Genocide Forecasting for Early Warning: How accurate (and useful) are our forecasts?

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Atrocity Forecasting Project

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Acknowledgements

- This is joint research with Arcot Sowmya (UNSW), Charles Butcher (NTNU [Norway]), and Dimitri Semenovich (UNSW)

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  - Asia-Pacific Centre for the Responsibility to Protect (UQ / AusAID) (2010-11)
  - University of Sydney and University of Otago (2010-11, 2014)
  - Australian Research Council (2016-18)

NEWS ANALYSIS

Spreadsheets and Global Mayhem

By SOMINI SENGUPTA LAST UPDATED: MARCH 30, 2014

A man sharpening a machete in Bangui, Central African Republic. A study shows the country a high risk for genocide. SIA KAMBOU/AGENCE FRANCE-PRESSE — GETTY IMAGES

UNITED NATIONS

IN this age of fine-grained prediction, a variety of algorithms hover aro all the time to divine what we might buy, whom we might mate with, an whom we are likely to vote for at election time. Now social scientists an using some of these same tools to predict when we are likely to do horri things to one another.

Australian researchers say they have developed a mathematical model predict genocide. A Swiss sociologist has sifted through a century of ne articles to predict when war will break out — both between and within

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This Political Scientist Forecasted the Central African Republic Genocide

A conversation about the grim business of predicting mass atrocities.

RYAN JACOBS · MAR 20, 2014

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Where Genocide Is Most Likely To Happen Next

APRIL 15, 2014 BY BEN WATSON KEDAR PAVGI

One university team may have found a way to predict the world's next genocides. By Ben Watson and Kedar Pavgi Strategy

Twenty years after the horrors of the Rwandan genocide, researchers at The University of Sydney have created a model predicting which countries will experience targeted mass violence across the globe.

Known as the Atrocity Forecasting Project, the model plugs in more than a dozen "instability variables," which include statistics on civil wars, regime changes, assassinations, neighboring state conflicts, infant mortality rates, and instances of previous genocides. It is similar to the Pentagon-funded Integrated Crisis Early Warning System (ICEWS), a data tool used to

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ATROCITY FORECASTING PROJECT

The project has the overall purpose of enhancing capacity for forecasting mass atrocities and genocide globally and in the Asia-Pacific region. The specific aims are to:

1. develop sophisticated, appropriate, and cutting-edge quantitative forecasting models,
2. improve understanding of the causes of political instability and conflict which greatly increase the probability of mass atrocities or genocide,
3. improve understanding of the crucial causal processes which lead from instability to mass atrocities or genocide, and
4. produce forecasting software and reports which are useful as early warning tools for protection of vulnerable populations.

The aim is to provide tools for analysts and policy makers. The project builds on the current academic literature, and employs econometric and machine-learning based forecasting techniques, which can greatly enhance analytical capacity in combination with standard qualitative and quantitative social science methods. The forecasts are intended to be used in combination with other quantitative and qualitative analysis and expert knowledge.

Funding for this project from AusAID's Responsibility to Protect Fund, via the Asia-Pacific Centre for the Responsibility to Protect, is gratefully acknowledged. However, the projects' Chief Investigators, based at the University of Sydney and the University of New South Wales, take full responsibility for the analysis and forecasts presented here and in the project's reports and publications.

Forecast for 2011 - 2015: Top 15 Countries at Risk of the Onset of Genocide or Politicide

1. Central African Republic
2. Democratic Republic of the Congo
3. Chad
4. Somalia
5. Angola
6. Myanmar
7. Sri Lanka
8. Ecuador
9. Burundi
10. Afghanistan
11. Syria
12. Guinea
13. Cameroon
14. Uganda
15. Libya

THE UNIVERSITY OF NEW SOUTH WALES

Asia Pacific Centre for the Responsibility to Protect

Australian Government
AusAID

Our Future Forecasts

Atrocity Forecasting Project: http://sydney.edu.au/arts/research/atrocity_forecasting/

**Forecast for 2011 - 2015: Top 15 Countries at
Risk of the Onset of Genocide or Politicide**

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2 Democratic Republic of the Congo
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10 Afghanistan
11 Syria
12 Guinea
13 Cameroon
14 Uganda
15 Libya

Central African Republic

The Guardian & BBC timelines   PITF (2013)

