Appendix F - Conflict Hazard and Population at Risk in Asia-Pacific

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F1  Introduction

The aim of this project has been to develop a methodology of conflict hazard and risk assessment and present results of such an analysis for countries of concern to the UN OCHA’s regional office in Bangkok. The project is limited to state-based internal armed conflict; other forms of political violence, including international conflict and communal violence, are not covered. Armed intrastate conflict is understood as armed violence between a state and an organized non-state actor over a clearly stated issue of incompatibility which causes at least 25 battle-related deaths per calendar year (see UCDP/PRIO Armed Conflict Dataset; Gleditsch et al., 2002). The assessment consists of three parts. First, a country-level model of conflict hazard is developed, which serves to identify the countries most likely to host armed intrastate conflict within the next year. Next, a sub-national conflict hazard assessment is conducted, which highlights where, within the conflict-prone countries, violence is most likely to take place. Finally, a simple model of population at risk is presented, combining the estimated sub-national conflict hazard with population density statistics. The resulting map displays areas with the highest maximum number of people potentially affected by conflict in the high-hazard provinces.

F2  National Conflict Hazard

While all armed conflicts have idiosyncratic traits, there are also a limited set of generic factors that correlate with the frequency of conflict. Armed intrastate conflict outbreak occurs disproportionately in countries with large and ethnically diverse populations, low national income, inconsistent and unstable political systems, and with a recent history of conflict (Hegre & Sambanis, 2006). In this analysis, we estimate the probability (hazard) of conflict occurrence (‘what is the probability of observing armed conflict in country i in year n?’), which is analytically distinct from most conflict studies that focus on conflict outbreak (‘what is the probability of observing a new armed conflict in country i in year n?’). However, as most of the important explanatory factors for conflict outbreak also influence occurrence, we apply a benchmark statistical model of conflict onset to evaluate the conflict propensity among the countries in the study region.

To establish the prediction model we first run a logit regression with corrections for temporal trends on empirical data for all countries in the world, 1950–2004 (Table F1). The results correspond well to Hegre & Sambanis’s (2006) analysis of conflict outbreak, though a different operationalization of political system to handle a possible endogeneity problem (see Gates, et al, 2006; Vreeland, 2008) returns weaker results for democracy.
The most influential country characteristic is conflict history – the number of years since the last active conflict. This is expressed as a decaying function to account for a non-linear healing effect of time, \( \text{decay} = 2^{-\frac{T}{\alpha}} \) where \( \alpha \) is the half-life (in years) and \( T \) is the duration of peace until the time of observation. Several iterations revealed that a half-life parameter of just one year generated the strongest results. Aside from conflict history, irregular regime change, poverty, population size, and ethnic diversity are found to systematically increase the likelihood of conflict occurrence, while the severity of recent natural disasters has little effect.

**Table F1** Determinants of armed intrastate conflict occurrence, 1950–2004

<table>
<thead>
<tr>
<th>Determinant</th>
<th>( \beta )</th>
<th>SE ( \beta )</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Democracy index( ^a )</td>
<td>.262</td>
<td>.274</td>
<td>.338</td>
</tr>
<tr>
<td>Democracy squared( ^a )</td>
<td>.540</td>
<td>1.037</td>
<td>.603</td>
</tr>
<tr>
<td>Regular regime change</td>
<td>.078</td>
<td>.188</td>
<td>.678</td>
</tr>
<tr>
<td>Irregular regime change</td>
<td>.929</td>
<td>.373</td>
<td>.013</td>
</tr>
<tr>
<td>GDP capita( ^a, b )</td>
<td>-.197</td>
<td>.094</td>
<td>.037</td>
</tr>
<tr>
<td>Population( ^b )</td>
<td>.197</td>
<td>.063</td>
<td>.002</td>
</tr>
<tr>
<td>Ethnic fractionalization</td>
<td>.556</td>
<td>.314</td>
<td>.076</td>
</tr>
<tr>
<td>Disaster deaths( ^a, b )</td>
<td>.023</td>
<td>.032</td>
<td>.474</td>
</tr>
<tr>
<td>Conflict history decay</td>
<td>5.168</td>
<td>.238</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Time squared</td>
<td>.005</td>
<td>.002</td>
<td>.004</td>
</tr>
<tr>
<td>Intercept</td>
<td>-23.212</td>
<td>6.114</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Note: Global logit regression model with robust standard errors clustered on countries, \( N=6,656 \);
\( ^a \) data lagged one time period; \( ^b \) natural logarithm.

