, Q9, Q10 and Q11 of Section B; Q1 and Q2 of Section C of the questionnaire (Appendix A). All the variables considered for economic vulnerability are ordinal data that are measured in Likert scale and labelled as *Occupa1t*, *avmfmin1*, *avmfmex1*, *avmfmsv1, avinslif1*, *avinsnf1, Htyp1* and *Hoccpncy1* (Appendix B). Physical vulnerability is hazard-specific and is therefore calculated independently. For earthquake; Q1, Q3, Q4, Q5, Q7, Q8, Q10, Q12, Q23 and Q24 of Section C; Q1 and Q3 of Section D of a questionnaire (Appendix A) are considered. The variables are labelled as *Htyp1*, *Hhght1*, *Hmain1*, *Hage1*, *Hwmat1*, *Hbmat1*, *Hopnspc1*, *Hdisadj1*, *Hroadtyp1*, *Hrdacess1*, *Wtopo1'*, *Wtopo4'*, *Wtopo5'* and *Whouden1* (Appendix B). Physical vulnerability for flood is calculated by formulations given by Eqn. 6 to Eqn. 9 derived from statistical analysis of variables defined by Q1, Q3, Q4, Q5, Q7, Q8, Q11, Q13, Q14, Q15 and Q25 of Section C; Q1, Q2, Q3, Q4 and Q5 of Section D of the questionnaire (Appendix A). The variables are labelled as *Htyp1*, *Hhght1*, *Hage1*, *Hmain1*, *Hwmat1*, *Hbmat2'*, *Htree1*, *Hdrnty1*, *Hflwcpc1*, *Hdrnclr1*, *Hplnth1*, *Wtopo3'*, *Wtopo5'*, *Wlnduseb1d1*, *Wlnduseb1d2'*, *Wlnduseoth1*, *Whouden1*, *Wwtrbodret1, Wwtrbodret2'*, *Wwtrbod1* and *WdisB1* (Appendix B). Physical vulnerability for urban flood is assessed from Q1, Q3, Q4, Q5, Q7, Q8, Q11, Q13, Q14, Q15, Q16 and Q25 of Section C; Q1, Q2, Q3, Q4, Q5 and Q8 of Section D of the questionnaire (Appendix A). Variables are labelled as *Htyp1*, *Hhght1*, *Hage1*, *Hmain1*, *Hwmat1*, *Hbmat2'*, *Htree1*, *Hdrnty1*, *Hflwcpc1*, *Hdrnclr1*, *Hwst1*, *Hplnth1*, *Wtopo3'*, *Wtopo5'*, *Wlndusebld1'*, *Wlndusebld2'*, *Wlnduseoth1*, *Whouden1*, *Wwtrbodret1'*, *Wwtrbodret2'*, *Wwtrbod1*, *Wwtrsrc4'*, *Wwtrsrc5'* and *WdisB*1(Appendix B). Lastly, physical vulnerability due to fire is calculated by variables relating to Q1, Q3, Q4, Q5, Q6, Q7, Q8, Q10, Q12, Q20, Q21, Q22, Q23 and Q24 of Section C of the questionnaire (Appendix A). The considered variables are labelled as *Htyp1*, *Hhght1*, *Hage1*, *Hmain1*, *Hrfmat1*, *Hwmat1*, *Hbmat3'*, *Hopnspc1*, *Hdisadj1*, *Hsmkdet1*, *Hfrextng1*, *Hemrgnext1*, *Hroadtyp1* and *Hrdacess1* (Appendix B). Variables considered for each vulnerability type are assumed to have linear associations expressed by mathematical formulation in Eqn. 4 to Eqn. 13. These variables are subsequently subjected to multiple linear regression analysis using IBM SPSS 21. Social and economic vulnerability are described by labels *SV1'* and *ECOVUL1'* respectively. The physical vulnerability of people of Silchar Town for a given hazard type is labelled as *PVQ1'* - earthquake, *PVFL1'* - flood, *PVUFL1'* - urban flood and *PVFR1'* – fire respectively.

$$SV1' = Age1+Gender1+Marital1+LangKA11+LangKB11+LangKH1+LangKE1+4*LangKA1OT1+Edu1+Tfamily1+Fmmbrs1+Nowmn1+Nochld1+Noagd1+Bdiffrable1+Noedu1 \quad (4)$$

$$ECOVUL1' = Occupat1+avmfmin1+avmfmex1+avmfmsv1+avinslif1+avinsnf1+Htyp1+Hoccpncy1 \quad (5)$$

$$PVQ1' = Htyp1+Hhght1+Hmain1+Hage1+Hwmat1-Hbmat1-Hopnspc1+Hdisadj1+Hroadtyp1+Hrdacess1+Wtopo1'+Wtopo4'+Wtopo5'+Whouden1 \quad (6)$$

$$PVFL1' = Htyp1-Hhght1+Hage1+Hmain1+Hwmat1-Hbmat2'-Htree1+Hdrnty1+Hflwcpc1-Hdrnclr1+Hplnth1+Wtopo3'+Wtopo5'+Wlndusebld1'+Wlndusebld2'+Wlnduseoth1+Whouden1+Wwtrbodret1'+2*Wwtrbodret2'-Wwtrbod1+WdisB1 \quad (7)$$

$$PVUFL1' = Htyp1-Hhght1+Hage1+Hmain1+Hwmat1-Hbmat2'-Htree1+Hdrnty1+Hflwcpc1-Hdrnclr1+Hwst1+Hplnth1+Wtopo3'+Wtopo5'+Wlndusebld1'+Wlndusebld2'+Wlnduseoth1+Whouden1+Wwtrbodret1'+2*Wwtrbodret2'-Wwtrbod1+Wwtrsrc4'+Wwtrsrc5'+WdisB1 \quad (8)$$

$$PVFR1' = Htyp1+Hhght1+Hage1+Hmain1+Hrfmat1+Hwmat1-Hbmat3'-Hopnspc1+Hdisadj1-Hsmkdet1-Hfrextng1-Hemrgnext1+Hroadtyp1+Hrdacess1 \quad (9)$$

$$TVQ1' = ECOVUL1'+SV1'+PVQ1' \quad (10)$$

$$TVFL1' = ECOVUL1'+SV1'+PVFL1' \quad (11)$$

$$TVUFL1' = ECOVUL1'+SV1'+PVUFL1' \quad (12)$$

$$TVFR1' = ECOVUL1'+SV1'+PVFR1' \quad (13)$$

DATA ANALYSIS AND INTERPRETATION

In mathematical formulations given by Eqn. 4 to Eqn. 9, vulnerability is considered as a multi-variable function that is linearly associated without determining how variance in causative factors influence social, economic and physical vulnerability for each type of hazard. Consequently, relevant data is subjected to multiple regression analysis configuring a statistical model with each type of vulnerability given by Eqn. 4 to Eqn. 9 as the dependent variable and respective causative variables of each formulation as independent variables thereby, to infer statistically significant standardized regressive coefficients and obtain new vulnerability equations given by Eqn. 14 to Eqn. 19 now denoted by *SV1R1*, *ECOVUL1R1*, *PVQ1R1*, *PVFL1R1*, *PVUFL1R1* and *PVFR1R1* respectively. Multiple linear regression analysis helps me) to determine the fitness of the model to explain the cause-effect relationship amongst the predictor variables and the predicted variables of vulnerability ii) explicitness of each predictor variable considered as a group as inferred from ANOVA table and iii) by t-test to determine how the variance of each independent variable uniquely affects the variance in the prediction of each type of vulnerability in the study.

A) Social Vulnerability

For social vulnerability, the model summary and ANOVA table are presented in Table 1 (a) and Table 1 (b) respectively.

Table 1(a) and Table 1(b) here

For social vulnerability, the standardised coefficients are presented in Table 2.

Table 2 here

From Table 1 (a) and Table 1 (b) and Table 2 it is observed that, F (16, 885) = 2263.282, p < 0.05 with adjusted R^2 = 0.902, demonstrating high goodness of fit for the model. Approximately, in the model 90.2% variance of the dependent variable is described by variance in independent variables. As observed from the ANOVA table, F-test at p < 0.05 statistically explains significant variance in dependent variable *SV1'* by variance of independent variables taken as a whole, while t-test results demonstrate that variance in *SV1'* is significantly explained by unique variance of each independent variable of the model. Standardised coefficients from Table 6.2 are considered for homogeneity in units of measurement and comparison for prediction. Part correlation result demonstrates positive correlation of all predictors except *LangKB11*, *LangKA11*, *LangKH1*, *LangKE1* and *LangKA1OT1.* Moreover, multicollinearity in predictors is absent as revealed by tolerance and Variance Inflation Factor values in Table 2. *Edu*1 shows the most positive effect followed by *Noedu1*, *Marital1* and *Age1* while *LangKB1*, *LangKA1*, *LangKH1 LangKE1* and *LangKA1OT1* indicate diminished effect on outcome variable *SV1'*.

For economic vulnerability, model summary and ANOVA table are given by Table 3 (a) and Table 3 (b).

Table 3(a) and Table 3(b) here

The regressed equation with standardised coefficients without constant is given by Eqn. 14 with new social vulnerability variable is labelled as *SV1R1*

*SV1R1=0.166*Age1+0.085*Gender1+0.172*Marital1-0.013*LangKA1-.080*LangKB1-0.069*LangKH1 -0.061*LangKE1-.317*4*LangKA1OT1+0.264*Edu1+0.119*Tfamily1+0.103*Fmmbrs1+0.156* Nowmn1+0.149*Nochld1+0.120*Noagd1+0.060*Bdiffrable1+0.257*Noedu1*

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(14)

B) Economic Vulnerability

For economic vulnerability, standardised coefficients are presented in Table 4.

Table 4 here

From Table 3 (a) and Table 3 (b) for economic vulnerability, it is observed that F (8, 893) = 2721.331, $p < 0.05$ with adjusted $R^2 = 0.89$, demonstrating high goodness fit for the model as approximately 89.10 % of the variance in dependent variables is explained by predictor variables variance. F-test at $p < 0.05$ explains statistically significant variance of dependent variable *ECOVUL1'* by variance of independent variables taken as a whole observed from ANOVA table. Also, t-test results reveal that variance in *ECOVUL1'* is significantly explained by the unique variance of each independent variable. Standardised coefficients from Table 4 are considered for uniformity in units and comparison for prediction. Part correlation shows a positive correlation of all predictors and absence of multicollinearity as understood from tolerance and Variance Inflation Factor values in Table 4. The average value of family life insurance *avinslif1* exerts the most positive effect followed by *Hoccpncy1*, *avinsnf1, Occupat1*, *avmfmin1*, *avmfmsv1* etc. on outcome variable *ECOVUL1'*. The regressed equation formed by standardised coefficients without constant is given by Eqn. 15 with a new economic vulnerability variable labelled as *ECOVUL1R1* for the study.

*ECOVUL1R1=0.251*Occupat1+0.238*avmfmin1+0.214*avmfmex1+0.236*avmfmsv1+0.285*avinsl if1+0.268*avinsnf1+0.139*Htyp1+0.273*Hoccpncy1* (15)

C) Physical Vulnerability

The model summary and ANOVA table for physical vulnerability towards earthquake are given in Table 5 (a) and Table 5 (b) respectively. Its Standardised coefficients are presented in Table 6.

Table 5(a) and 5(b) here

Table 6 here

It is observed from Table 5 (a) and 5 (b) that, F (14, 887) = 3108.221, $p < 0.05$ with adjusted R^2 = 0.893, which indicates high goodness of fit for the model. F-test at $p < 0.05$ also demonstrates statistically significant variance in dependent variable *PVQ'1* by variance of independent variables taken as a whole observed from ANOVA table. t-test results reveal variance of *PVQ1'* is significantly explained by the unique variance of each independent variable. Standardised coefficients from Table 6 are applied due to uniformity in units and intragroup comparison necessary for the prediction of the dependent variable. Positive dependence is found by Part correlation for fall predictors except for *Hbmat1'* and *Hopnspc1* and absence of multicollinearity are observed from tolerance and Variance Inflation Factor values in Table 6. Age of house *Hage1* is found to exert the most positive effect followed by other variables like house maintenance *Hmain1*, the distance between adjacent house *Hdisadj1*, house height *Hhght1* and wall material of house *Hwmat1* on outcome variable *PVQ1'*. The regressed equation formed by standardised coefficients without constant is given by Eqn. 16 with new physical vulnerability for earthquake variable labelled as *PVQ1R1*.

*PVQ1=0.226*Htyp1+0.282*Hhght1+0.428*Hmain1+0.456*Hage1+0.270*Hwmat1-0.140*Hbmat1'-0.131*Hopnspc1+0.365*Hdisadj1+0.286*Hroadtyp1+0.236*Hrdacess1+0.057*Wtopo1'+0.023**

*Wtopo4'+0.086*Wtopo5'+0.204*Whouden 1* (16)

Model summary and ANOVA table for physical vulnerability towards flood are represented by Table 7 (a) and Table 7 (b).

Table 7(a) and Table 7(b) here

For flood, standardised coefficients are presented in Table 8.