- **2007**: Three rebel groups – the Union of Democratic Forces for Unity, the Union of Republican Forces and the Convention of Patriots for Justice and Peace – form an alliance called Seleka. After an accord with the government, they join CAR army
- **2010** September - Voter registration begins for <u>presidential, parliamentary elections due in January 2011</u>.
- **2012**: Some rebels take up arms once more and gain control of the north and centre of the country
- **2013 March**: Seleka rebels overrun the capital and seize power. Bozizé flees. Rebel leader Michel Djotodia suspends constitution and dissolves parliament in a coup condemned internationally
- **2013 August**: Djotodia is sworn in as president
- **2013 October**: UN Security Council approves deployment of UN peacekeepers
- **2013 December**: French send new contingents to CAR amid signs of increasing lawlessness and violence
- **2015** January - UN accuses Christian militia of ethnic cleansing.
- **2015** February - The UN says that surging violence in the Central African Republic has forced tens of thousands to flee their homes since the beginning of the year to escape killings, rape and pillaging by militias.

- "A coalition of Islamist militias calling itself Seleka forcibly ousted the regime of President Bozizé on 24 March 2013 but were unable or unwilling to assert administrative authority and, instead, engaged in predatory actions against the population, leading to a collapse of central authority. Christian "anti-balaka" militias formed in response and attempted to drive Seleka forces from the capital city beginning on 5 December 2013; violent chaos ensued during which the Muslim community was generally targeted with retribution."

Overview

I. What do we mean by "Genocide Forecasting"?

II. Forecasting ('post-casting') method and assessment, 1988-2003

III. Assessing our forecasts for 2011-2015, against actual events

IV. Closing words & your feedback

How can we define 'genocide' for the purpose of forecasting it?

- Raphael Lemkin (1944, *Axis Rule in Occupied Europe* [emphasis added])
  - 'a coordinated plan of different actions aiming at the destruction of essential foundations of the life of national groups, with the aim of annihilating the groups themselves'
- United Nations, *Convention on the Prevention and Punishment of the Crime of Genocide* (1948)

Article II

In the present Convention, genocide means any of the following acts committed with intent to destroy, in whole or in part, a national, ethnical, racial or religious group, as such:

(a) Killing members of the group;

(b) Causing serious bodily or mental harm to members of the group;

(c) Deliberately inflicting on the group conditions of life calculated to bring about its physical destruction in whole or in part;

(d) Imposing measures intended to prevent births within the group;

(e) Forcibly transferring children of the group to another group.

Source: http://untreaty.un.org/cod/avl/ha/cppcg/cppcg.html;

What do we mean by "genocide forecasting"?

"Genocide" (PITF)

- 'Genocides and politicides are the promotion, execution, and/or implied consent of sustained policies by governing elites or their agents—or, in the case of civil war, either of the contending authorities—that are intended to destroy, in whole or part, a communal, political, or politicized ethnic group. In genocides the victimized groups are defined by their perpetrators primarily in terms of their communal characteristics. In politicides, in contrast, groups are defined primarily in terms of their political opposition to the regime and dominant groups.' Barbara Harff & Ted Robert Gurr (1988, 360)

Forecasting

- Using what we know today to develop expectations for some future period

- In-sample forecasting

- Out-of-sample forecasting

- Post-casting
  - 1988-2003 (JPR 2013)

- Forecasting
  - 2011-15 (AFP reports / web)

Genocide and Politicide Onsets, 1955-2015

country	year	country	year	country	year
Sudan	1956	Chile	1973	Sudan	1983
China	1959	Pakistan	1973	Burundi	1988
Algeria	1962	Angola	1975	Iraq	1988
Iraq	1963	Cambodia	1975	Somalia	1988
Rwanda	1963	Indonesia	1975	Sri Lanka	1989
Congo Kinshasa	1964	Argentina	1976	Bosnia	1992
Burundi	1965	Ethiopia	1976	Burundi	1993
Indonesia	1965	Congo Kinshasa	1977	Rwanda	1994
Vietnam South	1965	Afghanistan	1978	Angola	1998
China	1966	Guatemala	1978	Yugoslavia	1998
Nigeria	1967	Myanmar (Burma)	1978	Sudan	2003
Equatorial Guinea	1969	El Salvador	1980	Sri Lanka	2008
Pakistan	1971	Uganda	1980	Central African Republic	2013
Uganda	1971	Iran	1981	Iraq	2014
Philippines	1972	Syria	1981		

