State Fragility & Early Warning: Environmental Factors

NDIA Environment, Energy and Sustainability Symposium

14-17 June 2010, Denver, CO

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Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
JUN 2010		**00-00-2010 to 00-00-2010**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
State Fragility & Early Warning: Environmental Factors	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	8. PERFORMING ORGANIZATION REPORT NUMBER
Office of the Assistant Secretary of the Army (Installations & Environment),Army Environmental Policy Institute (AEPI),110 Army Pentagon Room 3E464,Washington,DC,20310-0110	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
Presented at the NDIA Environment, Energy Security & Sustainability (E2S2) Symposium & Exhibition held 14-17 June 2010 in Denver, CO.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**33**	

Topics

- Project Purpose and Relevance
- Fragile States: Conceptual Framework
- Fragility-Instability-Security Constructs
- Exploratory Analysis: Fragility-Environment
- Preliminary Findings and Recommendations

Project Purpose and Relevance

- Research the current state of both instability and fragility early warning systems, and assess their capabilities to account for environmental factors

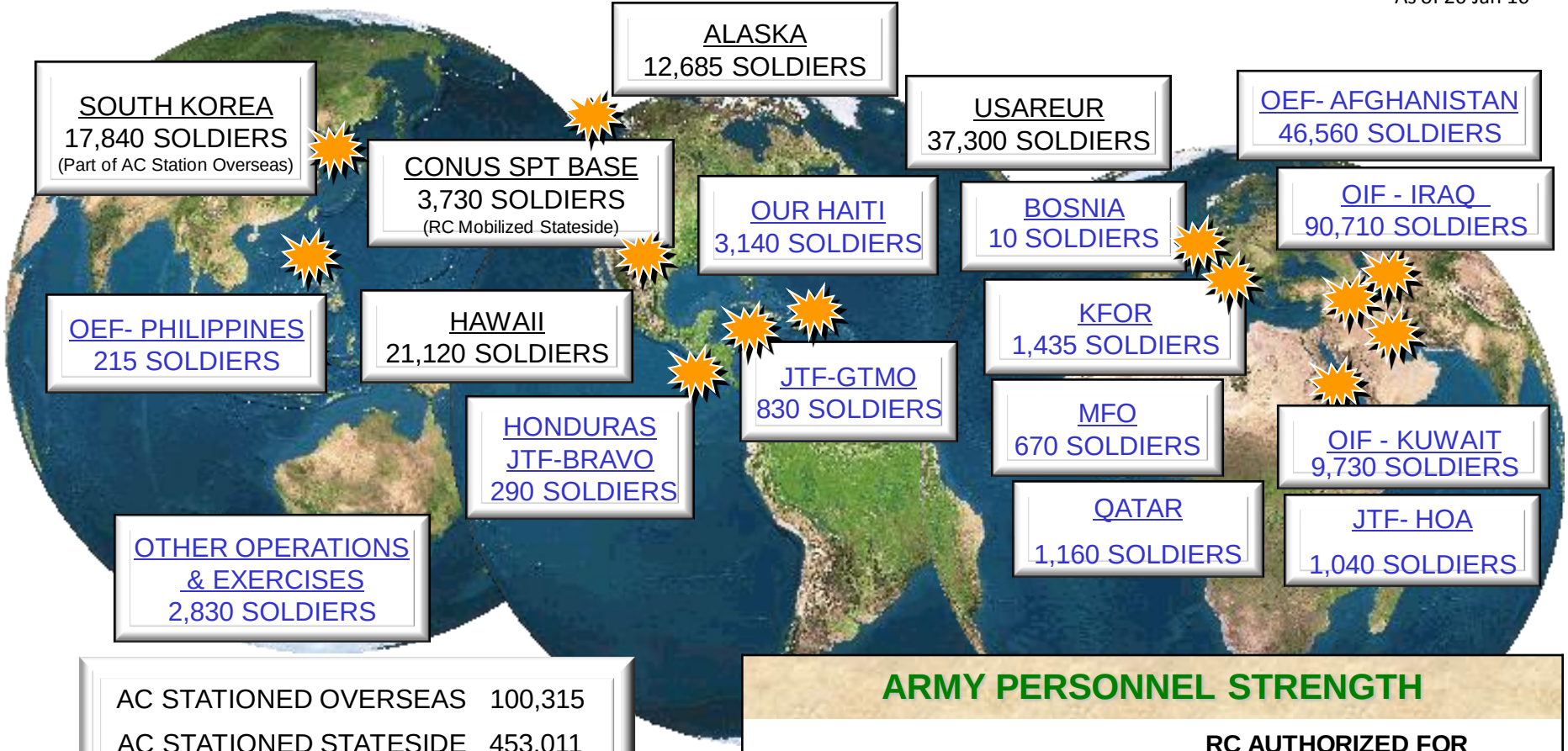
- Recommend how to incorporate such factors into meaningful frameworks supportive of U.S. Army, defense, and national security missions