Table 8 here

From Table 7 (a) and Table 7 (b) it is seen that, F (21, 880) = 3067.126, $p < 0.05$ having adjusted R^2 = 0.948, indicating high goodness of fit for the model. F-test at $p < 0.05$ shows statistically significant variance in dependent variable *PVFL1'* by variance of independent variables taken as a whole interpreted from ANOVA table. According to t-test results, variance in dependent variable *PVFL1'* is significantly explained by the unique variance of each independent variable. Standardised coefficients without constant from Table 8 are considered for the prediction of the dependent variable. A positive correlation is observed from Part correlation for all predictors except *Hhght1*, *Hbmat2'*, *Htree1, Hdrnclr1* and *Wwtrbod1*. The absence of multicollinearity in predictors is observed from tolerance and Variance Inflation Factor values in Table 8. Age of house *Hage1* exerts the most positive effect followed by other variables like house maintenance *Hmain1*, drain type of house *Hdrnty1*, plinth level *Hplnth1*, a distance of the house from the river Barak/major canal *WdisB1* and wall material of house *Hwmat*1 on outcome variable *PVFL1'*. The regression equation with standardised coefficients without constant for the physical vulnerability of flood is given by Eqn. 17 labelled as *PVFL1R1* for the study.

*PVFL1R1=0.135*Htyp1-0.169*Hhght1+0.273*Hage1+0.256*Hmain1+0.161*Hwmat1-0.082*
Hbmat2'-0.082*Htree1+0.227*Hdrnty1+0.116*Hflwcpc1-0.084*Hdrnclr1+0.182*Hplnth1+
0.064*Wtopo3'+0.052*Wtopo5'+0.050*Wlndusebld1'+0.084*Wlndusebld2'+0.036*Wlnduseoth1
+0.122*Whouden1+0.078*Wwtrbodret1'+0.162*2*Wwtrbodret2'-0.080Wwtrbod1+0.209*WdisB
1* (17)

Model summary and ANOVA table for physical vulnerability due to urban flood are given in Table 9 (a) and Table 9 (b).

<u>Table 9(a) and table 9(b) here</u>

Standardised coefficients of physical vulnerability for flood are presented in Table 10.

<u>Table 10 here</u>

From Table 9 (a), Table 9 (b) and Table 10 it is observed that, F (24, 877) = 657.720, $p < 0.05$ having adjusted R^2 = 0.911, which implies high goodness of fit for the model. F-test at $p < 0.05$ explains statistically significant variance in dependent variable *PVUFL1'* by variance of independent variables taken as a whole, inferred from ANOVA table. t-test significantly explains variance in *PVUFL1'* by unique variance of each independent variable of the model. Age of house *Hage1* exerts the most positive effect followed by other variables like house maintenance *Hmain1*, drain type of house *Hdrnt1y*, plinth level *Hplnth1*, a distance of the house from the river Barak/major canal *WdisB1*, wall material of house *Hwmat*1 and flow capacity of drain *Hflwcp1c* on outcome variable *PVUFL1'*. The regression equation of physical vulnerability for urban flood with standardised coefficients without constant is given by Eqn. 18 labelled as *PVUFL1R1*.

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*PVUF1R1=0.129*Htyp1-0.161*Hhght1+0.261*Hage1+0.244*Hmain1+0.154*Hwat1-0.078*Hbmat2'-0.078*Htree11+0.217*Hdrty1+0.111*Hflwcpc1-0.080*Hdrnclr1+0.074*Hwst1+0.174*Hplnth1+ 0.061*Wtopo3'+0.049*Wtopo5'+0.048*Wlndusebld1'+0.080*Wlndusebld2'+0.034*Wlnduseoth1 +0.117*Whouden1+0.074*Wwtrbodret1'+0.080*2*Wwtrbodret2'-0.076*Wwtrbod1+0.044* Wwtrsrc4'+0.009 *Wwtrsrc5'+0.20 0*WdisB1* (18)

Model summary and ANOVA table for physical vulnerability due to fire, are presented in Table 11 (a) and Table 11 (b).

Table 11(a) and Table 11(b) here

Standardised coefficients of physical vulnerability for fire are presented in Table 12.

Table 12 here

from Table 11 (a), Table 11 (b) and Table 12 it is observed that, F (14, 887) = 664.196, $p < 0.05$ having adjusted R^2 = 0.917, which indicates high goodness of fit for the model. F-test at $p < 0.05$ significantly explains the statistical variance in dependent variable *PVFR1'* by variance of independent variables taken as a whole inferred from ANOVA table and t-test also significantly explains variance in *PVFR1'* by unique variance of each independent variable of the model. House age, house height, house type, the distance between the house, roof and wall material of the house are significantly positive contributors to the physical vulnerability of fire. The regression equation with standardised coefficients without constant is given by Eqn. 19 with new physical vulnerability for fire variable labelled as *PVFR1R*.

*PVFR1R1=0.203*Htyp1+0.254*Hhght1+0.410*Hage1+0.384*Hmain1+0.265*Hrfmat1+0.243*Hw mat1-0.125*Hbmat3'-0.117*Hopnspc1+0.328*Hdisadj1-0.035*Hsmkdet1-0.083*Hfrextng1-0.126* Hemrgnext1+0.257*Hroadtyp1+0.212*Hrdacess1* (19)

D) Total vulnerability

For earthquake, total vulnerability is calculated using multiple linear regression analysis again on social vulnerability *SV1R1*, economic vulnerability *ECOVUL1R1* and *PVQ1R1* to assess the relationship amongst each of these predictor variables through F-test in ANOVA table and from t-test result. The variance in each independent variable uniquely affects the variance in the prediction of the dependent variable of total vulnerability due to earthquakes. Total vulnerability for an earthquake is construed from the model summary and ANOVA table given in Table 13 (a) and Table 13 (b) respectively.

Table 13(a) and Table 13(b) here

Standardised coefficients of total vulnerability for an earthquake are presented in Table 14.

Table 14 here

From Table 13 (a), Table 13 (b) and Table 14 it is observed that, F (20, 881) = 3256.34, $p < 0.05$ having adjusted R^2 = 0.917, indicating high goodness of fit for the model. F-test at $p < 0.05$ explains significantly that statistical variance in the dependent variable *TVQ1'* by variance of independent variables taken as a whole inferred from ANOVA table and t-test significantly also explains variance in *TVQ1'* by unique variance of each independent variables of the model. The most positive effect is demonstrated by social vulnerability on total vulnerability followed by the economic and physical vulnerability. Total vulnerability for earthquake *TVQ1'* is now transformed by regression equation with standardised coefficients without constant to a new total vulnerability variable labelled as *TVQ2'* given by Eqn. 20.

*TVQ2'=0.450*ECOVUL1R1+0.505*SV1R1+0.231*PVQ1R1* (20)

Multiple linear regression analysis is again performed to calculate total vulnerability for flood on social vulnerability *SV1R1*, economic vulnerability *ECOVUL1R1* and physical vulnerability for flood *PVFL1R1.* The regression analysis is performed to calculate the relationship between each predictor variable obtained from the F-test of ANOVA table and through t-test. Further, it enables to evaluate how variance in each of the independent variables uniquely affects variance in the prediction of the dependent variable thereby helping to obtain a new total vulnerability variable for the flood. Model summary and ANOVA table for total vulnerability for flood are presented in Table 15 (a) and Table 15 (b) respectively.

Table 15(a) and Table 15(b) here

Standardised coefficients of total vulnerability for flood are presented in Table 16.

Table 16 here

From Table 15 (a), Table 15 (b) and Table 16 it is observed that, F (20, 881) = 16894.287, $p < 0.05$ having adjusted R^2 = 0.979, which indicates high goodness of fit for the model. F-test at $p < 0.05$ explains significantly statistical variance in the dependent variable *TVFL1'* by variance of independent variables taken as a whole inferred from ANOVA table. t-test significantly explains the variance in *TVFL1'* by unique variance of each independent variable of the model. The important factors are social vulnerability followed by a physical and economic vulnerability that determine total vulnerability for the flood. Total vulnerability for flood *TVFL1'* is now transformed into a new variable labelled as *TVFL2'* using regression equation with standardised coefficients without constant given by Eqn. 21.

*TVFL2'=0.382*ECOVUL1R1+0.399*SV1R1+0.392*PVFL1R1* (21)

For urban flood total vulnerability is calculated using multiple linear regression analysis on social vulnerability *SV1R1*, economic vulnerability *ECOVUL1R1* and physical vulnerability for urban flood *PVUFL1R1*. Regression analysis enables the calculation of the relationship amongst each predictor variable through F-test in the ANOVA table and by t-test. Further, it enables to estimate how variance in each independent variable uniquely affects variance in the prediction of the dependent variable thus obtaining a new total vulnerability variable due to urban flood. For urban floods, the model summary and ANOVA table are given in Table 17 (a) and Table 17 (b).

Table 17(a) and 17(b) here

For urban floods, standardised coefficients of total vulnerability are presented in Table 18.

Table 18 here

From Table 17 (a), Table 17 (b) and Table 18 it is observed that, F (3, 898) = 20826.259, $p < 0.05$ having adjusted R^2 = 0.939, indicating a high goodness of fit for the model. F-test at $p < 0.05$ explains significantly statistical variance in the dependent variable *TVUFL1'* by variance of independent variables taken as a whole inferred from ANOVA table. t-test result explains variance in *TVUFL1'* uniquely variance of each independent variable of the model significantly. Physical vulnerability factor exerts the strongest influence followed by social and economic vulnerability on total vulnerability for the urban flood. The corresponding new variable for *TVUFL1'* is labelled as *TVUFL2'* obtained using regression analysis with standard coefficients without constant given by Eqn. 22.

*TVUFL2' = 0.377*ECOVUL1R1+0.394*SV1R1+0.405*PVUFL1R1* (22)

To calculate total vulnerability for fire, multiple linear regression analysis is performed on social vulnerability *SV1R1*, economic vulnerability *ECOVUL1R1* and *PVFR1R1* which helps determine the relationship amongst the predictor variables through the ANOVA table. t-test result helps evaluate how the variance of each independent variable uniquely affects variance in the prediction of the dependent variable, thus obtaining a new total vulnerability variable due to fire variable. Model summary and ANOVA table for total vulnerability due to fire are given by Table 19 (a) and Table 19 (b).
Table 19(a) and table 19(b) here
For total vulnerability for fire, standardised coefficients of are presented in Table 20.

Table 20 here

From Table 19 (a), Table 19 (b) and Table 20 it is observed that, F (3, 898) = 5618.176, $p < 0.05$ having adjusted R^2 value 0.906, indicating high goodness of fit for the model. F-test done at $p < 0.05$ significantly explains variance in the dependent variable *TVFR1'* by variance of independent variables taken as a whole given by ANOVA table. t-test result significantly explains variance in *TVFR1'* by unique variance of each independent variable of the model. From the model, it is observed that social vulnerability exerts the greatest influence followed by economic and physical vulnerability on total vulnerability due to fire. Total vulnerability for fire *TVFR1'* is transformed into a new variable labelled as *TVFR2*' using regression equation with standardised coefficients without constants given by Eqn. 23

*TVFR2' = 0.426*ECOVUL1R1+0.445*SV1R1+0.291*PVFR1R*1
(23)

The mean value of vulnerability and corresponding standard for four hazards viz. earthquake, flood, urban flood and fire is recorded in Table 21. Descriptive analysis using IBM SPSS 21 gives the mean and standard deviation of each of the vulnerability variables given by Eqn. 11 to Eqn. 20. *SV1R1, ECOVUL1R1, PVQ1R1, PVFL1R1, PVUFL1R1, PVFR1R1, TVQ2', TVFL2', TVUFL2'* and *TVFR2'* are obtained using multiple regression analysis and linear mathematical formulation with new transformed vulnerability variables of four hazards originally denoted by *SV1', ECOVUL1', PVQ1', PVFL1', PVUFL1', PVFR1', TVQ1', TVFL1', TVUFL1'* and *TVFR1'* in statistical models.

Table 21 here

Vulnerability indices for social vulnerability, economic vulnerability, physical vulnerability due to earthquake, flood, urban flood, fire hazard, total vulnerability for earthquake, flood, urban flood and fire hazard are presented in Table 22. For social vulnerability, the *SV1R1* index is considered low if the mean value lies in the range of 3.1968 to 4.3845, medium in the range of 4.3846 to 4.8522 and high in the range of 4.8523 to 5.3199. Economic Vulnerability, *ECOVUL1R1* index is low if the mean value lies in the range 4.5392 to 5.1529, a medium between 5.1530 to 5.7666 and high in the range of 5.7667 to 6.3803. Indices of physical vulnerability for earthquake denoted by *PVQ1R1* is low if the mean value lies between 7.5818 to 8.24711, the medium between 8.2472 to 8.9124 and high between 8.9125 to 9.5773. Physical vulnerability for flood denoted by variable *PVFL1R1* index is low if mean lies between 4.5840 to 5.2623, the medium between 5.2624 to 5.9406 and high between 5.9407 to 6.6190. Physical vulnerability for urban flood denoted by *PVUFL1R1* index is low if the mean value lies between 4.4100 to 5.0730, the medium between 5.0731 to 5.7360 and high between 5.7361 to 6.3990. Physical vulnerability for fire denoted by *PVUFR1R1* index is low if the mean value lies between 6.5679 to 7.2283, the medium between 7.2284 to 8.0087 and high between 8.0088-8.7292. Total vulnerability due to earthquake denoted by *TVQ2'* is considered low if the mean value lies between 16.3165 to 17.7614, the medium between 17.7615 to 19.2063 and high between 19.2064 to 20.6514. Total vulnerability for flood, *TVFL2'* is low if the mean value lies between 13.3187 to 14.9185, the medium between 14.9186 to 16.5183 and high between 16.5184 to 18.1181. Total vulnerability for urban flood, *TVUFL2'* is low if the mean value is between 13.1447 to 14.7107, the medium between 14.7108 to 16.2767 and high between 16.2768 to 17.8427. Total vulnerability for fire, *TVFR2'* is if mean value is in range of 15.3026 to 16.6637, medium in the range of 16.6638 to 18.0248 and high in the range of 18.0248-19.386.