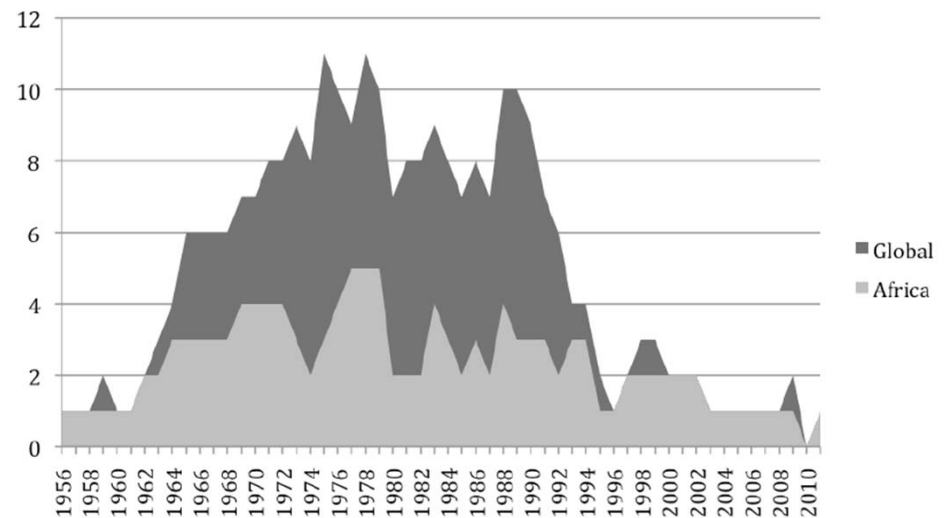Notes: PITF codings adapted and updated by Atrocity Forecasting Project.

Figure 1 – Ongoing Genocides and Politicides, Globally and in Africa, 1956-2011

Assessing Forecasting Performance

- Contingency Table ("confusion matrix")

- Statistical models produce probabilities or rankings

- Many ways exist to extract and assess forecasts from a list of probabilities

	Observation	
	No Onset	Genocide Onset
No Onset	(true negatives)	(false negatives)
Genocide Onset	(false positives)	(true positives)

Forecast

The Model

Stage 1

- Outcome: Political instability years
- Input variables:
  - *History* (Instability$_{t-1}$; PrevInstability$_{t-1}$; StabYrs$_{t-1}$; StabYrs$^2_{t-1}$)
  - *Politics / Econ* (PolChange3$_{t-1}$; MixedRegime$_{t-1}$; IMR$_{t-1}$; IMR$_{t-2}$; SLD$_{t-1}$; *ln*Population$_{t-1}$; *ln*Population$_{t-1}$; MENA; CSASIA)
  - *Time-specific events* (Assassin$_{t-2}$; NeighborConflict$_{t-1}$; ElectionPeriod; EthnicFract$_{t-1}$*ElectionPeriod)

Stage 2

- Outcome: Genocide/Politicide onsets
- Input variables:
  - *History* (PrevGen$_{t-1}$; NoGenYrs$^2_{t-1}$; NoGenYrs$^3_{t-1}$)
  - *Politics / Econ* (Excon*fdHumDefBur$_{t-1}$; Excon*lnHumDefBur$_{t-1}$;)
  - *Time-specific events* (Assassin$_{t-1}$; Assassin$_{t-2}$; ElectionPeriod$_{t+1}$)
  - *Pr(Instability)*

Genocide Forecasting, 1988-2003

- Our post-casting
  - *Journal of Peace Research* (2013)
- Training sample
  - 1974-1987
- Testing sample
  - 1988-2003
- Performance