The parameter estimates from this global analysis are then used in combination with the most recently available data (in this case, 2007) on the selected parameters. The result is a set of conflict hazard estimates, interpreted as the probability of observing conflict by country during the following year (2008). The countries in the study region, Asia-Pacific, can then be ranked according to conflict likelihood (Figure F1).

As Figure F1 demonstrates, the region is essentially split, in two in terms of conflict hazard. The top eight countries are estimated to have a probability of armed conflict that is more than ten times higher than the next country on the list. This significant divide is driven largely by the countries’ previous conflict history. Six of the top eight countries hosted one or more armed conflict in the last year of observation (2007), while the remaining two countries had just emerged from conflict (Nepal in 2006 and Indonesia in 2005). In contrast, the most recent armed conflict in the sample of low-risk countries ended ten years ago, in 1998 (Cambodia). A large population and low per capita income are other factors that explain the variation in conflict hazard, although the inertia of these features implies that they are better at estimating base-line hazard than
predicting the timing of conflict outbreak. One factor that does increase the short-time hazard is irregular regime change (coup, assassination of executive). While this effect is less pronounced than that of conflict history, it nonetheless constitutes a non-trivial hazard that frequently precedes armed intrastate conflict. In the case of China, the predicted probability of observing conflict during 2008 more than doubles (from 5% to 13%); for Indonesia, the change is measured at 13 percentage points (from 76% to 89%). As a means of forecasting the onset of new armed conflict, irregular regime changes serve as good early warning indicators.

Note: the dotted line, plotted against the right vertical axis, displays the scores from OCHA’s own assessment of conflict hazard, which also accounts for the intensity of earlier violence (OCHA Global Focus, August 2007).

Figure F1 Estimated probability of observing armed intrastate conflict in 2008 by country.

Figure F2 shows the geographic distribution of conflict hazard in the study region. It effectively highlights areas of high concern, but it can be misleading. Most active conflicts in this region are geographically limited, so for large countries such as India, Indonesia, and Thailand, the majority of the territories are unaffected by the violence and may not be considered particularly exposed.
F3 Sub-National Conflict Hazard

In order to provide a more realistic hazard map, we next estimate conflict likelihood at the first-order administrative level for twelve countries in the region. For some other countries, crucial socio-economic and demographic data were unavailable or inconsistent (e.g. China, Myanmar, North Korea), while a high-resolution hazard assessment was deemed irrelevant for democracies with no recent history of armed intrastate conflict (e.g. Australia, Japan, New Zealand).

Four complementary factors were assumed to affect the local conflict propensity: Socio-economic status, ethnic inclusion/exclusion, distance from the capital, and conflict history. A number of country-specific sources (such as national bureaus of statistics and human development reports), as well as international data providers (e.g. CIESIN, Columbia University), were consulted before creating the indices.

A. Socio-economic status
This index varies between 1 (relatively wealthy) and 5 (relatively poor) and is generated from 4–5 country-specific indicators of socio-economic status.

Note: the coloring of the countries represent estimated level of conflict hazard: negligible ($p < 0.25$); low ($0.25 \leq p < 0.5$); medium ($0.5 \leq p < 0.75$); and high ($p \geq 0.75$).

Figure F2 Hazard map of armed intrastate conflict in the Asia region, 2008.
Because the data sources differ between countries, the values on the index are expressed in relative terms (i.e. relative to the most well-off district) and are thus not immediately comparable between cases. However, most of the country indices contain local estimates of GDP per capita, infant mortality, and HDI scores from national Human Development Index reports. The sources and characteristics of the specific socio-economic indicators can be found in the appendix.

The 5-point scale for the socio economic variables gives the measured difference between each district and the district with the highest score on the given socio-economic indicator (this is normally the capital district, but not always). The values are given as standard deviations (0–1 SD = 1, 1–2SD = 2, 2–3SD = 3, 3–4SD = 4, 4>SD = 5). Finally the scores for the socio economic variables are added together to create the socio economic hazard indicator. We take the max total added score a district can get and dived this by 5 and use this as the cut off point for the indicators.