Table 22 here

The vulnerability due to considered hazards is grouped into the low, medium and high categories on basis of indices given in Table 23. A vulnerability zonation map is prepared based on indices for different vulnerability types with geographical North and the scale of 1cm = 1km. The Colour scheme is designated for zonation wherein green colour denotes low, yellow colour depicts medium and red colour signifies high value for each type of vulnerability. Fig. 1 to Fig. 10 represents a zonation map of various vulnerability types for various wards of Silchar Town.

Wards 2, 4, 5, 12, 17, 18, 21, 22, 23, 25, 26, 27, 28 and 29 show low social vulnerability, a medium social vulnerability in wards 3, 6, 7, 8, 10, 11, 13, 14, 15, 16, 19, 20 and 24 while high social vulnerability in wards 1 and 9 only. Overall social vulnerability of Silchar Town is found to be medium. Wards 4, 5, 18, 21, 22, 23, 25, 27, 28 and 29 show low economic vulnerability, medium economic vulnerability in wards 2, 9, 10, 11, 12, 13, 14, 15, 16, 17, 19, 20, 24 and 26, high economic vulnerability in wards 1, 3, 6, 7 and 8. Overall economic vulnerability of Silchar Town is found medium.

Table 23 here

Figure 1 to Fig 10 here

Low physical vulnerability due to earthquake is observed in wards 5, 19, 22, 23 and 29, medium in wards 4, 8, 9, 10, 11, 12, 15, 16, 17, 20, 21, 25, 26 and 27 while high in wards 1, 2, 3, 6, 7, 13, 14, 18, 24 and 28. Overall physical vulnerability for Silchar Town due to an earthquake is found medium. For flood, physical vulnerability is observed to be low in wards 22 and 23 only, medium in wards 4, 5, 8, 13, 15, 16, 17, 19, 20, 21, 25, 26, 27 and 29 while high in wards 1, 2, 3, 6, 7, 9, 10, 11, 12, 14, 18, 24 and 28. Overall physical vulnerability due to flood is found medium for Silchar Town. Low physical vulnerability due to urban flood is observed in wards 22 and 23 only, medium in wards 4, 5, 8, 9, 10, 13, 15, 16, 17, 19, 20, 21, 25, 26 27 and 29 while high in wards 1, 2, 3, 6, 7, 11, 12, 14, 18, 24 and 28. Overall for Silchar Town physical vulnerability due to urban flood is found medium. Low physical vulnerability for fire is observed in wards 5, 19, 22, 23 and 29, medium in 2, 4, 9, 11,12, 15, 16, 20, 21, 25, 26 and 27 while high in wards 1, 3, 6, 7, 8, 10, 13, 14, 17, 18, 24 and 28. Overall physical vulnerability for Silchar Town due to fire is found medium. Total vulnerability for an earthquake is observed as low in wards 4, 5, 19, 21, 22, 23, 25, 27 and 29, wards 2, 9, 11, 12, 13, 15, 16, 17, 18, 26 and 28, medium while wards 1, 3, 6, 7, 8, 10, 14, 20 and 24 have high total vulnerability. Overall, for Silchar Town, total vulnerability due to earthquakes is medium. Total vulnerability for flood is observed low in wards 5, 21, 22, 23, 25, 27 and 29, a medium vulnerability in wards 2, 4, 9, 10, 11, 12, 14, 15, 16, 17, 19, 20, 24, 26 and 28 while high vulnerability in wards 1, 3, 6, 7, 8, 13 and 18. Overall, for Silchar Town total vulnerability due to flood is observed as the medium. For urban flood, total vulnerability is observed as low in wards 5, 21, 22, 23, 25, 26, 27 and 29, the medium vulnerability in wards 2, 4, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 and 28 while high vulnerability in wards 1, 3, 6, 7, 8 and 24. Overall, for Silchar Town total vulnerability due to urban flood is found medium. For fire, total vulnerability is observed low in wards 5, 21, 22, 23, 25, 27 and 29, wards 2, 4, 11, 12, 16, 17, 18, 19, 26 and 28 have medium vulnerability while the high vulnerability is found in wards 1, 3, 6, 7, 8, 9, 10, 13, 14, 15, 20 and 24. Overall, for Silchar Town, total vulnerability due to fire is found medium.

The socio-economic profile of 901 respondents given by descriptive statistics measured by age, gender, marital status, languages known, educational background, occupation, type of family, number of family members, number of women, number of children, number of aged people, number of disabled people, number of educated members in the family together with average monthly income, expenses, savings and the average value of insurance cover of family. From Fig.11 (a) it is observed that respondents in the age group of 45 to 60 years form the majority representing 31.9% of them. 29.6% of respondents are in the age group of 30 to 45 years, 25.2%. respondents are in the age group of 15 to 30 years, 12.3% are in the age group of fewer than 15 years while 1% of respondents are above the age group of 60 years. Fig. 11 (b) represents that, female respondents are 51.2%, male 47.8% while 1% are others category. Fig. 11 (c) demonstrates married respondents are 52.8% of participants, 30.9% respondents single, 13.3% are widow, 2.3% separated while 0.7% widower. According to Fig. 11 (d), 60% of participants know Bengali, Assamese is known by 0.7% of respondents, Hindi known by 23%, English known by 16% and 36% know all these languages.

Fig 11(a) to Fig 11(d) here

The educational background of respondents in frequency per cent is given by Figure 12. From the figure, it is observed that uneducated respondents are around 40%, 18% respondents below class 5, 10% fall in the category of class 5 to 10, 10% of respondents fall in the category of class 10 to 12 while graduate and above are 22%.
Fig 12 here

From Fig.13 it is observed that service holders are 48.2%, 18.3% self-employed, 7.6% wage earners, 14.3% retired and 11.6% unemployed.

Fig 13 here
Regarding the type of family of participants, it is observed from Fig. 14 (a) and Fig. 14 (b) that, 64.1% live in the nuclear family, extended family 22.3%, joint family 12.3% and 1.3% live individually. Respondents having 3 to 5 family members is 72.4%, 6 to 8 family members is 18.9%, 9 to 11 family members is 6%, 2.3% have family members less than 3 while 0.3% have family members greater than 11.
Fig 14(a) and 14 (b) here

The configuration of the family of the respondent in frequency per cent is given in Figure 15. From the figure, it is observed, respondents with no women in the family are 0.7%, no children 32.2%, no aged members in family 31.9%, no differently-abled member 85.4% and 45.8% do not have even one educated member in the family. Also, only one woman in family 33.9%, one child 43.5%, at least one aged member 52.2%, one psychiatric or physically differently-abled person 14.3% and 8% have a single educated member in the family. Two women in the family are around 40.9%, two children 18.6%, two aged members 14.6%, two differently-abled persons 0.3% and 10.3% have two educated members. Respondent family having three women members is 15%, three children 4%, three aged members 0.7% and 21.9% have three educated members in the family. From the analysis, it is evident that respondents having more than three women is 9.6%, more than three children are 1.7%, more than three aged members is 0.7% and 14% have more than three educated members in the family.

Fig 15 here

Respondents' monthly income, expense and saving are given in Fig.16 (a), 16 (b) and 16 (c) in terms of frequency distribution. Participants having monthly income below 5,000 is about 37.5%; income range 15,000 to 20,000 is 35.5%; income range 10,000 to 15,000 is 13%; income range 5,000 to 10,000 is 10.6% and 3.3% have income above 20,000. Monthly expense greater than 17,000 is 34.9% ; expense in range 7,000-12,000 is 33.6%; expense in range 2,000 to 7,000 is 19.6%; expense in range 12,000 to 17,000 is 8.6% and 3.3% have expense less than 2,000. Also, respondents with no monthly savings is 33.6%, savings in range of 1,000 to 3,000, 24.9% respondents have savings in range of 3,000 to 5,000. 8.6% have monthly savings less than 1,000 and 8% have savings greater than 5,000.

Fig 16(a), 16(b) and 16(c) here

Insurance coverage of respondents for both life and non-life type is depicted in Fig. 17. Respondents with no life insurance coverage is 24.9%, less than 1,00,000 is 6.6%; life insurance coverage between 1,00,000 to 3,00,000 is 13.3%; life insurance coverage between 3,00,000 to 5,00,000 is 12.3% and 42.5% have life insurance coverage above 5,00,000. No non-life insurance coverage is 18.9%, less than 1,00,000 is 2.3%; non-life insurance coverage between 1,00,000 to 3,00,000 is 3%; non-life insurance coverage between 3,00,000 to 5,00,000 is 16.3% and 59.5% have non-life insurance coverage above 5,00,000.

Fig 17 here

Frequency per cent on some salient factors of hazard and vulnerability using descriptive statistics over the sample N = 901 respondents are summarized. A descriptive study of physical vulnerability factors shows that respondents living in their own house are 41.9%, 46.5% stay in rented houses, 11% stay in shared houses and 1.7% stay in a public place. 49.2% of respondents reside in RCC houses, 30.2% in semi RCC, 19.6% in wood and bamboo house and 1% reside in a mud house. 42.5% reside in houses with one storey, 35.9% reside in the two-storied house, 13.3% reside in a three-storied house, 5.6% reside in the four-storied house and 2.7% reside in a five-storied house, 16.6% of respondents do monthly maintenance of their house, 2.3% do quarterly maintenance, 3.3% maintain half-yearly, 5% maintain annually, while 72.8% do need-based maintenance of the house. 53.8 % of people opine that they have used earthquake-resistant building material, 59.8% have used flood-resistant building material, 54.5% have used fire-resistant building material and 46.2% have used building material resistant to all considered hazards. 7.3% of respondents live in houses with concrete walls, 53.8% have brick cement walls,12% have net Cement walls in the house and 26.9% have bamboo made walls. Regarding distance between adjacent buildings, 10.3% have no distance with the adjacent house,10% have < 3 ft distance, 14% have 3 ft distance, 32.9% have 4 ft distance and 32.9% have > 4 ft distance with adjacent house. 30.9% of respondents live in houses whose age is less than 5 years, 15.3% live in a house whose age is 5 to 10 years, 16.6% live in 10 to 15 years old houses, 7.3% live in 15 to 20 years old houses while 29.9% reside in the house whose age is more than 20 years. Respondents having no open space around their house is 68.1%. 31.9% of participants have open space around their house. 20.3% of the respondents have concrete road type, 17.3% have CC block, 30.9% have mettled roads and 30.9% of the respondents have kutcha road type About 18.6% respondents opine that housing density in their ward is medium, 43.2% say low and 38.2% say housing density of ward is high. Sufficient flow capacity of the drain is opined by 33.7%, 66.3% are of opinion flow capacity of drain insufficient. 46.2% opine that drain is cleared while 53.8% say drain is not cleared. 69.1% are of opinion waste is thrown in a drain while 30.9% say waste is not thrown in drain. 6.6% of respondents have plinth of house < 1 ft. 7.6% have plinth 1 - 2ft, 13.6% have plinth 2 - 3ft, 50.5% have plinth 3 - 4ft while 21.6% say plinth of house > 4 ft. Interestingly, about 61.5% of people do not have trees around their houses. 55.1% have concrete drain type, 13.3% have concrete and covered drain type, 0.3% have kutcha drain type, 30.6% have drain made of hume pipes, 0.7% have another drain type. Respondents with emergency exit doors in their house are 49.5% while 50.5% of people do not have emergency exit doors. 98% do not have smoke detectors installed in the house while 87.7% do not have a fire extinguisher in the house. Regarding topography of ward, 4.3% of respondents are of opinion that hillocks are present in their ward, 90% opine about the presence of plain lands inward, 17.9% opine on the presence of low lands, 0.7% opine about steep slopes inward and 10.6% say that there are places inward near river/canal bank. Regarding major land-use inwards of Silchar Town, 70% are of opinion that major land-use inward are residential buildings, 28% say commercial buildings and 2% say others while all say that major land-use inward is not social and cultural buildings. 2% of respondents say that barren land is present in their ward. 65.8% of participants say that water bodies are present inward while 34.2% opine that there are no water bodies. About, 31.6% say water bodies present are protected by retaining walls inward. About 16.3% of the participants say the Barak river/major canal is less than 1 km from their ward, 19.6% say distance is 1 km, 19.3% say distance is 2 km and 24.8% say distance is 3 km from the ward and the rest say distance is above 3km. Regarding roof material of the house, about 16.6% say usage of asbestos as roof material, 2.3% use metal sheets, 3.3% concrete roof, 5% use bamboo and grass while 72.8% use another type of roof material. It is revealed that 50.5% of people do not have an emergency exit door in the house.

CONCLUSIONS

Although, previous studies on CBDRM reveal that, education reduces vulnerability ironically, here in this study evidences that indicate formal education levels necessarily do not have an impact on disaster literacy or awareness. Social vulnerability for people of Silchar Town is medium with inter ward variations of low, medium and high. Aged, separated couples, single parents, unmarried, widows or widowers are found more socially vulnerable. On one hand, families with fewer children, women, differently-abled persons, aged members while on the other hand, families having disaster risk awareness living jointly are less vulnerable. Earning, pregnant, ill-health women and lactating mothers are found socially very vulnerable. People incapable of reading or writing in various regional and national languages, differently-abled people, geriatric patients, female, transgender and aged people above sixty are found to be more vulnerable.