Out-of Sample Forecasts for Genocide/Politicide Onsets, 1988-2003

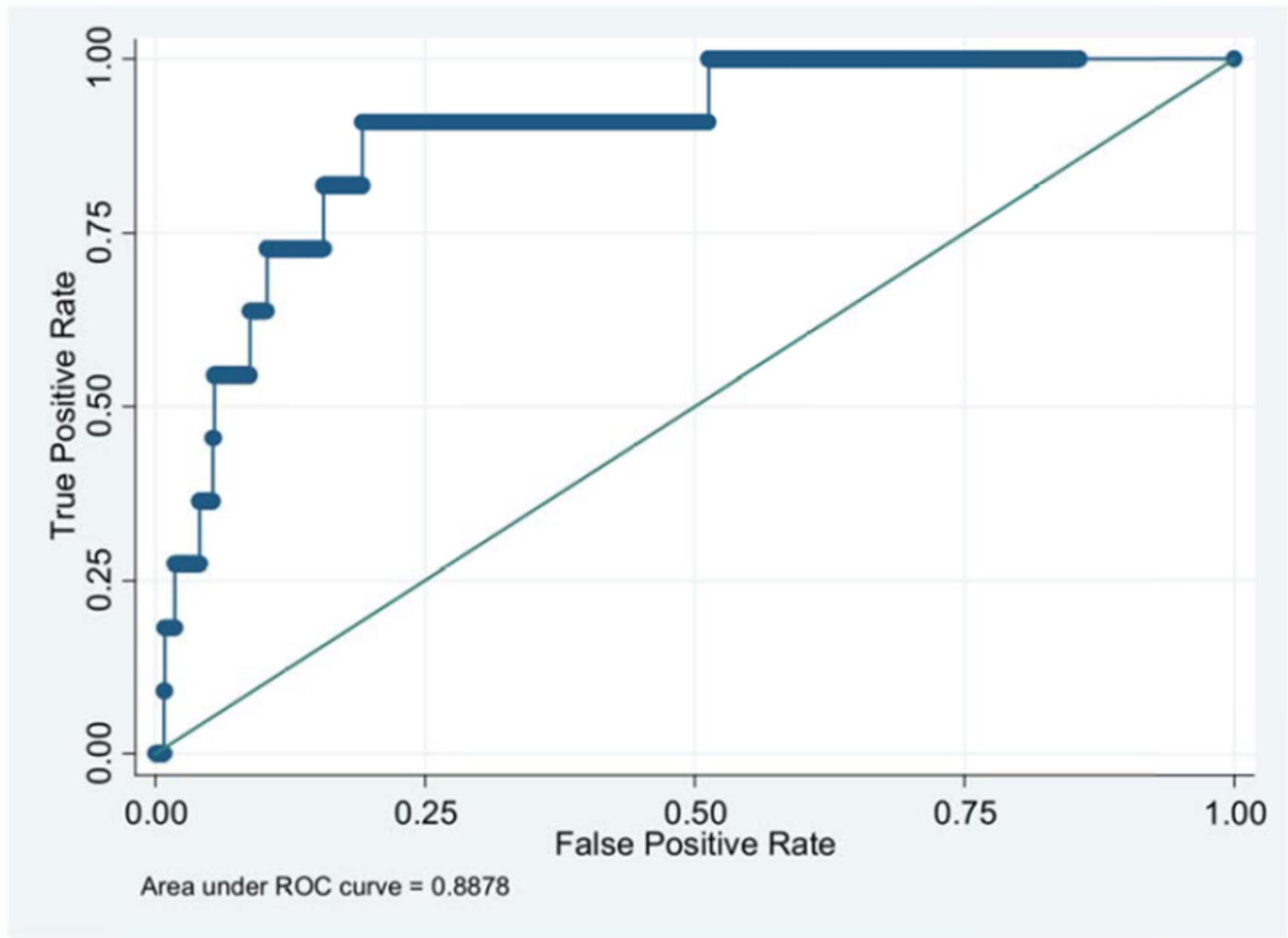| Country	Onset Year	Correctly Forecasted
Burundi	1988	✓
Iraq	1988	✓
Somalia	1988	✓
Sri Lanka	1989	✓
Bosnia and Herzegovina	1992	✓
Burundi	1993	✓
Rwanda	1994	✓
DRC	1997	✓
Angola	1998	✓
Yugoslavia (Kosovo)	1998	
Sudan	2003	✓

Note: Based on Goldsmith et al. 2013, *Journal of Peace Research*, second-stage model Table IIb. Training data 1974-1987. Of 2084 country-years, there are: 10 true positives (above); 1 false negative (above, Yugoslavia [Kosovo] 1998); 432 false positives; and 1641 true negatives. Positive forecast if predicted probability >= 0.000767. Receiver Operating Characteristic (ROC) Area Under the Curve (AUC) = .8878.

