Floods and Armed Conflict

Ramesh Ghimire and Susana Ferreira

Agricultural and Applied Economics
The University of Georgia
Athens, GA, 30602

(ghimire@uga.edu)

Introduction

Natural disasters tend to increase risk of armed conflict (Drury and Olson 1998; Keefer 2009; Nel and Righarts 2008; Sipic 2010)

- Negative income shock
- Increase financial and political demands on government (Homer-Dixon 1994)

Unclear link between floods and armed conflict in light of new evidence (Fomby et al. 2011)

Motivation

- Previous studies group all natural disasters in an undifferentiated manner
- Data source - EM DAT
- No account for potential spatial dependency of armed conflict
- Indicator for natural disasters (fatalities) likely to be endogenous

Motivation

Incidence of natural disasters depends on income and institutions (Cavallo and Noy 2010; Ferreira et al. 2011; Kahn 2005)

Floods are endogenous (Ferreira and Ghimire 2012)

- Correlated with socioeconomic and institutional indicators
- Not based on hydrometric definition, rather based on damages (reported events)

Contribution

1. Separate floods from other natural disasters
2. Instrument floods
3. Use better flood specific data from Dartmouth Flood Observatory
4. Control for potential spatial dependency of armed conflict
5. Use alternative conflict indicators - incidence, and intensity in addition to onsets

Relevance

- Floods accounted for 40% of all the natural disasters between 1985-2009 (CRED/OFDA 2011) Figure 1
- Frequency of large floods increasing overtime (Brakenridge 2011) Figure 2

Revisiting conflict literatures

Greed, grievance, and opportunity views (Collier and Hoeffler, 2004)

- Greed motivation: rebels motivated by a desire to better their situation
- Grievance motivation: people rebel over issues of identity, such as ethnicity, religion, and social class

BUT... some countries not engaged in conflict despite favorable socioeconomic and geo-physical characteristics

Revisiting conflict literatures

Environmental scarcity view (Homer-Dixon, 1991, 1994)

- Environmental scarcity and armed conflict (e.g. - war in Darfur, violence in Somalia, Ivory Coast and Burkina Faso)

BUT..climate change is excuse used by irresponsible government to relieve itself of responsibility, politics is real cause of bloodshed in conflict-ridden areas like Darfur (Foerstel 2008)

Revisiting conflict literatures

Spatial dependency view (Alcock, 1972)

- Social unrest clusters in space and has propensity for contagion
- Onsets - either a gain in knowledge in war-related tactics, or a physical movement of rebellious activities from war-affected area (e.g. - Arab spring started in Tunisia in 2010 and spread across the Arab nations)

BUT...it fails to explain civil unrest in many countries with peaceful neighbors

Data

Unit of analysis: country-year, 1985-2009

- Conflict data - onset, incidence, and intensity from UCDP (2011) Figure 3

  "a contested incompatibility that concerns government and/or territory where the use of armed force between two parties, of which one is the government of state, results in at least 25 battle-related deaths"

Data

- Flood data - frequency, and magnitude from Brakenridge (2011) Figure 4

  Frequency: counts of large floods

  Magnitude: log(duration $\times$ severity $\times$ affected area)

  Severity: class 1, 1.5, and 2

  Large floods: "significant damages to structures or agriculture, long (decades) reported intervals since the last similar event, and/or fatalities"

Data

Controls

- Socioeconomic indicators: Infant mortality rate, GDP growth, GDP/capita, population density, youth population, oil dependency (=1), ethnic fractionalization
- Political robustness: democracy (=1), anocracies (=1)
- Geophysical characteristics: country area, terrain ruggedness
- Other controls: conflict in neighboring country(s) (=1), brevity of peace in onset, year dummies

Estimation strategy

- Endogeneity test for floods (Wooldridge 2002, ch. 15, pp. 752-5): p-value of $\hat{v}_2$ is 0.05
- Hausman test statistic with p-value 0.0033 supports a two step estimation procedure
- Instrumenting flood frequency with rainfall, costal proximity, and latitude Table A1
- Sargan-Hansen test statistic $= 3.312$ with p-value 0.1909