In an assessment of economic vulnerability, participants have identified occupation, average monthly family income, saving, life and non-life insurance value, house type and occupancy as determining factors. Unemployed, inconsistent wage earners, people with lesser monthly family income and savings, higher monthly family expense, lesser life and non-life insurance value and people living in a shared house made of mud, wood and bamboo in informal settlements or slum areas are found to be economically weak. These people are also found trapped in the debt cycle making them more vulnerable economically and easy prey of private lenders or exploitative microfinance creditors. However, the economic vulnerability of the people of Silchar Town is found to be medium with inter ward low, medium and high levels of economic vulnerability.

Physical vulnerability is influenced by hazard-specific factors. For earthquake hazard, people have identified that age of house exerts the most positive effect followed by other factors such as frequency of house maintenance, the distance between adjacent house, house height, wall material of the house, type of house and accessibility of road to the house. Lack of open space around the house increases vulnerability due to earthquakes. However, the physical vulnerability of people of Silchar Town for an earthquake is found medium with inter ward low, medium and high vulnerability. For flood hazards, significant determiners are the age of the house, frequency of house maintenance, drain type of house, a distance of the house from the river Barak/major canal, plinth level of the house, wall material of the house, water bodies without retaining wall and house density. Lesser is drain clearance and the number of water-retaining bodies, higher is a vulnerability for the flood. However, the physical vulnerability of people of Silchar Town for flood is found medium with inter ward low, medium and high vulnerability. Similarly, for urban flood, participants have identified age of the house, frequency of house maintenance, drain type of house, plinth level, the distance of the house from the river Barak/major canal, wall material of house and flow capacity of the drain as important drivers of physical vulnerability. The physical vulnerability of people of Silchar Town for urban flood is found medium with ward wise low, medium and high vulnerability. For fire hazard, respondents have identified house age, the height of the house, type of house, distance between house, roof and wall material of house as significant positive contributors to physical vulnerability for fire. The presence of water source, smoke detectors, fire extinguishers, access road to the house, emergency exit door, open space around the house, periodic electrical maintenance, fireproof wall and roof material of house are found to bear decreasing effect on vulnerability. The physical vulnerability of people of Silchar Town for fire is found medium with ward wise low, medium and high vulnerability.

An assessment of the total vulnerability of people of Silchar Town, social, economic and physical factors of vulnerability are considered for earthquake, flood, urban flood and fire hazard. For earthquakes, social vulnerability shows the most positive effect on total vulnerability followed by the economic and physical vulnerability. In the case of flood, social vulnerability followed by physical and economic vulnerability are found as important factors determining total vulnerability. For urban floods, physical vulnerability exerts the strongest influence followed by the social and economic vulnerability. For fire, social vulnerability exerts the most dominant influence followed by the economic and physical vulnerability. Statistical models and analyses suggest that the total vulnerability of people of Silchar Town for earthquake, flood, urban flood and fire is medium with inter ward low, medium and high vulnerability.

Results from descriptive statistical analyses of few but important determining factors of vulnerability over the sample N = 901, when extrapolated to the population of the study, presents some significant inferences, albeit with limitations. However, a more detailed survey and investigation are necessary for more inferences on these determining factors.

Bengali is the most prevalent language known Assamese is known to only 0.7% of people indicating a socio-cultural gap with the Brahmaputra Valley. Approximately 40% of people residing in Silchar Town are uneducated, 22% of them are graduates and beyond. Constitution of families are changing rapidly mainly due to socio-economic and cultural factors as corroborated by results of descriptive analyses Income opportunity for the people of Silchar Town is limited inferred from analyses Also, insurance value of life, non-life and health needs to be extended beyond Below Poverty Line families. Silchar Town in the last two decades like all other urban centres have witnessed rapid and unplanned building construction in commercial and residential areas. Ironically, many of such constructions are violative to standard protocols for safe building regulations of the Government of Assam. Reconstruction and renovation of housing structures of slum or informal settlement dwellers need suitable policy formulation. The maintenance frequency of the house needs to be enhanced. Open spaces around houses are fast disappearing. Risk enforcement by the local authority is found to be weak and also awareness of citizens on compliance of safe building protocols of the Government is poor as inferred from the observation that in there are cases wherein the requisite distance between houses is absent. Public infrastructure in Silchar Town like roads, lane and bye lanes, footpaths, walkways, bridges, sluice gates, markets, playgrounds, parking places, drains, water bodies, parks, socio-cultural buildings etc. are inadequate and stressed indicated from the findings of the study. Only 20.3% of people state that the road to their house is concrete, Unplanned urbanisation, unsustainable development practices and solid waste disposal mechanisms are major drivers of urban flood hazard, which is manifested from the statistical findings. The majority of households are dependent on PHE supply water Emergency exit doors, smoke detectors and fire extinguishers are absent in the majority of houses.

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APPENDIX A QUESTIONNAIRE

Kindly mark (√) against every response inappropriate place/cells for sharing your valued opinion.
AOT *means All of these,* **NOT** *means None of these in the questionnaire.*

A. About Me.

1.	**Resident of Ward No**	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28				
2.	**Age in years**	< 15	15 – 30	30 - 45	45 - 60	> 60
3.	**Gender:**	Male	Female	Other		
4.	**Marital status**	Married	Single	Separated	Widow	Widower
5.	**Languages known**	Bengali	Assamese	Hindi	English	All of these.
6.	**Education**	Uneducated	Below Class 5	Class 5-10	Class 10-12	Graduate and above
7.	**Occupation**	Service	Self-employed	Wage- earner	Retired	Unemployed

B. My Famil

1.	**Type of family**	Individual	Nuclear	Extended	Joint	Other
2.	**No. of family members**	<3	3-5	6-8	9-11	> 11
3.	**No. of women**	None	1	2	3	>3
4.	**No. of children**	None	1	2	3	>3
5	**No. of aged people**	None	1	2	3	>3
6.	**No. of differently able (physical &/or**	None	1	2	3	>3

	psychiatric)						
7.	**No. of educated members**	None		1	2	3	>3
8.	**Avg. Monthly income of family (Rs.)**	<5000		5000-10000	10000-15000	15000-20000	>20000
9.	**Avg. Monthly expense of family (Rs.)**	<2000		2000-7000	7000-12000	12000-17000	>17000
10.	**Avg. Monthly savingsof family (Rs.)**	NIL		<1000	1000-3000	3000-5000	>5000
11.	**Avg. value of insurance cover of family Life and Non Life(Rs.)**	**Life**	NIL	< 100000	100000-300000	300000-500000	>500000
		Non-Life	NIL	< 100000	100000-300000	300000-500000	>500000

C. My House

1	**Type of house**	RCC	Semi –RCC	Wood and Bamboo	Mud	Other
2	**Occupancy type**	Own house	Rented house	Shared house	Public place	
3	**Height**	1 storey	2 storied	3 storied	4 storied	>4 storied
4	**Age in years**	<5	5-10	10-15	15-20	More than 20 years
5	**Maintenance**	Monthly	Quarterly	Half-yearly	Annually	Need-based
6	**Roof material**	Asbestos	Metal sheets	Concrete	Bamboo and grass	Other
7	**Wall material**	Concrete	Brick -cement	Net-cement	Bamboo	Mud
8.	**Building material**	Earthquake resistant	Flood resistant	Fire resistant	All of these	None of these
9	**Boundary wall**	**Yes**		**No**		
10	**Sufficient open space**	**Yes**		**No**		
11	**Sufficient trees around my house**	**Yes**		**No**		
12	**Distance between adjacent buildings**	Attached	<3feet	3ft	4 ft	>4ft
13	**Drain type**	Concrete	Concrete and covered	Kutcha	Hume pipe	Other
14	**Flow capacity of drain sufficient**	**Yes**		**No**		
15	**Drain cleared**	**Yes**		**No**		
16	**Waste thrown in drain**	**Yes**		**No**		
17	**Main source of energy**	Electricity	Solar energy	Organic energy	Other	
18	**Cooking energy**	LPG	Kerosene	Electricity	Wood	Coal

19	**Utilities available**	TV Radio	Mobile	Internet	**2wheeler**	**3wheeler**	4wheeler	Heavy vehicle
					Bike	Rickshaw		
					Bicycle	Autorickshaw		
					Scooty	Toto		

20	**Smoke detectors**	**Yes**		**No**		
21	**Fire extinguisher**	**Yes**		**No**		
22	**Emergency exit doors**	**Yes**		**No**		
23	**Type of road**	Concrete	C.C block	Metaled	Unmetalled/Kutchha	Other
24	**Road accessible by**	2 wheeler	3 wheeler	4 wheeler	Heavy vehicle	
25	**Plinth level**	<1 ft	1 - 2 ft	2-3 ft	3-4 ft	>4 ft

Universe International Journal of Interdisciplinary Research
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D. My ward

1	**Topography of my ward**	Hillock	Plains	Low land	Slope	River/Canal bank	
2	**Major land use in my ward**	Buildings				Water Bodies	Barren land
		Residence	Commercial	Office	Social and cultural		
3	**Housing density in my ward**	Very High	High	Medium	Low	Very low	
4	**Presence of water bodies (ponds/rivers/lakes) in my ward**	**Yes**	**No**				
		With retaining walls					
		Without retaining walls					
5	**Distance of the Barak River/major khaal from my ward**	<1km	1 km	2 km	3km	>3 km	

Appendix B Implication of Variables

Age1	Age in years
Gender1	Gender
Marital1	Marital status
LangKB1	Knowledge of Bengali language
LangKA1	Knowledge of Assamese language
LangKH1	Knowledge of Hindi language
LangKE1	Knowledge of English language
LangKAOT1	Knowledge of these languages
Edu1	Educational qualification
Occupat1	Occupation
Tfamily1	Type of family
Fmmbrs1	Number of family members
Nowmn1	Number of women in family
Nochld1	Number of children in family
Noagd1	Number of aged members in family
Bdiffrable1	Number of differently abled members in family
Noedu1	Number of educated members in family
avmfmin1	Average monthly income of family
avmfmex1	Average monthly expense of family
avmfmsv1	Average monthly saving of family
avinslif1	Average value of life insurance of family
Avinsnf1	Average value of non-life insurance of family
Htyp1	Type of house
Hoccpncy1	Occupancy type
Hhght1	Height of house

Hage1	Age of house
Hmain1	Frequency of maintenance of house
Hrfmat1	Roof material of house
Hwmat1	Wall material of house
Hbmat1'	Building material is earthquake resistant
Hbmat2'	Building material is flood resistant
Hbmat3'	Building material is fire resistant
Hbmat4'	Building material is resistant to considered hazards
Hbmat5'	Building material is non-resistant to considered hazards
Hbndwall1	Boundary wall of house
Hopnspc1	Sufficient open space around house
Htree1	Sufficient trees around house
Hdisadj1	Distance between house and adjacent building
Hdrnty1	Drain type of house
Hflwcpc1	Flow capacity of house drain
Hdrnclr1	Drain of house is cleared
Hwst1	Waste from house is thrown in drain
Hsmkdet1	Smoke detector in house
Hfrextng1	Fire extinguisher in house
Hemrgnext1	Emergency exit doors in house
Hroadtyp1	Road type connected to house
Hrdacess1	Road accessibility of house
Hplnth1	Plinth level of house