Observation

Forecast	No Onset	Genocide Onset
No Onset	1641	1
Genocide Onset	432	10

Assessing the Post-casts

- out-of-sample forecasts for 1988-2003 predict 90.9% of genocide onsets correctly while also predicting 79.2% of non-onset years correctly
- 16 annual forecasts based only on previous years' data, identify six of eleven genocide/politicide onsets in top 5% of at risk countries per year
- "ROC AUC"
  - Goldsmith et al. = .8878
  - Harff = .7478 (see the paper, though)

Figure 1. ROC Analysis, Out-of-Sample Forecasting 1988-2003.

Area under ROC curve = 0.8878

Some Potent Predictors

(see also: http://sydney.edu.au/arts/research/atrocity_forecasting/forecasts/future_forecasts.shtml)

Forecast %	Onset year	State	SLD_{t-1}	$PrevGen_{t-1}$	$Instability_{t-1}$	$PrInst_t$	$Uncon\_HDB_{t-1}$	$NoGenYrs_{t-1}$	$EthnicPowerRel_{t-1}$	$Polity_{t-1}$	$NUMIGO_{t-1}$	EF_{t-1}	$PolChange3_{t-1}$	$Uncon\_fdHDB_{t-1}$	$Assassin_{t-1}$	$ElectionPeriod_t$	HDB_{t-1}	$Assassin_{t-2}$
1.45%	2003	Sudan	1	2	1	0.99	6724.51	18	2	-6	72	0.71	1	0.00	0	0	6724.51	0
2.13%	1997	DRC	1	2	1	0.99	2833.80	18	2	0	58	0.93	0	563.93	0	0	2833.80	0
2.56%	1994	Rwanda	1	1	1	0.91	1924.25	29	1	-6	44	0.18	1	9.99	1	0	1924.25	0
3.31%	1988	Burundi	1	1	0	0.01	646.66	21	2	-7	39	0.33	0	-0.81	0	0	646.66	0
3.52%	1998	Angola	1	1	1	0.99	0.00	21	2	-3	45	0.76	-2	0.00	0	0	5799.59	0
4.96%	1988	Iraq	1	1	1	0.98	54058.20	23	2	-9	55	0.55	0	6006.47	0	1	54058.20	0
13.22%	1988	Somalia	1	0	0	0.04	3190.44	27	0	-7	46	0.81	0	0.00	0	0	3190.44	0
26.72%	1993	Burundi	0	2	1	0.91	833.84	3	1	-3	42	0.33	4	63.30	0	1	833.84	0
40.00%	1989	Sri Lanka	1	0	1	0.99	0.00	40	1	5	58	0.43	0	0.00	0	1	1321.42	1
42.25%	1998	Yugoslavia	1	0	0	0.02	7258.42	49	1	-6	38	0.57	1	636.63	1	0	7258.42	0
42.62%	1992	Bos. & Herz.	0	0	0	0.00	0.00	31	1	-5	53	0.57	0	0.00	1	0	10666.73	0

Genocide Forecasting, 2011-2015

- Our forecasting
  - AFP website
- Training sample
  - 1974-2010
- Testing sample
  - None, until now (2011-15)
- Performance
  - UN warnings
  - Genocide Watch
  - PITF (updated to 2014)

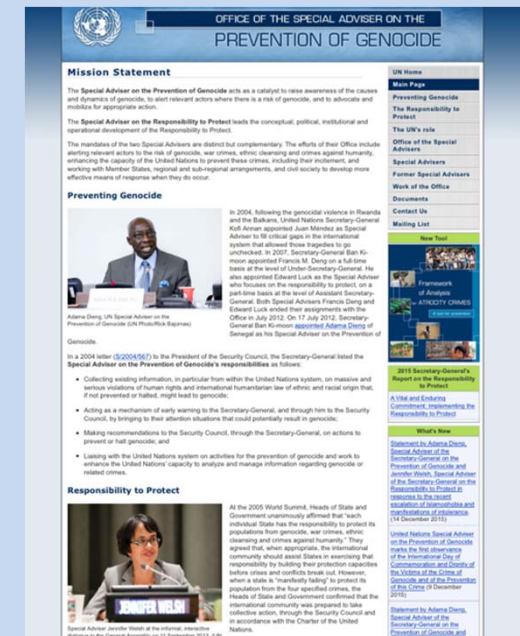**Forecast for 2011 - 2015: Top 15 Countries at Risk of the Onset of Genocide or Politicide**