The mission of the Army Environmental Policy Institute (AEPI) is to assist the Army Secretariat in the development of proactive policies and strategies to address environmental issues that may have significant future impacts on the Army

Source: www.aepi.army.mil

Army Global Commitments

As of 26 Jan 10



AC STATIONED OVERSEAS	100,315
AC STATIONED STATESIDE	453,011

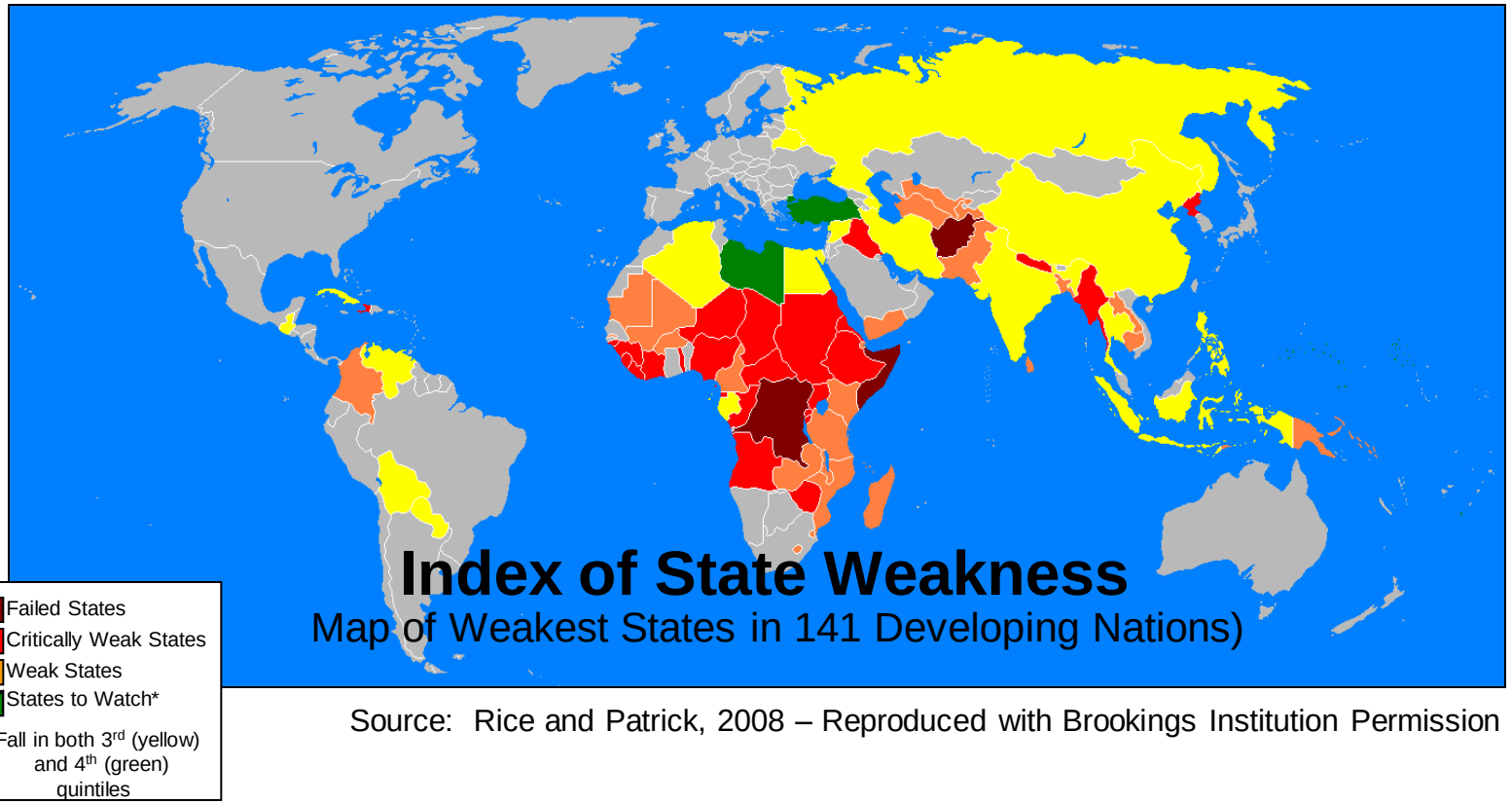
260,160 SOLDIERS DEPLOYED/"FORWARD STATIONED" IN NEARLY 80 COUNTRIES OVERSEAS
*INCLUDES AC STATIONED OVERSEAS