Appendix C Figures

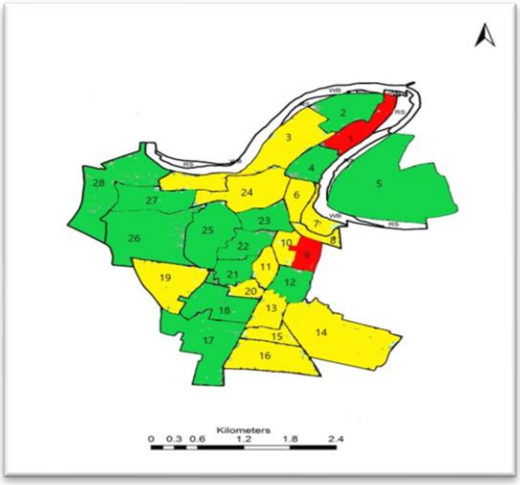

Fig. 1 Economic vulnerability mapping

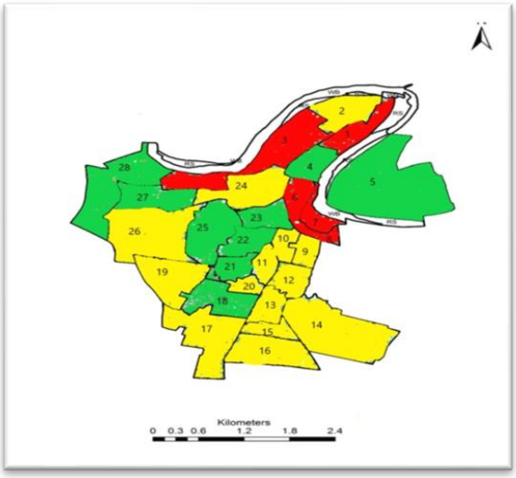

Fig. 2 Social vulnerability mapping

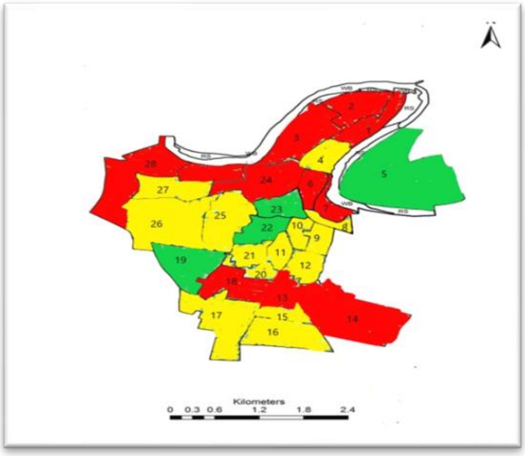

Fig. 3 Physical vulnerability mapping for earthquake

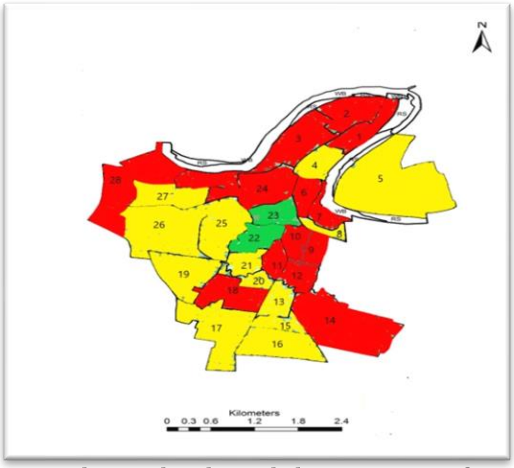

Fig. 4 Physical vulnerability mapping for flood

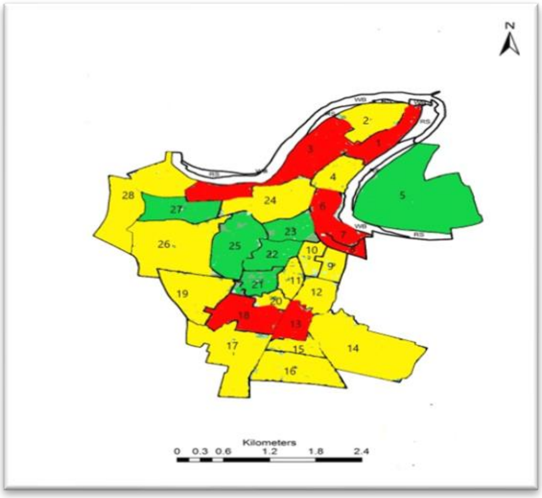

Fig. 5 Physical vulnerability mapping for urban flood

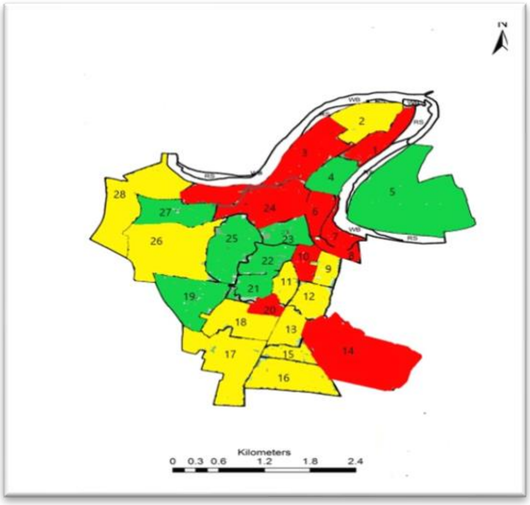

Fig. 6 Physical vulnerability mapping for fire

Low Medium High

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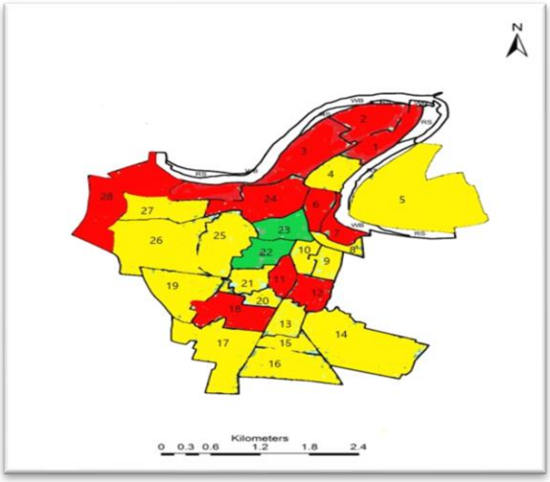