Estimation strategy

Two step estimation procedure

$$Conflict_{it} = f(Floods_{it}, \mathbf{Z_1}) \quad (1)$$

$$Floods_{it} = h(\mathbf{Z_1}, \mathbf{Z_2}) \quad (2)$$

where,
Conflict: Indicator for armed conflict
Floods: Indicator for floods
$\mathbf{Z_1}$: Socioeconomic and institutional indicator, geophysical characteristics, other controls
$\mathbf{Z_2}$: Instruments-rainfall, costal proximity, and latitude

Estimation strategy

- One period lag in explanatory variables to mitigate endogeneity bias
- 3-year moving average in floods to accommodate the lagged effects

Econometric methods

- Estimate eq. (2) using random effects OLS estimates
- Estimate eq. (1) using random effects logit model for incidence and onsets and random effects ordered logit for intensity

$$Conflict_{it} = \delta_1 \mathbf{Z_1} + \delta_2 \widehat{Floods}_{it} + u_1 \qquad (3)$$

$$Floods_{it} = \alpha_1 \mathbf{Z_1} + \alpha_2 \mathbf{Z_2} + v_2 \qquad (4)$$

Econometric methods

Random-effects model

- Hausman test (p-value 0.8399) support the use of random effects model
- Incidental parameters problem with fixed-effects model
- Little variation in dependent variable

Results and discussion

Floods and conflict incidence (AME)

VARIABLES	No IV	IV
Floods	**0.0089****	**0.0893****
Socioeconomic indicators		
Infant mortality rate	0.0019***	0.0016***
Youth population (%)	0.0056*	0.0097**
Ln(population density)	0.0898***	0.0340
GDP growth (%)	-0.0013**	-0.0011*
Ln(GDP/capita)	-0.0017	-0.0247
Oil dependency (=1)	0.0528	0.1018**
Ethnic fractionalization	0.1099	0.0611
Political robustness		
Democracy (=1)	-0.0334*	-0.055**
Anocracies (=1)	0.0068	0.0036
Geophysical characteristics		
Ln(area, km^2)	0.0524***	-0.0144
Terrain ruggedness	0.0371	0.0216
Other controls		
Conflict in neighboring country (=1)	0.0172	0.0297**

Results and discussion

Floods and conflict onset (AME)

VARIABLES	No IV	IV
Floods	**0.0011**	**0.002**
Socioeconomic indicators		
Infant mortality rate	0.0003*	0.0003*
Youth population (%)	-0.0004	-0.0003
Ln(population density)	0.0113**	0.0107
GDP growth (%)	6.51e-06	0.00001
Ln(GDP/capita)	-0.004	-0.0044
Oil dependency (=1)	0.0209**	0.021*
Ethnic fractionalization	0.0138	0.012
Political robustness		
Democracy (=1)	-0.004	-0.005
Anocracies (=1)	0.0038	0.003
Geophysical characteristics		
Ln(area, km^2)	0.0078**	0.007
Terrain ruggedness	0.0042	0.003
Other controls		
Conflict in neighboring country (=1)	0.0144**	0.014*
Brevity of peace	-0.010	-0.011

Results and discussion

Floods and conflict intensity (AME)

VARIABLES	No IV	IV
Floods	**0.158*** **	**1.32***
Socioeconomic indicators		
Infant mortality rate	1.84***	1.56***
Youth population (%)	1.80	2.517**
Ln(population density)	5.52	2.09
GDP growth	-.145***	-.134***
Ln(GDP/capita)	0.737	-1.89
Oil dependency (=1)	0.066	0.156
Ethnic fractionalization	0.851	0.517
Political robustness		
Democracy (=1)	-0.420***	-.515***
Anocracies (=1)	-0.022	-0.016
Geophysical characteristics		
Ln(area, km^2)	10.97***	-1.59
Terrain ruggedness	0.480	0.3142
Other controls		
Conflict in neighboring country (=1)	0.149	0.2515*

Results and discussion

Robustness of the results to flood magnitude

VARIABLES	No IV	IV
Incidence	0.0407***	0.228*
Onset	0.0048	0.196
Intensity	0.306***	1.868**