Source: US Army, Office of the Chief of Staff, 2010

ARMY PERSONNEL STRENGTH

Component		RC AUTHORIZED FOR MOBILIZATION / ON CURRENT ORDERS
Active (AC)	553,326	N/A
Reserve (RC)		
USAR	207,400	23,200
ARNG	362,000	61,695
	1,126,080	

Fragility as a Global Threat

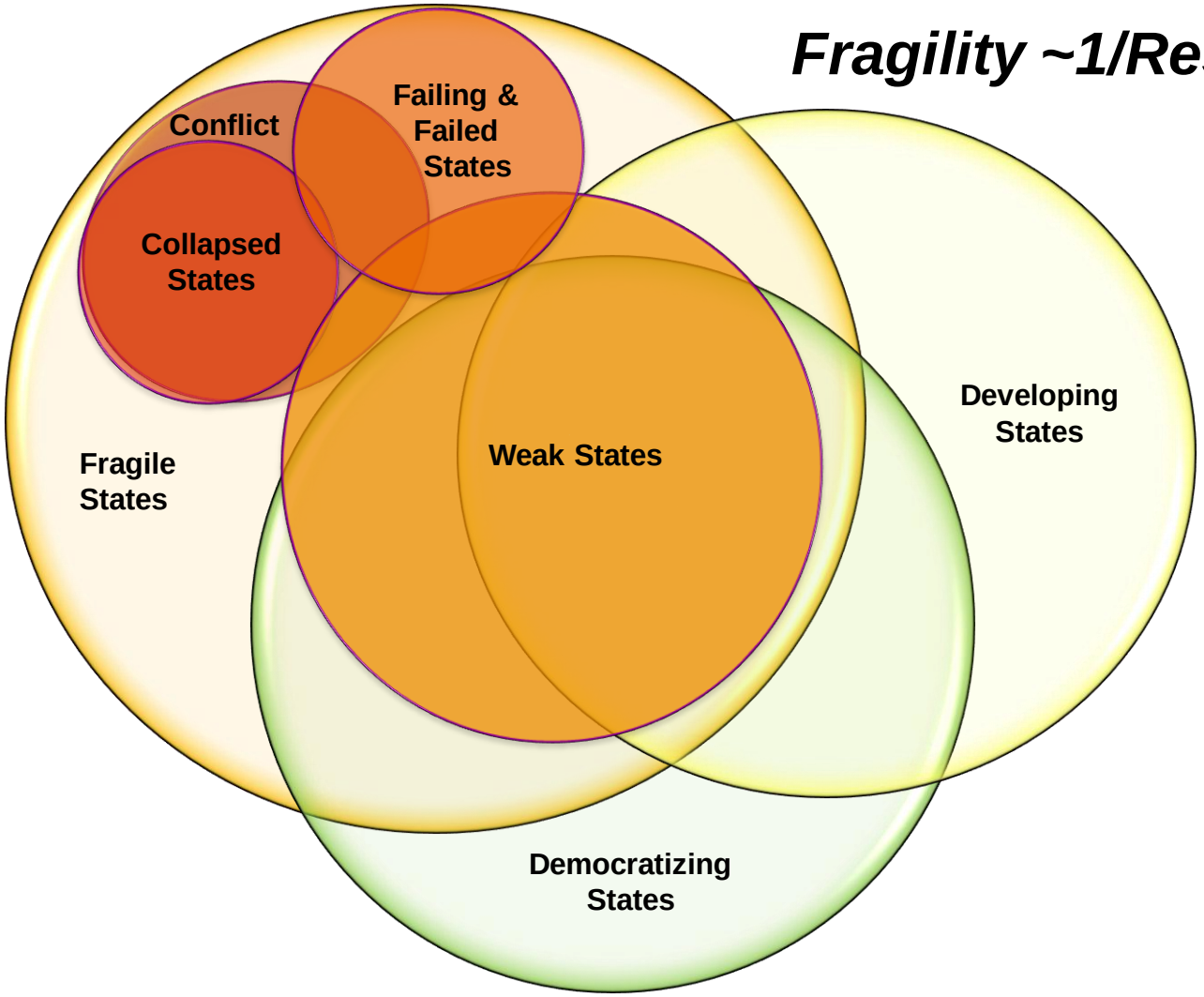


Source: Rice and Patrick, 2008 – Reproduced with Brookings Institution Permission

"America is now threatened less by conquering states than we are by failing ones"

(National Security Strategy 2002)