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8	Ecuador
9	Burundi
10	Afghanistan
11	Syria
12	Guinea
13	Cameroon
14	Uganda
15	Libya

Data for Genocide / Politicide Onsets, 2011-2015

- PITF
  - 2011-2014 (previous slide, CAR & Iraq)
  - http://www.systemicpeace.org/inscrdata.html
- Genocide Watch
  - 2011-2015 (9 onsets)
  - http://genocidewatch.net/
- UN Warnings
  - 2011-2015 (32 warnings issued)
  - Special Advisers for the Prevention of Genocide and the Responsibility to Protect
  - http://www.un.org/en/preventgenocide/adviser/

AFP and PITF (Harff & Gurr) using Genocide Watch data

- Barbara Harff and Ted R. Gurr's risk assessments
- http://www.gpanet.org/content/barbara-harffs-risk-assessments

Observation

Forecast	No Onset	Genocide Onset
No Onset	na	na
Genocide Onset	11 or 26(AFP), 33(H&G)	4(AFP), 4(H&G)

Genocide Watch onsets 2011-14		AFP	Harff & Gurr
1 DR Congo	2011	1	1
2 Libya	2011	1	
3 Syria	2011	1	1
4 Yemen	2011		
5 Sudan (LRA)	2011		1
6 Uganda (LRA)	2011	1	1
7 Iraq	2014		
8 Nigeria	2014		
9 South Sudan	2014		

Notes: Harff & Gurr (2011 [list of 20]; 2013[list of 17]).
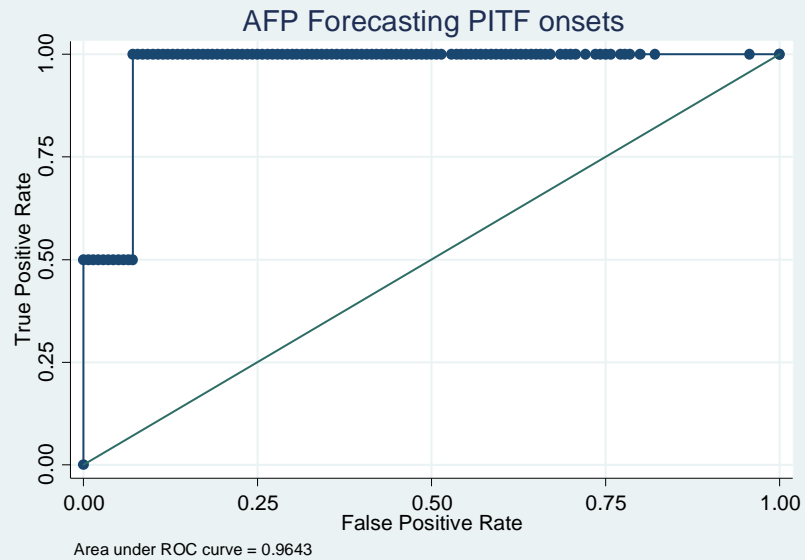
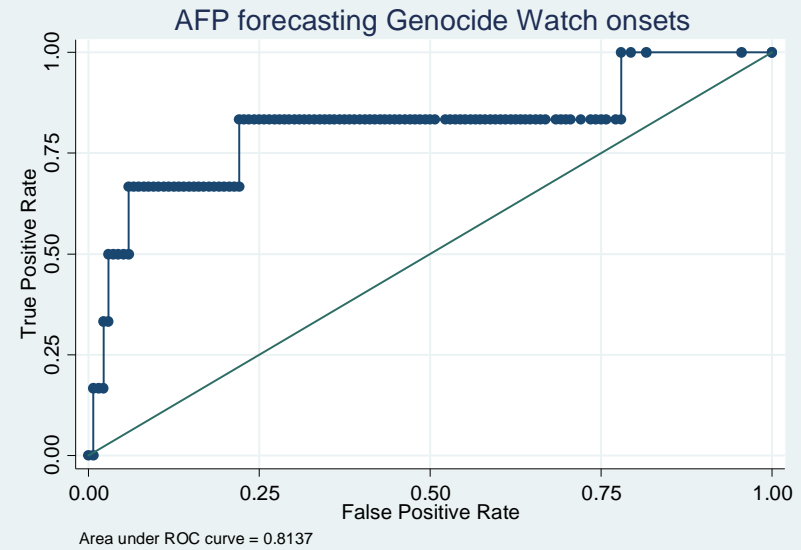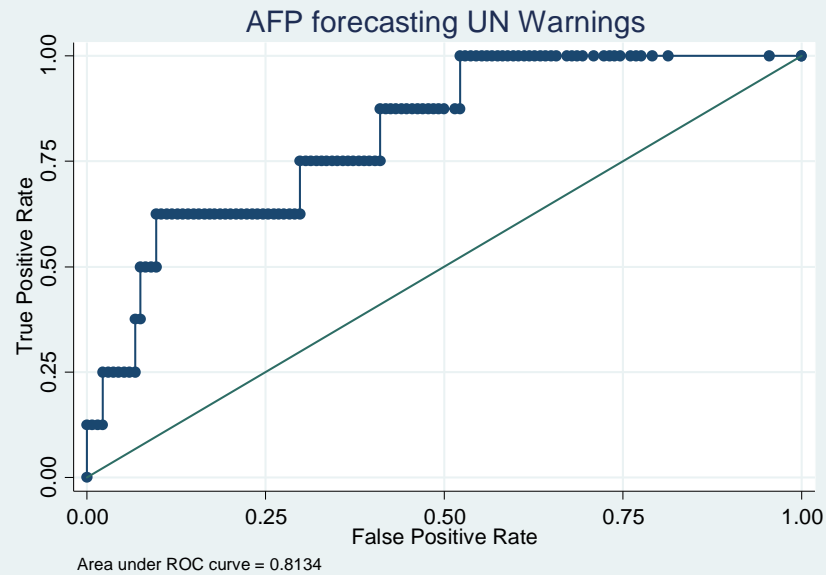# AFP and PITF (Harff & Gurr) using UN Warnings data