B. Ethnicity
The ethnic indicators consist of two variables:
- A dichotomous indicator on whether the main ethnic group in the sub-national region has access to national power according to the ETH Zurich Ethnic Power Relations (EPR) data (0 if in power, 2 if not in power).
- An indicator of the composition of ethnic groups in the the sub-national region, measuring whether the region is dominated by the group(s) in power (EGIP) or by a marginalized group (MEG):
  Size of largest MEG/( Size of largest MEG + Size of EGIP(s)).

The ratio values are divided in two three groups and given a score:
0–0.33 = 1
0.34–0.66= 2
0.67–1 = 3

When summing the exclusion and ratio indicators, a joint ethnicity scale is created, ranging from 1-5.

C. Conflict history
The variable indicates whether the province has been in conflict in previous years, and if so, how long ago. We use 5 time periods.
1 = 1946–1989
2 = 1990–1997
3 = 1998–2002
4 = 2003–2006
5 = 2007

Sub-national regions with no previous conflict are assigned a value of 0.
D. Distance from the capital
The indicator of center vs. periphery consists of two dichotomous variables that jointly form a 3-point scale (0–2):

- Dummy variable indicating whether the sub-national region is situated on a different island than the capital city or along an international border (1 if yes, 0 otherwise).
- Dummy variable indicating whether the sub-national region is situated further away from the capital city than the average distance for all sub-national regions in country (1 if further away than the average; 0 otherwise).

From these components, a relative conflict hazard index was constructed. The first three components are assigned equal weight (all have maximum values of 5) while the fourth component, distance, is considered less important (the maximum value is 2).\(^1\) A summary relative hazard index of the four components ranges between 2 and 17, which is then converted to a five-point scale with equal intervals. A threshold value of 3.4 (17/5) is used as the cut-off point between the categories (1 = 0–3.4, 2 = 3.5–6.8, 3 = 6.9–10.2, 4 = 10.3–13.6, 5 = 13.7–17).

The relative hazard scores were then joined with the country-level hazard scores to facilitate comparison between countries. The resulting unified sub-national hazard indicator consists of four categories, denoting a negligible, low, medium, or high overall conflict likelihood:

- 0 = Sub-national relative hazard < 3
- 1 = Sub-national relative hazard = 3, OR Sub-national relative hazard > 3 and national conflict hazard < 0.25
- 2 = Sub-national relative hazard = 4 and national conflict hazard ≥ 0.25, OR Sub-national relative hazard = 5 and national conflict hazard ≥ 0.25 and < 0.8
- 3 = Sub-national relative hazard = 5 and national conflict hazard ≥ 0.8

Figure F3 shows the results and provides a more nuanced picture of where armed conflict is more likely, compared to the cross-national analysis presented in Figure F3. Most of the twelve countries have considerable sub-national variation in conflict likelihood. India, in particular, displays high internal variation in conflict hazard, with violence being very likely in the northwest and northeast but much less so in central parts of the country. This reflects the long-lasting separatist conflicts in Kashmir, Assam, Manipur, and Nagaland, as well as the Naxalite rebellion around Chhattisgarh, Jharkhand, and Andhra Pradesh. Recent conflict history, peripheral location, and local

\(^1\) The relative importance of these components may differ between countries; the presented methodology can be modified to account for this.
dominance of minority groups also explain the high likelihood of violence in
the predominantly Muslim southern provinces of Thailand. In Nepal, the
conflict hazard is highest among the border districts, most of which are
economically marginalized and contain politically excluded populations. This
is also where the rural Maoist rebellion took place. In Indonesia and Sri Lanka,
too, periphery, poverty, ethnicity, and earlier violence all overlap, thus leading
to considerable sub-national variations in estimated likelihood of armed
conflict.

Figure F1  Sub-national distribution of conflict hazard, 2008.

F4  Sub-National Conflict Risk

Finally, the size of the exposed population in the medium-to-high hazard
regions is considered. While population density is a poor indicator of likely
casualty levels if a conflict occurs, it gives some indication of the number of
people potentially affected by the conflict. For simplicity, Figure F4
distinguishes merely between regions with above-average population density
and those that are less densely populated, but the underlying data can be
displayed in various fashions depending on purpose. Orange regions represent
medium to high conflict hazard and below-average population density, whereas
red denotes high conflict hazard and high population density. This procedure
limits the number of high-hazard (red) provinces compared to Figure E3, and can be an effective means to single out high-priority areas where more people are at risk.