Fig. 7 Total vulnerability mapping for earthquake

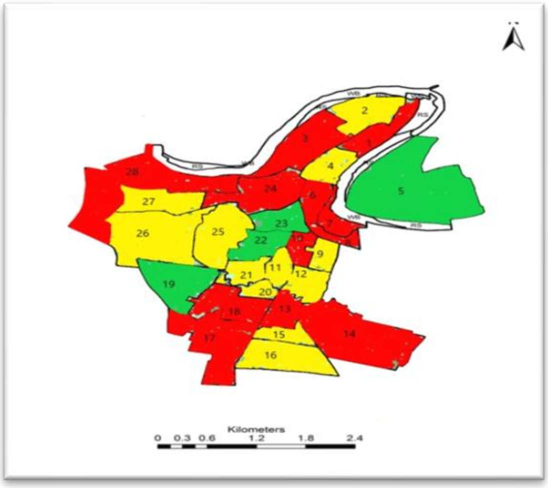

Fig. 8 Total vulnerability mapping for flood

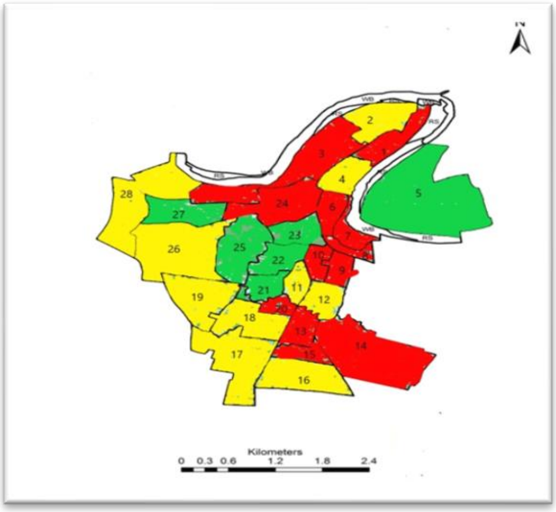

Fig. 9 Total vulnerability mapping for urban flood

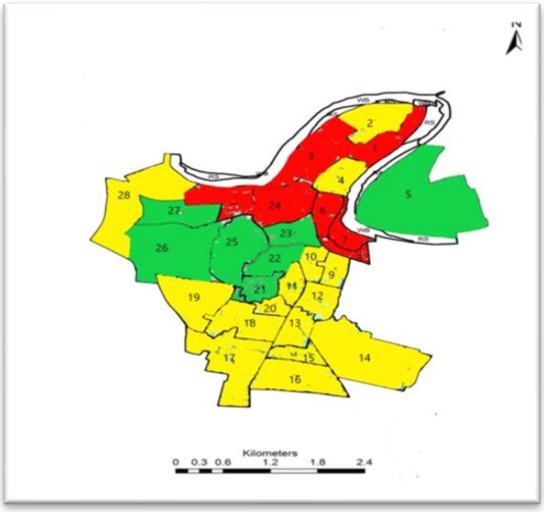

Fig. 10 Total vulnerability mapping for fire

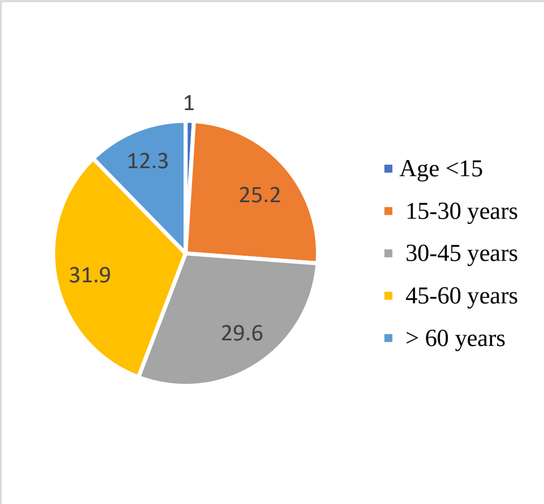

Fig. 11 (a) Age of respondents

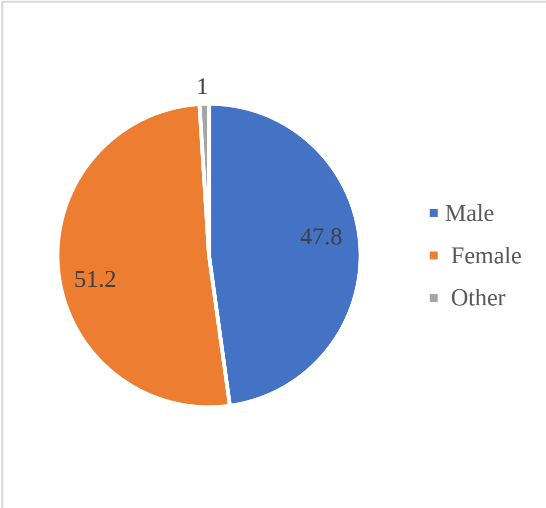

Fig.11 (b) Gender of respondents

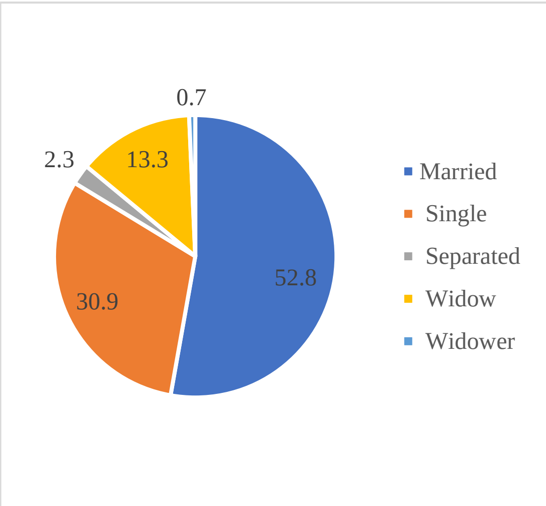

Fig. 11 (c) Marital status of respondents

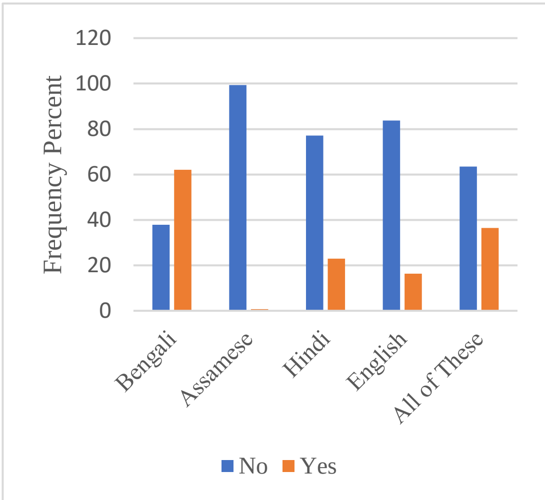

Fig. 11 (d) Languages known by respondents

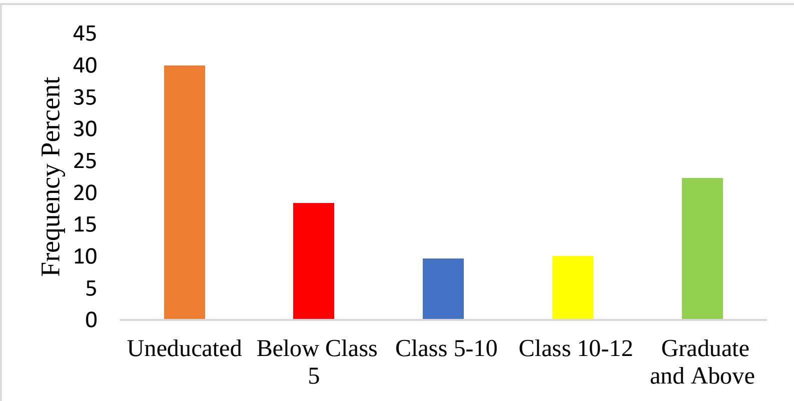

Fig. 12 Educational background of respondents

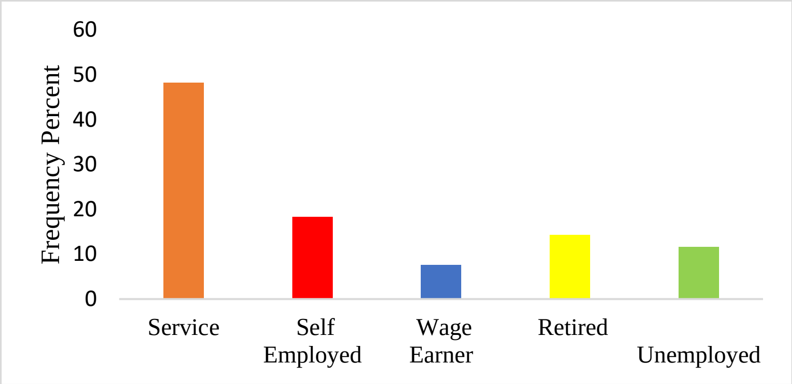

Fig. 13 Occupation of respondents

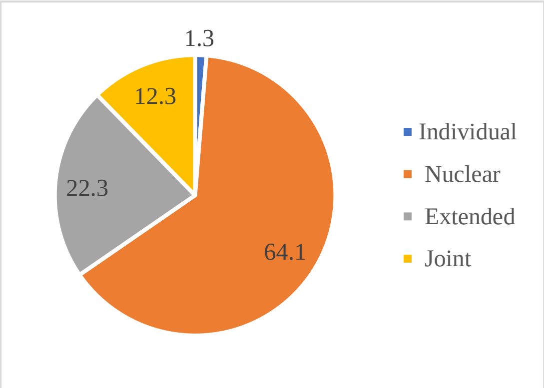

Fig. 14 (a) Type of family of respondents

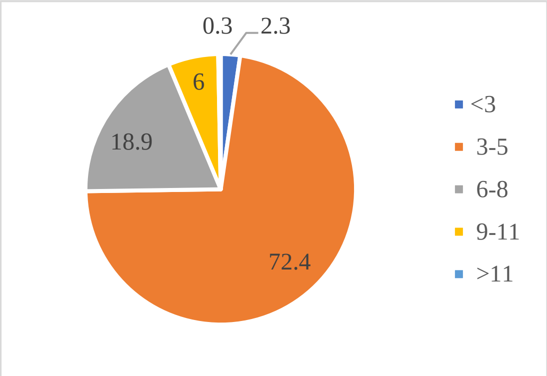

Fig. 14 (b) Number of family members of respondents

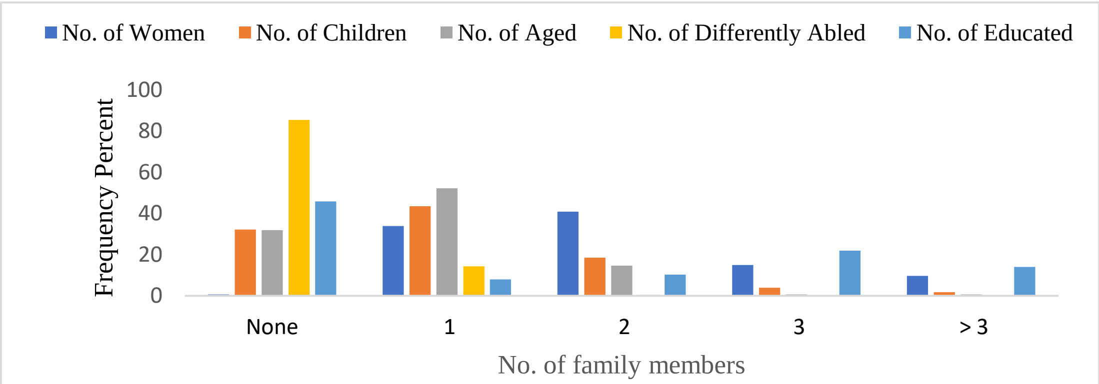

Fig. 15 Type of family members of respondents

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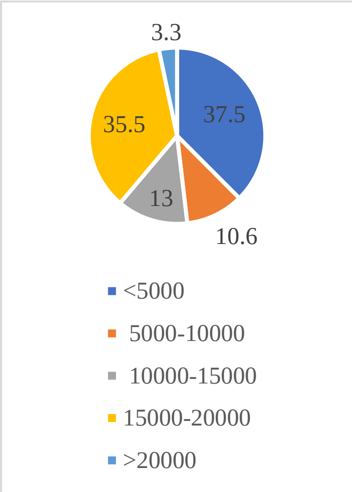

Fig. 16 (a) Monthly income of respondents

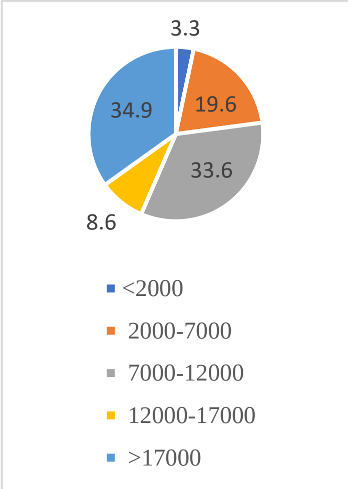

Fig. 16 (b) Monthly expense of respondents

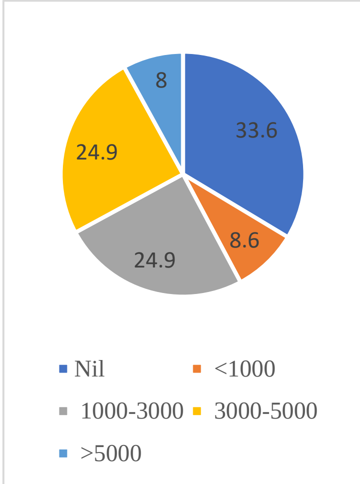

Fig. 16 (c) Monthly savings of respondents

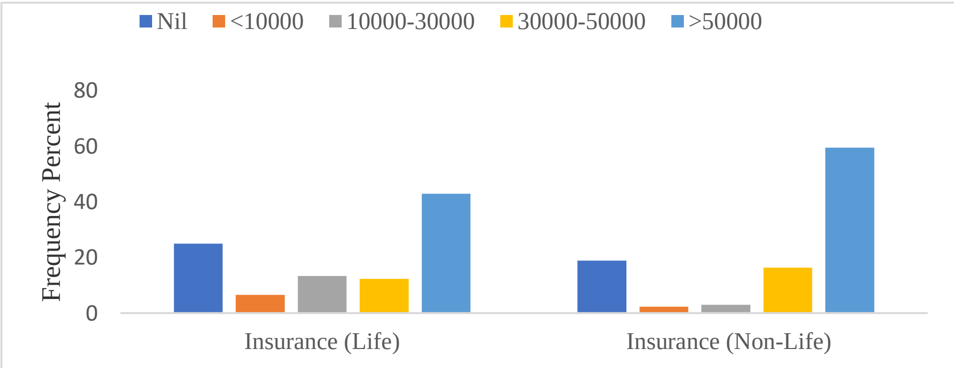

Fig. 17 Insurance value of respondents

Appendix D Tables

Table 1 (a) Model summary of social vulnerability

Model Summary

Model	R	R Square	Adjusted R Square	Std. The error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.923[a]	.911	.902	.00364	.911	1688.362	16	885	.000

a. Predictors: *(Constant), Noedu1, Tfamily1, LangKA11, LangKH1, Age1, Gender1, Noagd1, Nochld1, Bdiffrable1, Marital1, Nowmn1, LangKB11, LangKE1, Edu1, Fmmbrs1, LangKA1OT1*

Table 1 (b) ANOVA table of social vulnerability

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11102.671	16	693.917	1688.362	.000[b]
	Residual	364.248	885	.411		
	Total	11466.919	901			

a. Dependent Variable: *SV1'*

b. Predictors: *(Constant), Noedu1, Tfamily1, LangKA11, LangKH1, Age1, Gender1, Noagd1, Nochld1, Bdiffrable1, Marital1, Nowmn1, LangKB11, LangKE1, Edu1, Fmmbrs1, LangKA1OT1*

Table 2 Standardised coefficients of social vulnerability

Model		Standardized Coefficients	t value	Sig.	Collinearity Statistics	
		Beta			Tolerance	VIF
1	*Constant*					
	Age1	0.166	29.874	.004	0.758	1.319
	Gender1	0.085	15.675	.000	0.744	1.345
	Marital1	0.172	24.342	.003	0.538	1.860
	LangKB11	-0.080	-17.634	.000	0.350	2.744
	LangKA11	-0.013	-13.621	.021	0.818	1.223
	LangKH1	-0.069	-29.478	.000	0.357	2.610
	LangKE1	-0.061	-15.301	.000	0.317	2.159
	LangKA1OT1	-0.317	-16.345	.000	0.045	2.004
	Edu1	0.264	27.742	.000	0.294	3.403
	Tfamily1	0.119	44.298	.030	0.396	2.527
	Fmmbrs1	0.103	18.118	.000	0.294	3.402
	Nowmn1	0.156	21.390	.000	0.537	1.863
	Nochld1	0.149	34.685	.000	0.577	1.735
	Noagd1	0.120	18.774	.000	0.778	1.285
	Bdiffrable1	0.060	22.654	.002	0.667	1.500
	Noedu1	0.257	27.065	.000	0.468	2.135

a. Dependent Variable: *SV1'*

Table 3 (a) Model summary of economic vulnerability

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.898[a]	.895	.891	.00731	.895	1794.623	8	893	.000

a. Predictors: *(Constant), Hoccpncy1, Htyp1, Occupat1, avmfmex1, avinsnf1, avinslif1, avmfmsv1, avmfmin1*

Table 3 (b) ANOVA table of economic vulnerability

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10150.392	8	1268.799	1794.623	.000[b]
	Residual	632.023	893	.707		
	Total	10782.415	901			

a. Dependent Variable: *ECOVUL1'*

b. Predictors: *(Constant), Hoccpncy1, Htyp1, Occupat1, avmfmex1, avinsnf1, avinslif1, avmfmsv1, avmfmin1*

Table 5 (a) Model summary of physical vulnerability for earthquake

Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.898[a]	.893	.889	.00078	.893	924.381	14	887	.000

a. Predictors: *(Constant), Whouden1, Hroadtyp1, Wtopo4', Wtopo1', Wtopo5', Hrdacess1, Hage1, Hbmat1', Hmain1, Hopnspc1, Hhght1, Hdisadj1, Hwmat1, Htyp1*

Table 5 (b) ANOVA table of physical vulnerability for earthquake

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12830.645	14	273.617	924.381	.000[b]
	Residual	263.312	887	.296		
	Total	13093.957	901			

a. Dependent Variable*: PVQ1'*

b. Predictors: *(Constant), Whouden1, Hroadtyp1, Wtopo41, Wtopo1', Wtopo5', Hrdacess1, Hage1, Hbmat1', Hmain1, Hopnspc1, Hhght1, Hdisadj1, Hwma1t, Htyp1*

Table 6 Standardised coefficients of physical vulnerability for earthquake

Model		Standardized Coefficients	t value	Sig.	Correlation	Collinearity Statistics	
		Beta			Part	Tolerance	VIF
1	*(Constant)*						
	Htyp1	0.226	137.091	.018	0.124	0.300	3.336
	Hhght1	0.282	128.092	.000	0.195	0.479	2.089
	Hage1	0.456	232.601	.000	0.333	0.532	1.880
	Hmain1	0.428	111.991	.006	0.367	0.736	1.359
	Hwmat1	0.270	241.685	.000	0.157	0.339	2.949
	Hbmat1'	-0.140	-218.704	.009	-0.113	0.649	1.541
	Hopnspc1	-0.131	-92.634	.000	-0.108	0.686	1.458
	Hdisadj1	0.365	47.256	.000	0.275	0.568	1.761
	Hroadtyp1	0.286	133.203	.000	0.241	0.711	1.407
	Hrdacess1	0.236	176.152	.000	0.200	0.722	1.385
	Wtopo1'	0.057	186.872	.035	0.055	0.931	1.074
	Wtopo4'	0.023	124.121	.000	0.022	0.96	1.042
	Wtopo5'	0.086	141.835	.000	0.081	0.879	1.137
	Whouden1	0.204	304.704	.000	0.177	0.753	1.327

a. Dependent Variable*: PVQ1'*

Table 7 (a) Model summary of physical vulnerability for flood

Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.966[a]	.959	.948	.00032	.959	438.234	21	880	.000

a. Predictors: *(Constant), WdisB1, Hflwcp1c, Wlnduseoth1, Wwtrbodret2', Wtopo3', Hplnth1, Htree1, Wtopo5', Wlndusebld2', Hmain1, Hbmat2', Hage1, Whouden1, Wwtrbodret1', Wlndusebld1', Hhght1, Hdrnclr1, Hdrnt1y, Hwmat1, Htyp1, Wwtrbod1*

Table 7 (b) ANOVA table of physical vulnerability for flood

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10703.017	21	509.667	438.234	.000[b]
	Residual	1023.678	880	1.163		
	Total	11726.695	901			

a. Dependent Variable: *PVFL1*

b. Predictors: *(Constant), WdisB1, Hflwcp1c, Wlnduseoth1, Wwtrbodret2', Wtopo3', Hplnth1, Htree1, Wtopo5', Wlnduseblld2', Hmain1, Hbmat2', Hage1, Whouden1, Wwtrbodret'1, Wlnduseblld1', Hhght1, Hdrnclr1, Hdrnt1y, Hwmat1, Htyp1, Wwtrbod1*