Results and discussion

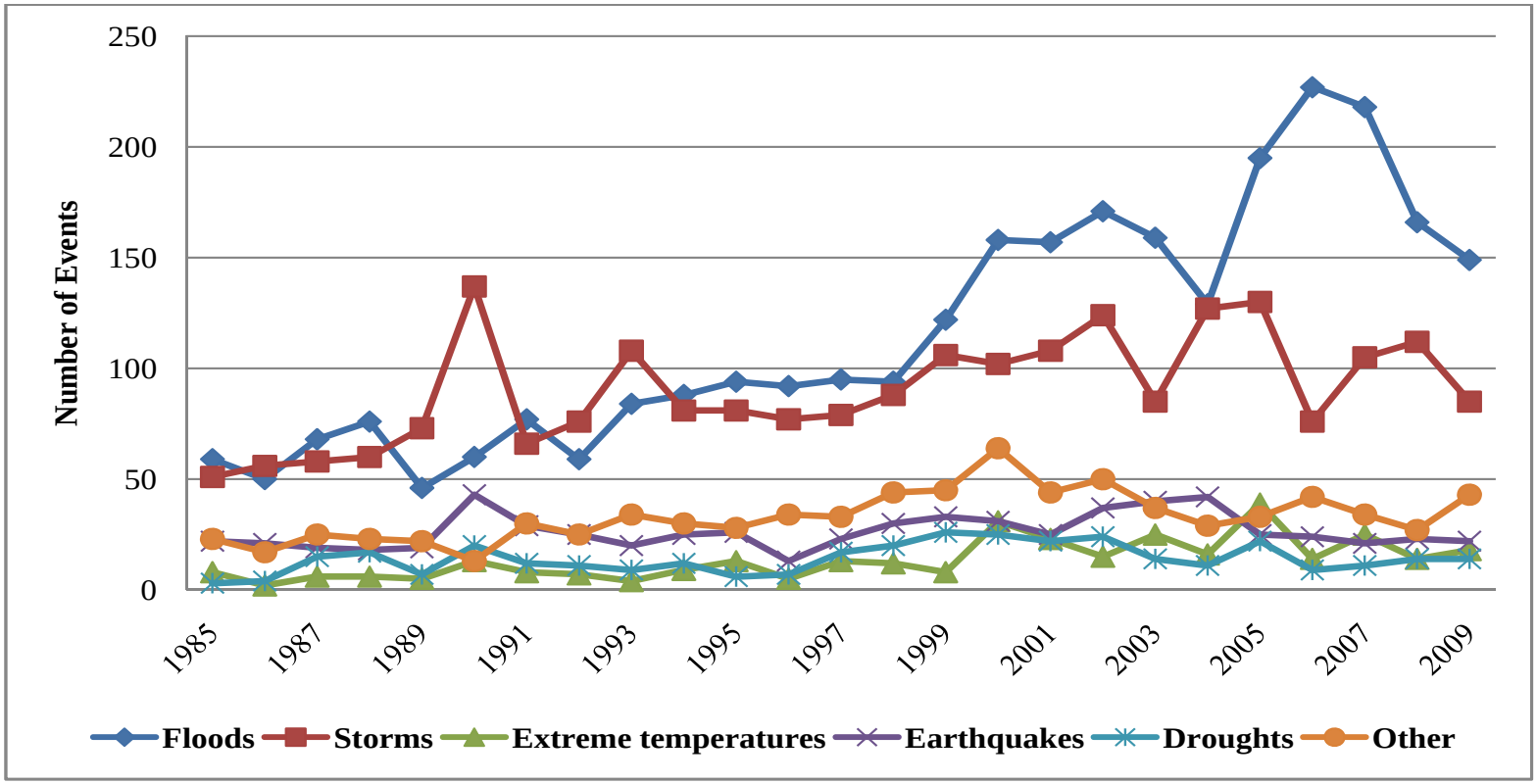
Anecdotal evidences

- Risk of armed conflict has increased following the 2010 floods in Pakistan (Righarts 2010)
- Conflict intensified in rural area after the 2009 flooding in Somalia and in the immediate aftermath of the tsunami in Sri Lanka (Brancati 2007)