The difference between Figure F3 and F4 is clearly illustrated by the case of Nepal. Most rural border districts have high conflict hazard due to adverse socioeconomic and cultural characteristics and a recent history of conflict. However, many of these districts, in particular those in the northern Himalayan region, are sparsely populated so the number of high-risk areas is substantially lower. A similar result is evident for the relatively sparsely populated Indian states of Kashmir, Naga-land and Manipur, all of which have a high conflict likelihood but with comparably low numbers of maximum potential people at risk.

![Population-weighted hazard map in high-to-very-high conflict hazard regions, 2008.](image)

Figure F4  

2 When conflict casualty estimates become available in a geo-referenced format, the sub-national population at risk model should be modified to account for severity levels of prior violence, which arguably is a better indicator of future casualties than population density. This would probably contribute to marking off parts of Sri Lanka and Kashmir as high-risk areas while e.g. southern Thailand (Pattani) might be downgraded.
F5 References

Literature:


Sources of Socio-Economic Data:

**Indonesia**


d. **Infant Mortality Rate** – The data range from 24 – 81 (Source: Center for International Earth Science Information Network (CIESIN))

**Nepal**


c. **GDP per Capita**: The data range from 679 - 3438 (source: Nepal Human Developing Report 2004)

d. **Infant Mortality Rate** – The data range from 60.1 – 112.2. (Source: Center for International Earth Science Information Network, CIESIN)

### The Philippines

a. **Human Development Index 2000** – The data is divided into 5 categories. (Source: Philippines Human Development Report)

b. **Poverty Incidence 2006** – The data ranges from 3.4 to 64.6. (Source: National Statistical Coordination Board, [www.nscb.gov.ph](http://www.nscb.gov.ph))

c. **GDP per Capita – Per Capita Gross Regional Domestic Product at Constant 1985 prices (in pesos).** The data range from 37855 to 3486. (Source: National Statistical Coordination Board, [www.nscb.gov.ph](http://www.nscb.gov.ph))

d. **Infant Mortality Rate** – The data range from 23.6 to 60.8. (Source: Center for International Earth Science Information Network, CIESIN)

### Sri Lanka

a. **GDP/cap by province (2005):** The data range from 0.07 to 0.2. (Source: Sarvananthan 2007 Economy of the Conflict Region in Sri Lanka: From Embargo to Repression, p 6: Central Bank of Sri Lanka).


c. **Borrowing (2003)** – Borrowing as percentage of total household income. The data range from 14.2 to 43.6 (Source: Sarvananthan 2007 Economy of the Conflict Region in Sri Lanka: From Embargo to Repression, p 41).

d. **Infant Mortality Rate (200)** – The data range from 4.1 to 27.8 (Source: Center for International Earth Science Information Network, CIESIN) However, the data for the following districts have been replaced by data from the World Health Organization: Ampara, Butticaloa, Tricomalee, Jaffina, Kilinochchi, Mannar, Mullaitivu, Vavuniya. (Source: Sarvananthan 2007 Economy of the Conflict Region in Sri Lanka: From Embargo to Repression, p 32).

### Pakistan*

a. **Literacy Ratio % (1998):** The data range from 11.1 to 72 (Source: Pakistan Human Developing Report 2004)


c. **Enrolment Ration% (1998)** The data range from 6.9 to 78.3 (Source: Pakistan Human Developing Report 2004)

d. **Human Development Index** The data range from 0.332 to 0.624 (Source: Pakistan Human Developing Report 2004)
There exists no socioeconomic data for Azad Kashmir, F.A.T.A and Northern Areas – these have been assigned a value of 5 (relatively least developed) on the socioeconomic scale.