Table 8 Standardised coefficients of physical vulnerability for flood

Model		Standardized Coefficients	t value	Sig.	Correlation	Collinearity Statistics	
		Beta			Part	Tolerance	VIF
1	*(Constant)*						
	Htyp1	0.135	248.022	.000	0.069	0.257	3.889
	Hhght1	-0.169	-312.089	.000	-0.109	0.420	2.382
	Hage1	0.273	403.023	.000	0.185	0.462	2.165
	Hmain1	0.256	323.105	.000	0.216	0.714	1.401
	Hwmat1	0.161	260.547	.000	0.083	0.261	3.828
	Hbmat2'	-0.082	-89.981	.033	-0.061	0.544	1.838
	Htree1	-0.082	-97.632	.000	-0.068	0.702	1.425
	Hdrnty1	0.227	284.003	.000	0.147	0.417	2.396
	Hflwcpc1	0.116	18.112	.000	0.082	0.493	2.030
	Hdrnclr1	-0.084	-19.734	.000	-0.060	0.515	1.943
	Hplnth1	0.182	318.467	.025	0.161	0.776	1.289
	Wtopo3'	0.064	79.608	.000	0.057	0.776	1.289
	Wtopo5'	0.052	88.241	.000	0.045	0.759	1.317
	Wlnduseblld1'	0.050	86.073	.000	0.041	0.675	1.481
	Wlnduseblld2'	0.084	91.088	.000	0.067	0.645	1.551
	Wlnduseoth1	0.036	10.634	.000	0.033	0.856	1.168
	Whouden1	0.122	12.780	.000	0.101	0.679	1.474
	Wwtrbodret1'	0.078	76.328	.000	0.028	0.131	7.654
	Wwtrbodret2'	0.162	254.322	.000	0.054	0.712	1.404
	Wwtrbod1	-0.080	-81.707	.000	-0.026	0.709	1.410
	WdisB1	0.209	311.373	.000	0.183	0.766	1.306

a. Dependent Variable: *PVFL1'*

Table 9 (a) Model summary of physical vulnerability for urban flood

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	,923[a]	.920	.911	.006382	.920	657.720	24	877	.000

a. Predictors: *(Constant), Wwtrsrc5', Wlnduseoth1, Wlnduseblld1', Whouden1, Wwtrbod1, Hmain1, Hplnth1, Wtopo5', Htree1, Wtopo'3, Hwst1, WdisB1, Hflwcpc1, Hbmat2', Hage1, Wwtrbodret1', Wlnduseblld2', Hhght1, Wwtrsrc4', Hdrnclr1, Hdrnty1, Hwmat1, Htyp1, Wwtrbodret2'*

Table 9 (b) ANOVA table of physical vulnerability for urban flood

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11744.252	24	489.344	657.720	.000[b]
	Residual	678.866	877	.774		
	Total	12423.118	901			

a. Dependent Variable: *PVUFL1*

b. Predictors: *(Constant), Wwtrsrc5', Wlnduseoth1, Wlndusebld1', Whouden1, Wwtrbod1, Hmain1, Hplnth1, Wtopo5', Htree1, Wtopo3', Hwst1, WdisB1, Hflwcpc1, Hbmat2', Hage1, Wwtrbodret1', Wlndusebld2', Hhght1, Wwtrsrc4', Hdrnclr1, Hdrnty1, Hwmat1, Htyp1, Wwtrbodret2'*

Table 10 Standardised coefficients of physical vulnerability for urban flood

Model		Standardized Coefficients	t value	Sig.	Correlation	Collinearity Statistics	
		Beta			Part	Tolerance	VIF
1	*(Constant)*						
	Htyp1	0.129	248.022	.000	0.065	0.250	3.997
	Hhght1	-0.161	-312.089	.000	-0.103	0.411	2.432
	Hage1	0.261	403.023	.033	0.176	0.454	2.202
	Hmain1	0.244	323.105	.000	0.205	0.704	1.420
	Hwmat1	0.154	260.547	.000	0.078	0.255	3.917
	Hbmat2'	-0.078	-89.981	.000	-0.058	0.538	1.859
	Htree1	-0.078	-97.632	.000	-0.065	0.701	1.426
	Hdrnty1	0.217	284.003	.000	0.140	0.417	2.397
	Hflwcpc1	0.111	18.112	.000	0.077	0.487	2.054
	Hdrnclr1	-0.08	-19.734	.001	-0.056	0.496	2.017
	Hwst1	0.074	318.467	.000	0.063	0.718	1.392
	Hplnth1	0.174	79.608	.000	0.152	0.767	1.304
	Wtopo3'	0.061	88.241	.000	0.053	0.757	1.321
	Wtopo5'	0.049	86.073	.041	0.037	0.562	1.781
	Wlndusebld1'	0.048	91.088	.023	0.039	0.666	1.502
	Wlndusebld2'	0.08	10.634	.000	0.063	0.618	1.617
	Wlnduseoth1	0.034	12.780	.000	0.031	0.838	1.193
	Whouden1	0.117	76.328	.009	0.095	0.666	1.501
	Wwtrbodret1'	0.074	254.322	.000	0.027	0.429	2.331
	Wwtrbodret2'	0.154	81.707	.000	0.051	0.715	1.398
	Wwtrbod1	-0.076	-11.373	.011	-0.025	0.605	1.652
	WdisB1	0.200	17.233	.000	0.174	0.76	1.316
	Wwtrsrc4'	0.044	79.608	.034	0.033	0.552	1.812
	Wwtrsrc5	0.009	28.241	.000	0.009	0.948	1.055

a. Dependent Variable: *PVUFL1'*

Table 11 (a) Model summary of physical vulnerability for fire

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change

1	.896[a]	.891	.872	.00345	.872	664.196	14	887	.000
a. Predictors: *(Constant), Hemrgnext1, Hroadtyp1, Hsmkdet1, Hopnspc1, Hrdacess1, Hbmat3', Hfrextng1, Hmain1, Hage1, Hdisadj1, Hrfmat1, Hhght,1 Htyp1, Hwmat1*									

Table 11 (b) ANOVA table of physical vulnerability for fire						
ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4742.359	14	338.740	664.196	.000[b]
	Residual	453.112	887	.510		
	Total	5195.471	901			
a. Dependent Variable: *PVFR1*						
a. Predictors: *(Constant), Hemrgnext1, Hroadtyp1, Hsmkdet1, Hopnspc1, Hrdaces1s, Hbmat3', Hfrextng1, Hmain1, Hage1, Hdisadj1, Hrfmat1, Hhght1, Htyp1, Hwmat1*						

Table 12 Standardised coefficients of physical vulnerability for fire							
Model		Standardized Coefficients	t value	Sig.	Correlation	Collinearity Statistics	
		Beta			Part	Tolerance	VIEW
1	*(Constant)*						
	Htyp1	0.203	39.238	.003	0.108	0.282	3.540
	Hhght1	0.254	28.141	.000	0.162	0.407	2.459
	Hage1	0.410	80.123	.000	0.293	0.509	1.963
	Hmain1	0.384	51.188	.000	0.317	0.681	1.467
	Hrfmat1	0.265	40.221	.000	0.155	0.344	2.911
	Hwmat1	0.243	32.280	.000	0.117	0.233	4.295
	Hbmat3'	-0.125	-86.182	.000	-0.098	0.608	1.644
	Hopnspc1	-0.117	-54.221	.010	-0.099	0.712	1.405
	Hdisadj1	0.328	91.707	.000	0.248	0.572	1.747
	Hsmkdet1	-0.035	-11.373	.000	-0.032	0.851	1.176
	Hfrextng1	-0.083	-273.233	.000	-0.062	0.565	1.771
	Hroadtyp1	0.257	79.608	.000	0.216	0.705	1.419
	Hrdacess1	0.212	128.241	.000	0.178	0.703	1.423
	Hemrgnext1	-0.126	-56.328	.000	-0.107	0.716	1.397
a. Dependent Variable: *PVFR1'*							

Table 13 (a) Model summary of total vulnerability for earthquake									
Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.992[a]	.985	.985	.00880	.985	19579.923	3	898	.000
a. Predictors: *(Constant), PVQ1R1, SV1R1, ECOVUL1R1*									

Table 13 (b) ANOVA table of total vulnerability for earthquake					
ANOVA[a]					
Model	Sum of Squares	df	Mean Square	F	Sig.

1	Regression	57388.855	3	19129.618	19579.923	.000b
	Residual	877.418	898	.977		
	Total	58266.273	901			
a. Dependent Variable: *TVQ1'*						
b. Predictors*: (Constant), PVQ1R1, SV1R1, ECOVUL1R1*						

Table 14 Standardised coefficients of total vulnerability for earthquake

Model		Standardized Coefficients	t value	Sig.	Correlation	Collinearity Statistics	
		Beta			Part	Tolerance	VIF
1	*(Constant)*						
	SV1R1	0.505	380.103	.000	0.378	0.561	1.783
	ECOVUL1R1	0.450	451.811	.000	0.315	0.490	2.043
	PVQ1R1	0.231	640.001	.000	0.204	0.781	1.28
a. Dependent Variable: *TVQ1'*							

Table 15 (a) Model summary of total vulnerability for flood

Model Summary

Model	R	R Square	Adjusted R Square	Std. The error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.987a	.979	.970	.00310	.979	16894.287	3	898	.000
a. Predictors: *(Constant), PVFL1R1, SV1R1, ECOVUL1R1*									

Table 15 (b) ANOVA table of total vulnerability for flood

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	69739.668	3	23246.556	16894.287	.000b
	Residual	1235.982	898	1.376		
	Total	70975.650	901			
a. Dependent Variable: *TVFL1'*						
b. Predictors: *(Constant), PVFL1R1, SV1R1, ECOVUL1R1*						

Table 16 Standardised coefficients of total vulnerability for flood

Model		Standardised Coefficients	t value	Sig.	Correlation	Collinearity Statistics	
		Beta			Part	Tolerance	VIF
1	*(Constant)*						
	SV1R1	0.399	801.353	.000	0.291	0.531	1.885
	ECOVUL1R1	0.382	554.123	.000	0.266	0.485	2.062
	PVFL1R1	0.392	406.101	.000	0.309	0.623	1.606
a. Dependent Variable: *TVFL1'*							

Table 17 (a) Model summary of total vulnerability for urban flood

Model Summary

Model	R	R	Adjusted	Std.	Change Statistics

		Square	R Square	Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.953[a]	.947	.939	.04181	.947	20826.259	3	898	.000
a. Predictors: *(Constant), PVUFL1R1, SV1R1, ECOVUL1R1*									

Table 17 (b) ANOVA table of total vulnerability for urban flood						
ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	71538.206	3	23846.069	20826.259	.000[b]
	Residual	1028.692	898	1.145		
	Total	72566.898	901			
a. Dependent Variable: *TVUFL1'*						
a. Predictors: (*Constant), PVUFL1R1, SV1R1, ECOVUL1R1*						

Table 18 Standardised coefficients of total vulnerability for urban flood							
Model		Standardized Coefficients	t value	Sig.	Correlation	Collinearity Statistics	
		Beta			Part	Tolerance	VIF
1	*(Constant)*						
	SV1R1	0.394	1891.883	.000	0.288	0.533	1.877
	ECOVUL1R1	0.377	3654.321	.000	0.263	0.487	2.054
	PVUFL1R1	0.405	5406.181	.000	0.322	0.633	1.579
a. Dependent Variable: *TVUFL1'*							

Table 19 (a) Model summary of total vulnerability for fire									
Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.917[a]	.912	.906	.00302	.912	5618.176.	3	898	.000
a. Predictors: *(Constant), PVFR1R1, SV1R1, ECOVUL1R1*									

Table 19 (b) ANOVA table of total vulnerability for fire						
ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	56058.266	3	18686.089	5618.176	·000[b]
	Residual	2987.312	898	3.326		
	Total	56058.266	901			
a. Dependent Variable: *TVFR1'*						
b. Predictors: *(Constant), PVFR1R1, SV1R1, ECOVUL1R1*						

Table 20 Standardised coefficients of total vulnerability for fire					
Model	Standardized Coefficients	t value	Sig.	Correlation	Collinearity Statistics

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FEB. 2022 | Vol. 2 Issue 9
www.uijir.com

		Beta			Part	Tolerance	VIF
1	*(Constant)*						
	SV1R1	0.445	1076.312	.000	0.330	0.550	1.819
	ECOVUL1R1	0.426	1241.018	.000	0.283	0.442	2.261
	PVFR1R1	0.291	740.001	.000	0.224	0.591	1.691
a. Dependent Variable: *TVFR1'*							

Table 21 Ward wise mean and standard deviation of different types of vulnerabilities for considered hazards

WARD NO.		*SV1R1*	*ECOVUL1R1*	*PVQ1R1*	*PVFL1R1*	*PVUFL1R1*	*PVFR1R1*	*TVQ2'*	*TVFL2'*	*TVUFL2'*	*TVFR2'*
1	Mean	5.3199	6.3803	8.9512	6.4179	6.1425	8.1358	20.6514	18.1181	17.8427	19.836
	Std. Dev	.94481	.25868	0.57137	.33528	.35075	.56529	.313	.29592	2.29065	.2966
2	Mean	4.3269	5.4467	8.9202	6.172	5.8626	7.9448	18.6938	15.9456	15.6362	17.7184
	Std. Dev	.93163	.84503	.12559	.93651	.87553	.18475	.77748	.94369	2.88931	.8326
3	Mean	4.4497	5.8602	9.4206	6.4453	6.1504	8.5337	19.7305	16.7552	16.4603	18.8436
	Std. Dev	.69899	.76933	.93159	.53608	.52317	.94936	.296	.85788	0.88954	.33259
4	Mean	4.3456	5.0221	8.3886	5.7747	5.5184	7.5487	17.7563	15.1424	14.8861	16.9164
	Std. Dev	.86979	.47412	.18234	.82369	.81743	.12882	.84492	.63462	2.67861	.88294
5	Mean	4.0961	4.8486	7.6959	5.73	5.4757	6.9248	16.6406	14.6747	14.4204	15.8695
	Std. Dev	.87200	.03555	.12152	.98352	.90044	.08426	.10373	.72046	1.70207	.13254
6	Mean	4.5507	6.3209	9.2438	6.259	6.062	8.3939	20.1154	17.1306	16.9336	19.2655
	Std. Dev	0.83091	.27024	.20184	.2937	.27409	.27841	.79474	.92709	1.9391	.83521
7	Mean	4.3866	6.1968	8.9187	6.111	5.9087	8.0346	19.5021	16.6944	16.4921	18.618
	Std. Dev	.17586	.31891	.31738	.47921	.50669	.4743	.61528	.90012	2.92882	.80459
8	Mean	4.8416	6.1277	8.7255	5.7954	5.5606	8.14	19.6948	16.7647	16.5299	19.1093
	Std. Dev	.58462	.11583	.765	.88711	.86534	.60847	.73074	.08055	2.05729	.50556
9	Mean	4.891	5.5445	8.6433	5.9564	5.6466	7.8678	19.0788	16.3919	16.0821	18.3033
	Std. Dev	.6373	.80405	.73644	.7188	.74295	.49274	.24446	.28816	2.28811	.39733
10	Mean	4.8145	5.5703	8.8404	5.9552	5.6456	8.0369	19.2252	16.34	16.0304	18.4217
	Std. Dev	.80069	.80679	.47129	.52111	.54437	.36734	.22357	.24957	2.24139	.42275
11	Mean	4.4958	5.4967	8.8478	5.9916	5.7396	7.9587	18.8403	15.9841	15.7321	17.9512