Conclusion

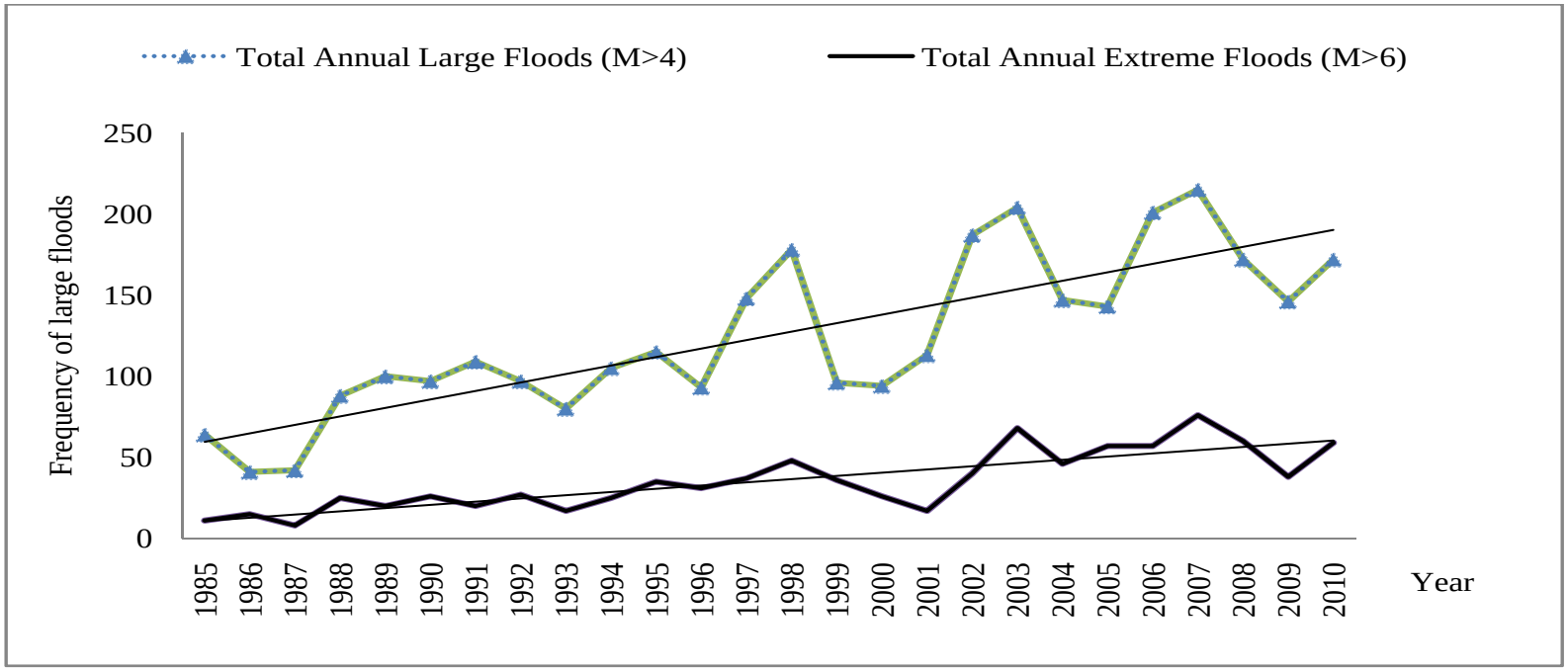
- "Large" floods increase the probability of armed conflict - in terms of conflict incidence and conflict intensity
- GDP growth, infant mortality rate, youth population, and oil-dependency, democracy, and unrest in neighboring countries are significant determinant of armed conflict in the expected direction

Figure: Incidence of natural disasters



Source: Ferreira et al. (2011), based on OFDA/CRED (2011)