- Our forecasts capture 20 of 32 UN warnings, including 3 of 7 countries with multiple warnings.

- If we drop South Sudan, we capture 20 of 30 warnings, and 3 of 6 countries with multiple warnings.

Observation

Forecast		No Onset	Genocide Onset
	No Onset	na	na
	Genocide Onset	10(AFP), 16(H&G)	20(AFP), 20(H&G)

	UN Warnings		AFP	Harff & Gurr	Harff & Gurr (2011 only)
1	Myanmar	2015	1	1	1
2	Syria	2015	1	1	1
3	Syria	2015	1	1	1
4	Syria	2015	1	1	1
5	Yemen	2015		1	
6	Yemen	2015		1	
7	Burundi	2015	1		
8	Syria	2014	1		1
9	Iraq	2014			
10	Iraq	2014			
11	Israel	2014			
12	South Sudan	2014			
13	Central African Republic	2014	1		1
14	Central African Republic	2014	1		1
15	South Sudan	2013			
16	Central African Republic	2013	1		1
17	Central African Republic	2013	1		1
18	Syria	2013	1	1	1
19	Syria	2013	1	1	1
20	Egypt	2013			
21	Myanmar	2013	1	1	1
22	Mali	2013			
23	Syria	2012	1		1
24	Syria	2012	1		1
25	Syria	2012	1		1
26	Syria	2012	1		1
27	Sudan	2011		1	1
28	Sudan	2011		1	1
29	Syria	2011	1	1	1
30	Syria	2011	1	1	1
31	Libya	2011	1		
32	Ivory Coast	2011			

Notes: Harff & Gurr (2011[20];2013[17]; 2015[20];)

AUC for Atrocity Forecasting Project, 2011-15: .8134 - .9643

Final Words

- Our website: http://sydney.edu.au/arts/research/atrocity_forecasting/
  - Please send an email to ben.goldsmith@sydney.edu.au if you would like to be added to our email list
- New Forecasts for 2016-2020
  - We hope to have these out in March
- Next: better definition and dataset focused on "Targeted Mass Killing"
- Thanks for your attention and I look forward to your questions & feedback

Some References

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