	Std. Dev	.03080	.66523	.94486	.63294	.61318	.7776	.42699	.48911	2.4703	.53844
12	Mean	4.2367	5.1606	8.7442	6.068	5.8202	7.9053	18.1415	15.4653	15.2175	17.3026
	Std. Dev	.96428	.71424	.90834	.71936	.67201	.89841	.49734	.58658	2.55319	.59477
13	Mean	4.572	5.2635	9.1925	5.8136	5.5768	8.3684	19.028	15.6491	15.4123	18.2039
	Std. Dev	.80908	.79967	.89923	.57652	.54447	.70289	.29555	.57915	2.5377	.40587
14	Mean	4.5003	5.3767	9.4632	6.3962	6.1117	8.6464	19.3402	16.2732	15.9887	18.5234
	Std. Dev	.85209	.68822	.55989	.37048	.35316	.48077	.44259	.59203	2.53898	.54391
15	Mean	4.6576	5.6789	8.7237	5.5356	5.2959	7.8475	19.0602	15.8721	15.6324	18.184
	Std. Dev	.76309	.63476	.87543	.62465	.59872	.70774	.23772	.33056	2.31265	.3155

16	Mean	4.4538	5.3807	8.3169	5.5655	5.3322	7.6194	18.1514	15.4	15.1667	17.4539
	Std. Dev	.71369	.46832	.91977	.68919	.67491	.80089	.43471	.47291	.45423	.4623
17	Mean	4.1047	5.4069	8.798	5.7799	5.462	8.0215	18.3096	15.2915	14.9736	17.5331
	Std. Dev	.97415	.33815	.08531	.73793	.72437	.95702	.61456	.67734	.63538	.58231
18	Mean	4.2840	4.9259	9.5773	6.3524	6.0693	8.7292	18.7872	15.5623	15.2792	17.9391
	Std. Dev	.85434	.83876	.82687	.40062	.38424	.73248	.70834	.8169	.80027	.72947
19	Mean	4.3975	5.3634	7.8602	5.344	5.1283	7.0784	17.6211	15.1049	14.8892	16.8393
	Std. Dev	.07844	.50783	.00681	.97128	.89286	.96175	.97877	.8126	.72701	.81515
20	Mean	4.7619	5.6444	8.8045	5.9045	5.7012	7.9214	19.2108	16.3108	16.1075	18.3277
	Std. Dev	.81461	.61886	.91258	.60485	0.6036	.7364	.31826	.29204	.29344	.39792
21	Mean	4.1610	4.8839	8.5437	5.7237	5.4387	7.582	17.5886	14.7686	14.4836	16.6269
	Std. Dev	.92594	.73981	.10737	.05197	.99045	.93642	.22168	.31093	.31765	.1969
22	Mean	3.9168	4.8179	7.5818	4.584	4.41	6.5679	16.3165	13.3187	13.1447	15.3026
	Std. Dev	.50171	.224	.03857	.6029	.58425	.9094	.54263	.36386	.37927	.51389
23	Mean	4.3816	4.7644	7.9461	5.0823	4.8791	7.0993	17.0921	14.2283	14.0251	16.2453
	Std. Dev	.67674	.0183	.67201	.33333	.30864	.49584	.18464	.4908	.49834	.51352
24	Mean	4.6457	5.2536	9.4156	6.619	6.399	8.5724	19.3149	16.5183	16.2983	18.4717
	Std.D	.7226	.43379	.7181	.76036	.72679	.60176	.0254	.2484	.2299	.9473

Table 22 Vulnerability indices for considered hazards

Variables	L	M	H
Social vulnerability *SV1R1*	3.1968-4.3845	4.3846-4.8522	4.8523-5.3199
Economic Vulnerability *ECOVUL1R1*	4.5392-5.1529	5.1530-5.7666	5.7667-6.3803
Physical Vulnerability for Earthquake *PVQ1R1*	7.5818-8.24711	8.2472-8.9124	8.9125-9.5773
Physical Vulnerability for Flood *PVFL1R1*	4.5840-5.2623	5.2624-5.9406	5.9407-6.6190
Physical Vulnerability for Urban Flood *PVUFL1R1*	4.4100-5.0730	5.0731-5.7360	5.7361-6.3990
Physical Vulnerability for Fire *PVFR1R1*	6.5679-7.2283	7.2284-8.0087	8.0088-8.7292
Total Vulnerability for Earthquake *TVQ2’*	16.3165-17.7614	17.7615-19.2063	19.2064-20.6514
Total Vulnerability for Flood *TVFL2’*	13.3187-14.9185	14.9186-16.5183	16.5184-18.1181
Total Vulnerability for Urban flood *TVUFL2’*	13.1447-14.7107	14.7108-16.2767	16.2768-17.8427
Total Vulnerability for Fire *TVFR2’*	15.3026-16.6637	16.6638-18.0248	18.0248-19.386

	ev	9		9				9	7	3	6
25	Mean	4.1909	4.5392	8.6504	5.5689	5.2379	7.9141	17.3805	14.299	13.968	16.6442
	Std. Dev	.72584	.83939	.82165	.70417	.69774	.62597	.48108	.35531	.34075	.49966
26	Mean	4.2255	5.2841	8.4424	5.4099	5.139	7.6957	17.952	14.9195	14.6486	17.2053
	Std.Dev	.94400	.32117	.18959	.79465	.70904	.03593	.80472	.7062	.67851	.89152
27	Mean	4.1747	4.5554	8.312	5.4986	5.1862	7.6351	17.0421	14.2287	13.9163	16.3652
	Std. Dev	.52915	.94659	.45658	.65847	.60368	.36289	.04052	.21221	.18499	.03412
28	Mean	4.3337	5.1456	9.0754	6.2526	5.9216	8.3519	18.5547	15.7319	15.4009	17.8312
	Std. Dev	.81309	.7992	.02253	.65536	.60896	.93909	.79077	.95664	.91571	.91382
29	Mean	4.1492	4.866	7.737	5.3222	5.0768	7.163	16.7523	14.3374	14.092	16.1783
	Std. Dev	.67347	.34625	.25953	.84548	.80385	.20351	.28897	.14167	.11523	.28213
Silchar	Mean	4.4263	5.3315	8.6476	5.8234	5.5642	7.8445	18.4053	15.5811	15.322	17.6022
	Std. Dev	.8394	.4780	.05382	.80381	.77333	.97122	.40746	.38537	.36989	.43753

Table 23 Ward wise value of different types of vulnerability for considered hazards

WARD NO.		*SV1R1*	*ECOVUL1R1*	*PVQ1R1*	*PVFL1R1*	*PVUFL1R1*	*PVFR1R1*	*TVQ2’*	*TVFL2’*	*TVUFL2’*	*TVFR2’*
1	Mea	5.319	6.3803	8.9512	6.4179	6.1425	8.1358	20.65	18.11	17.842	19.83

	n	9						14	81	7	6
	Index	H	H	H	H	H	H	H	H	H	H
2	Mean	4.3269	5.4467	8.9202	6.172	5.8626	7.9448	18.6938	15.9456	15.6362	17.7184
	Index	L	M	H	H	H	M	M	M	M	M
3	Mean	4.4497	5.8602	9.4206	6.4453	6.1504	8.5337	19.7305	16.7552	16.4603	18.8436
	Index	M	H	H	H	H	H	H	H	H	H
4	Mean	4.3456	5.0221	8.3886	5.7747	5.5184	7.5487	17.7563	15.1424	14.8861	16.9164
	Index	L	L	M	M	M	M	L	M	M	M
5	Mean	4.0961	4.8486	7.6959	5.73	5.4757	6.9248	16.6406	14.6747	14.4204	15.8695
	Index	L	L	L	M	M	L	L	L	L	L
6	Mean	4.5507	6.3209	9.2438	6.259	6.062	8.3939	20.1154	17.1306	16.9336	19.2655
	Index	M	H	H	H	H	H	H	H	H	H
7	Mean	4.3866	6.1968	8.9187	6.111	5.9087	8.0346	19.5021	16.6944	16.4921	18.618
	Index	M	H	H	H	H	H	H	H	H	H
8	Mean	4.8416	6.1277	8.7255	5.7954	5.5606	8.14	19.6948	16.7647	16.5299	19.1093
	Index	M	H	M	M	M	H	H	H	H	H
9	Mean	4.891	5.5445	8.6433	5.9564	5.6466	7.8678	19.0788	16.3919	16.0821	18.3033
	Index	H	M	M	H	M	M	M	M	M	H
10	Mean	4.8145	5.5703	8.8404	5.9552	5.6456	8.0369	19.2252	16.34	16.0304	18.4217
	Index	M	M	M	H	M	H	H	M	M	H
11	Mean	4.4958	5.4967	8.8478	5.9916	5.7396	7.9587	18.8403	15.9841	15.7321	17.9512
	Index	M	M	M	H	H	M	M	M	M	M
12	Mean	4.2367	5.1606	8.7442	6.068	5.8202	7.9053	18.1415	15.4653	15.2175	17.3026
	Index	L	M	M	H	H	M	M	M	M	M
13	Mean	4.572	5.2635	9.1925	5.8136	5.5768	8.3684	19.028	15.6491	15.4123	18.2039
	Index	M	M	H	M	M	H	M	H	M	H
14	Mean	4.5003	5.3767	9.4632	6.3962	6.1117	8.6464	19.3402	16.2732	15.9887	18.5234
	Inde	M	M	H	H	H	H	H	M	M	H

	x										
15	Mean	4.6576	5.6789	8.7237	5.5356	5.2959	7.8475	19.0602	15.8721	15.6324	18.184
	Index	M	M	M	M	M	M	M	M	M	H
16	Mean	4.4538	5.3807	8.3169	5.5655	5.3322	7.6194	18.1514	15.4	15.1667	17.4539
	Index	M	M	M	M	M	M	M	M	M	M
17	Mean	4.1047	5.4069	8.798	5.7799	5.462	8.0215	18.3096	15.2915	14.9736	17.5331
	Index	L	M	M	M	M	H	M	M	M	M
18	Mean	4.284	4.9259	9.5773	6.3524	6.0693	8.7292	18.7872	15.5623	15.2792	17.9391
	Index	L	L	H	H	H	H	M	H	M	M
19	Mean	4.3975	5.3634	7.8602	5.344	5.1283	7.0784	17.6211	15.1049	14.8892	16.8393
	Index	M	M	L	M	M	L	L	M	M	M
20	Mean	4.7619	5.6444	8.8045	5.9045	5.7012	7.9214	19.2108	16.3108	16.1075	18.3277
	Index	M	M	M	M	M	M	H	M	M	H
21	Mean	4.161	4.8839	8.5437	5.7237	5.4387	7.582	17.5886	14.7686	14.4836	16.6269
	Index	L	L	M	M	M	M	L	L	L	L
22	Mean	3.9168	4.8179	7.5818	4.584	4.41	6.5679	16.3165	13.3187	13.1447	15.3026
	Index	L	L	L	L	L	L	L	L	L	L
23	Mean	4.3816	4.7644	7.9461	5.0823	4.8791	7.0993	17.0921	14.2283	14.0251	16.2453
	Index	L	L	L	L	L	L	L	L	L	L
24	Mean	4.6457	5.2536	9.4156	6.619	6.399	8.5724	19.3149	16.5183	16.2983	18.4717
	Index	M	M	H	H	H	H	H	M	H	H
25	Mean	4.1909	4.5392	8.6504	5.5689	5.2379	7.9141	17.3805	14.299	13.968	16.6442
	Index	L	L	M	M	M	M	L	L	L	L
26	Mean	4.2255	5.2841	8.4424	5.4099	5.139	7.6957	17.952	14.9195	14.6486	17.2053
	Index	L	M	M	M	M	M	M	M	L	M
27	Mean	4.1747	4.5554	8.312	5.4986	5.1862	7.6351	17.0421	14.2287	13.9163	16.3652
	Index	L	L	M	M	M	M	L	L	L	L
28	Mean	4.333	5.1456	9.0754	6.2526	5.9216	8.3519	18.55	15.73	15.400	17.83

	n	7						47	19	9	12
	Index	L	L	H	H	H	H	M	M	M	M
29	Mean	4.1492	4.866	7.737	5.3222	5.0768	7.163	16.7523	14.3374	14.092	16.1783
	Index	L	L	L	M	M	L	L	L	L	L
Silchar	Mean	4.4263	5.3315	8.6476	5.8234	5.5642	7.8445	18.4053	15.5811	15.322	17.6022
	Index	M	M	M	M	M	M	M	M	M	M