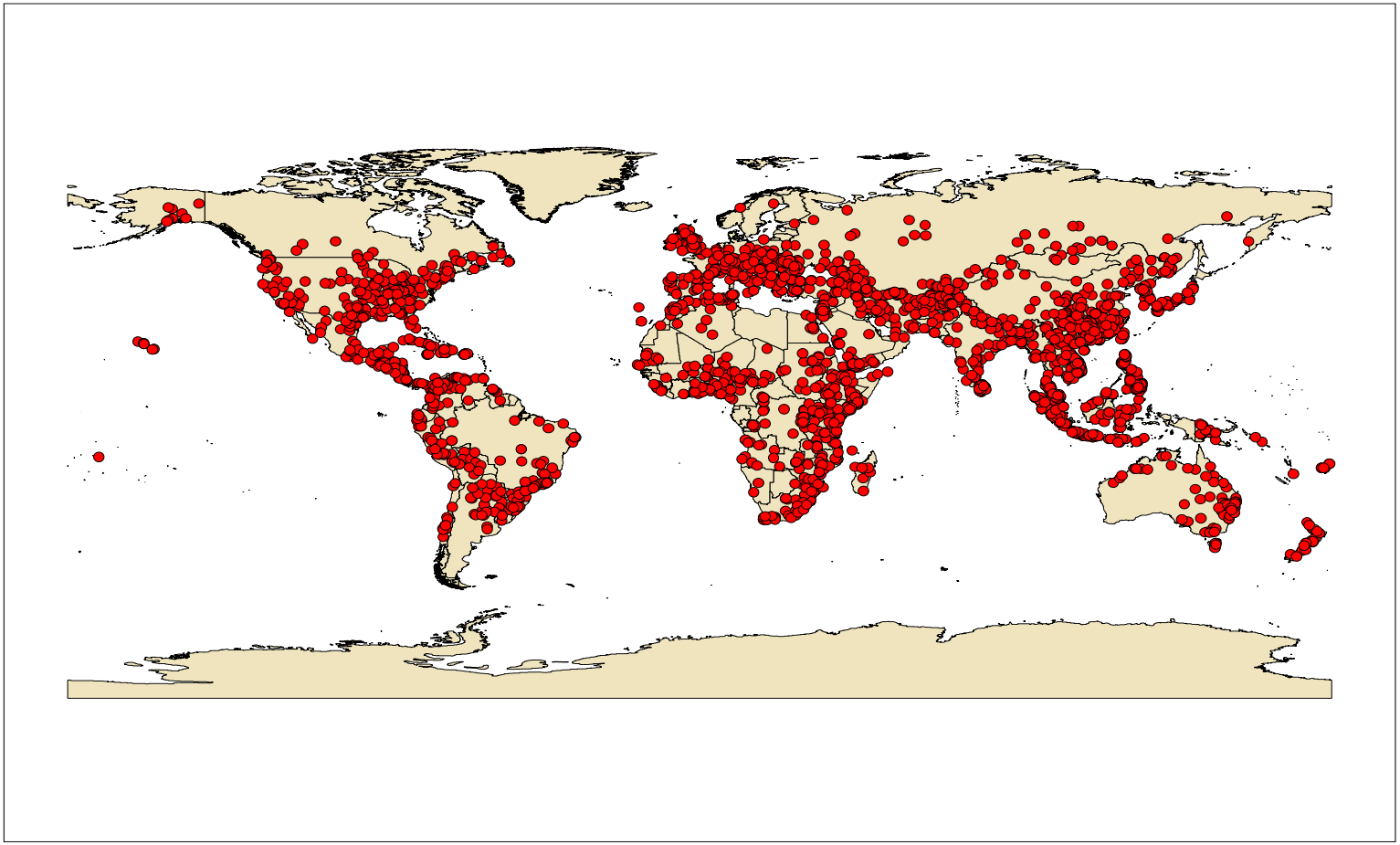
Figure: Frequency of floods



Notes: M is flood magnitude, computed as log(duration in days × severity × affected area in square km). Severity can take the value 1, 1.5 and 2. (Floods are divided into three severity classes depending on their estimated recurrence interval. Class 1 floods have a 10-20 year-long reported interval between similar events, class 1.5 has a 20-100 year recurrence interval, and class 2 has a recurrence interval greater than 100 year.)