**Cambodia**


b. **Temporary Housing (2004):** Data ranging from 3.1 to 45.1 (Source: Cambodia Human Developing Report 2007)

c. **Human Development Index (2004):** Data ranging from 0.3 to 0.83 (Source: Cambodia Human Developing Report 2007)

d. **Human Poverty index (2004):** Data ranging from 14.3 to 46.2 (Source: Cambodia Human Developing Report 2007)

**Thailand**


b. **GDP per capita (2004):** Data ranging from 17083 to 691093 (Source: Thailand Human Developing Report 2007)

c. **Household debt (2004):** Data ranging from 29.1 to 86.2 (Source: Thailand Human Developing Report 2007)

d. **Poverty incidence (2004):** Data ranging from 0 to 33.97 (Source: Thailand Human Developing Report 2007)

**Laos**


b. **GDP per capita (2002):** Data ranging from 889 to 2516 (Source: Laos Human Developing Report 2006)

c. **Human Development Index (2002):** Data ranging from 0.458 to 0.652 (Source: Laos Human Developing Report 2006)

d. **Poverty Head Count Ratio (2002):** Data ranging from 17 to 54 (Source: Laos Human Developing Report 2006)

**Bangladesh**

a. **Infant Mortality Rate** – The data range from 64.5 to 126. (Source: Center for International Earth Science Information Network, CIESIN)

b. **Percentage of households with electricity supply** – 6.69% to 74.27% (source: Bangladesh Bureau of Statistics, December 2005, Bangladesh Case Study: [http://gisweb.ciat.cgiar.org/povertymapping/](http://gisweb.ciat.cgiar.org/povertymapping/))
c. **Average years of schooling of adult (> 15 years of age) household members** – 1.84 to 5.3. (source: Bangladesh Bureau of Statistics, December 2005, Bangladesh Case Study: [http://gisweb.ciat.cgiar.org/povertymapping/](http://gisweb.ciat.cgiar.org/povertymapping/))


e. **Gini coefficient based on per capita income** – 33.84 to 44.67. (source: Bangladesh Bureau of Statistics, December 2005, Bangladesh Case Study: [http://gisweb.ciat.cgiar.org/povertymapping/](http://gisweb.ciat.cgiar.org/povertymapping/))

a. **India**

a. **Per Capita Consumption Expenditure 1999-2000** – The data range from 413.71 to 1382.87 (source: National Human Development Report 2001)*

b. **Percentage of Population below the poverty line 1999-2000** - The data range from 3.48% to 47.15% (source: National Human Development Report 2001)*

c. **Per capita net state domestic product at current prices 2004-05** - The data range from 5606 to 60787 (source: Indian Public Finance Statistics 2007-08, Ministry of Finance, department of Economic Affairs, Economic Division)

d. **Literacy rate 2001** - The data range from 47% to 90.86%. (source: [http://indiabudget.nic.in](http://indiabudget.nic.in))

e. **Infant Mortality Rate** – The data range from 28 to 133. (Source: Center for International Earth Science Information Network (CIESIN))

* Chhattisgarh is assigned the same value as Madhya Pradesh, to which it belonged until 2000.
* Uttarakhand is assigned the same value as Uttar Pradesh, to which it belonged until 2000.
* Jharkhand is assigned the same value as Bihar, to which it belonged until 2000.

**Vietnam**


b. **Adult literacy rate** - The data range from 96.9 to 51.3 (Source: National Human Development Report 2001: Doi Moi and Human Development in Vietnam: [http://planipolis.iiep.unesco.org/upload/Viet%20Nam/Viet%20Nam%20HDR%202001.pdf](http://planipolis.iiep.unesco.org/upload/Viet%20Nam/Viet%20Nam%20HDR%202001.pdf))
c. **Education index** - The data range from 0.86 to 0.54 (Source: National Human Development Report 2001: Doi Moi and Human Development in Vietnam: [http://planipolis.iiep.unesco.org/upload/Viet%20Nam/Viet%20Nam%20HDR%202001.pdf](http://planipolis.iiep.unesco.org/upload/Viet%20Nam/Viet%20Nam%20HDR%202001.pdf))

d. **Human Development Index** - The data range from 0.835 to 0.486 (Source: National Human Development Report 2001: Doi Moi and Human Development in Vietnam: [http://planipolis.iiep.unesco.org/upload/Viet%20Nam/Viet%20Nam%20HDR%202001.pdf](http://planipolis.iiep.unesco.org/upload/Viet%20Nam/Viet%20Nam%20HDR%202001.pdf))

e. **Infant Mortality Rate** – The data range from 10.5 to 82.6. (Source: Center for International Earth Science Information Network, CIESIN)

*GDP in Ba Ria-Vung Tau is assigned the average GDP for the high human development states, because the GDP is very high and skewed due to oil and gas. This would have affected the standard deviation as an outlier.

**Malaysia**