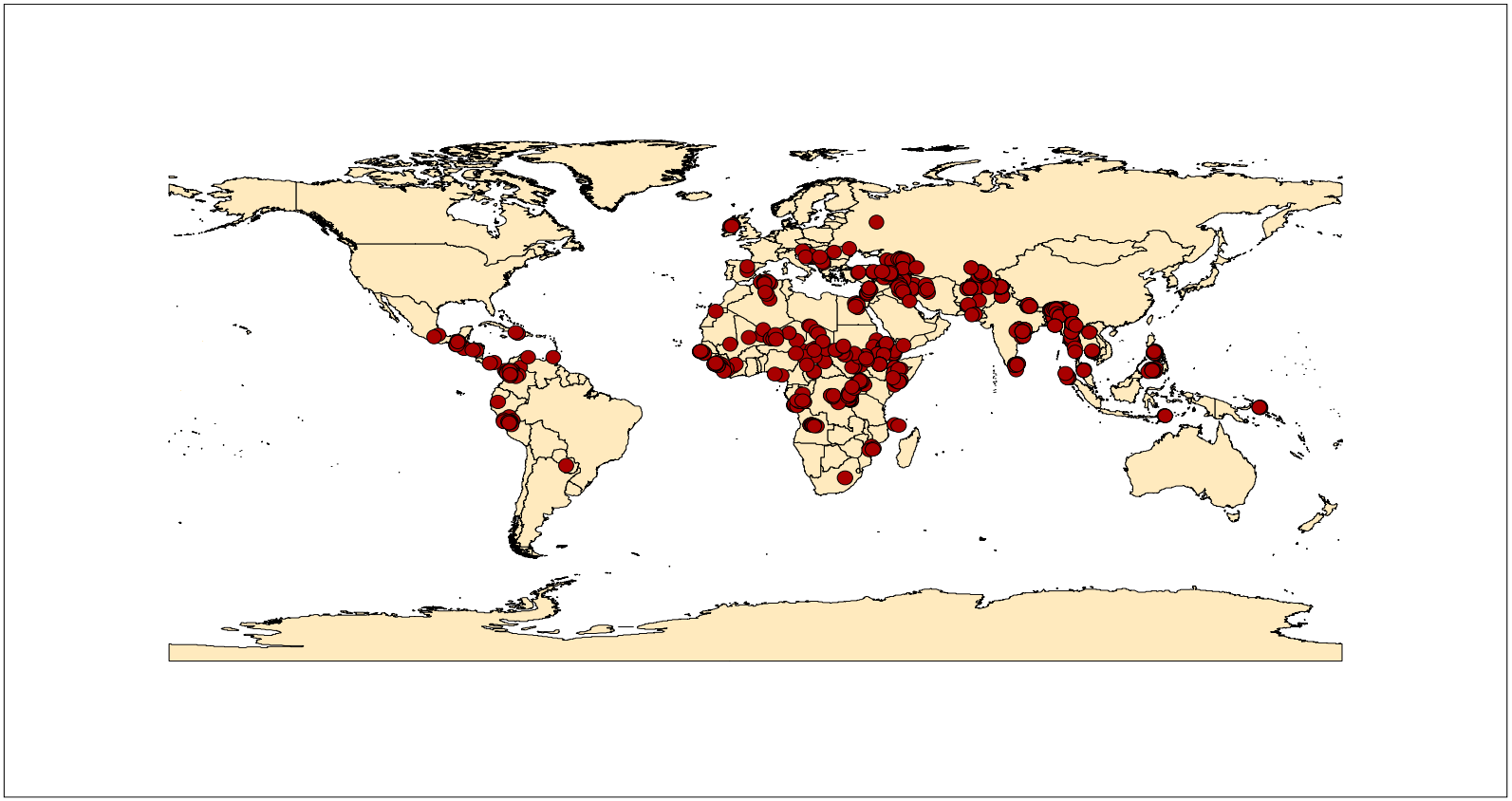
Source: Authors, based on Brakenridge (2011)

Figure: Geographic location of floods



Source: Authors, based on Brakenridge (2011)

Figure: Geographic location of armed conflict



Source: Authors, based on UCDP (2011)

Table: Flood-instruments correlation

VARIABLES	Coefficients
Rainfall (mm)	0.000926***
Coastal proximity (%)	-0.00875***
latitude	0.0218***
Constant	-0.271
Observations	3,068
Number of id	144