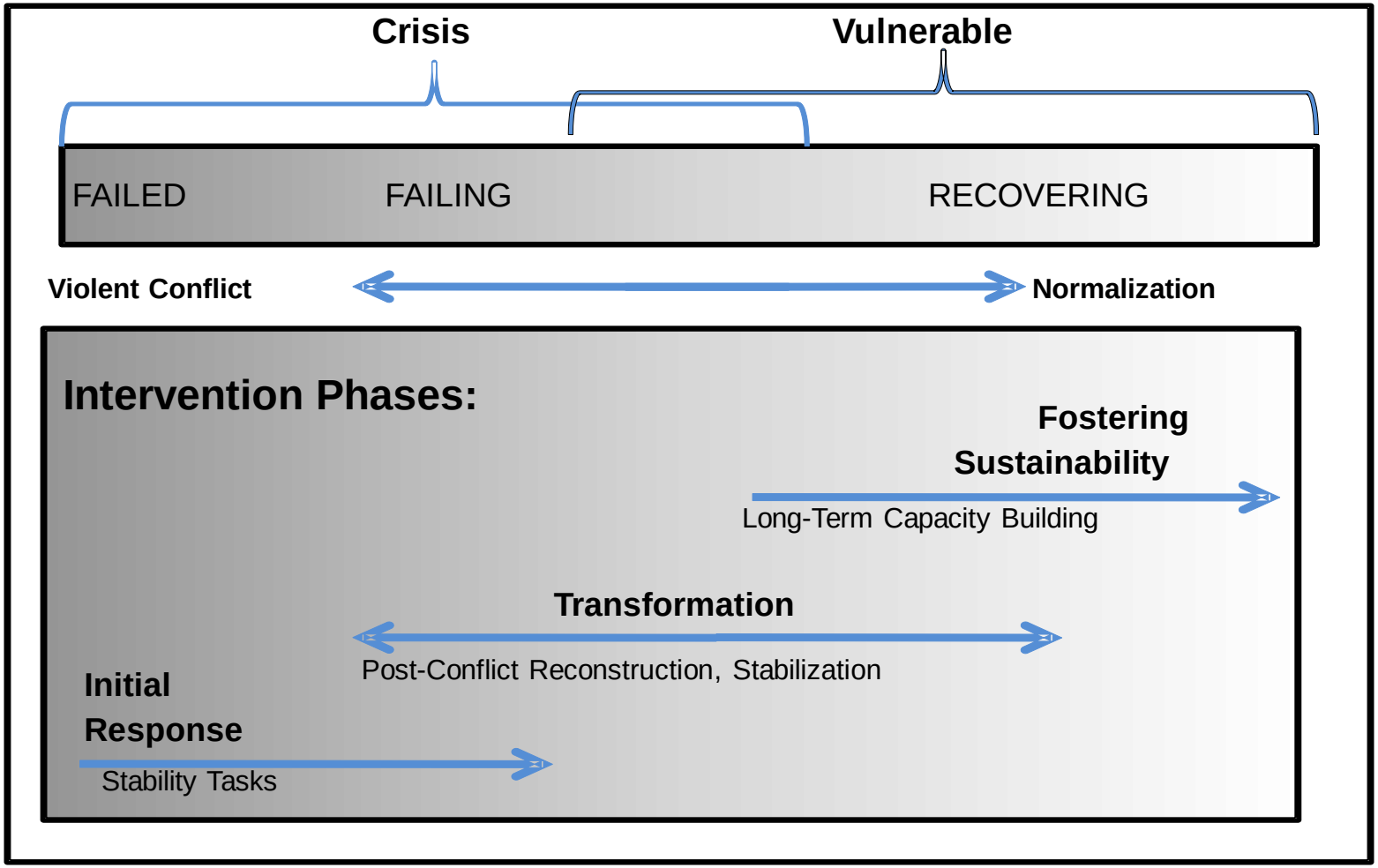
Fragility – Terminology/Framework



Source: Adapted from Carment *et al.*, Security, Development, and the Fragile State, 2010

Response to Instability and Fragile States

Fragile States Spectrum & Stability Operations Frameworks



Source: US Army Field Manual (FM) 3-07, Stability Operations, 2008

Fragility Defined

- Definition of fragility varies depending on the source referenced, e.g., comprehensive definition in FM 3-07

- Concise OECD definition of a **Fragile State**:

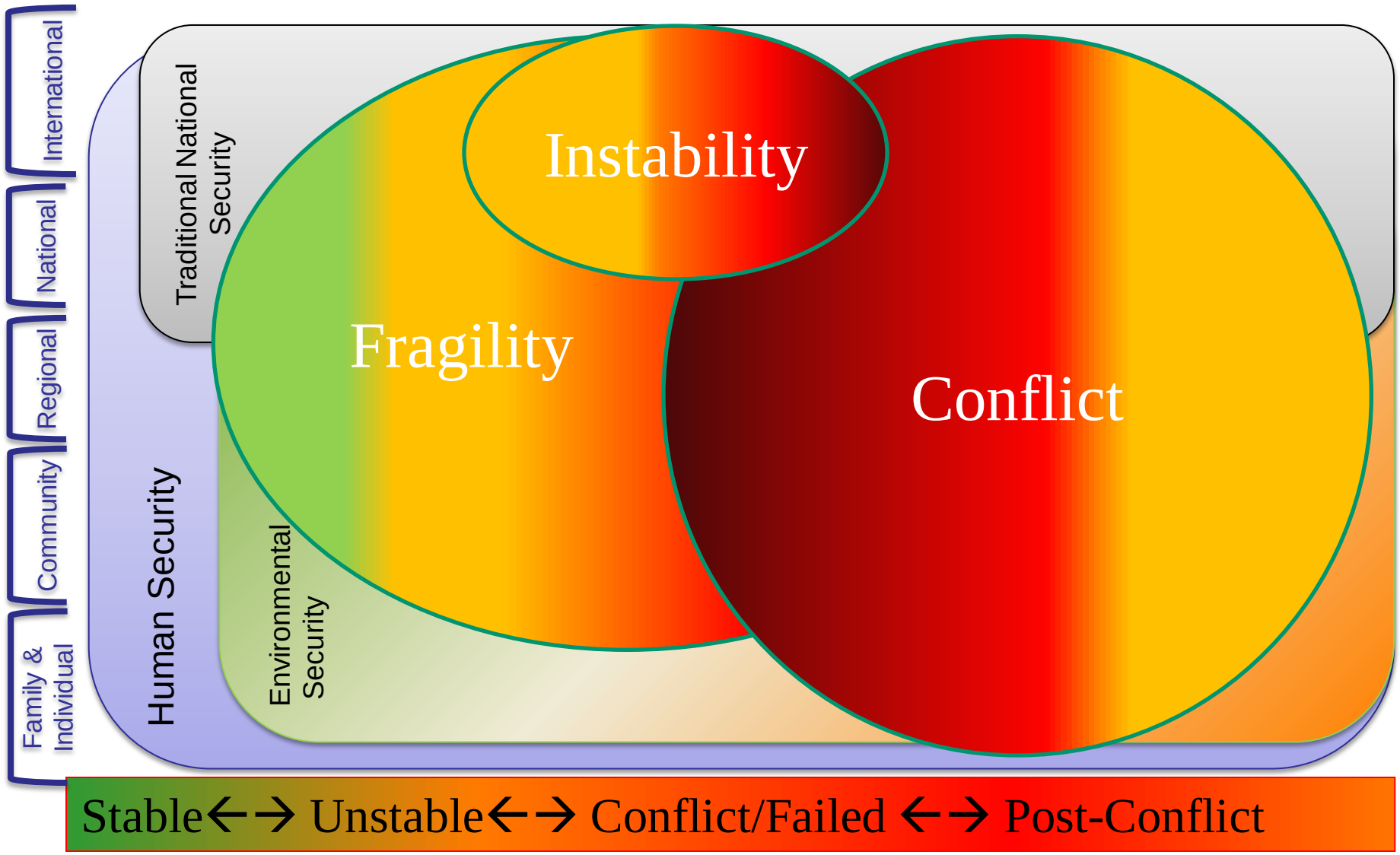
"States are fragile when state structures lack political will and/or capacity to provide the basic functions needed for poverty reduction, development, and to safeguard the security and human rights of their populations"

Source: OECD definition provided in Principles for Good International Engagement in Fragile States and Situations, 2007, as reported by Mata and Ziaja, in User's Guide on Measuring Fragility, 2009

Fragility vs. Instability and Conflict

- This is in contrast to **instability** … *the occurrence of of severe political conflicts and regime crisis*, e.g.,
  - Revolutionary wars, ethnic wars, adverse regime changes, genocides and politicides (Source: Marshall, 2009 – Political Instability Task Force)
- Most research to date has focused on factors that contribute to **conflict**
  - This project is unique in that it compares environmental factors to fragility indices, rather than to conflict or instability
  - Environmental factors have not shown strong correlation with instability or conflict indices to date – this project aimed to see what the correlation to fragility might be

Fragility vs. Instability and Conflict



Comparison of Security Constructs

Type	Focus	Concerns	Threats/Vulnerabilities	Responses
Traditional Security	The State	Sovereignty & Territorial Integrity	• Challenges from other states and stateless actors	• Diplomatic intervention • Economic crisis response • Military intervention • Humanitarian support
Environmental Security	The Ecosystem	Protection of Natural Infrastructure	• Resource scarcity/depletion • Resource degradation – pollution/waste • Demographic changes • Shocks – natural, manmade	• Multi-national governance • Conflict prevention • Conflict resolution
Human Security	The Individual	Integrity of Individual [freedom from fear] --- [freedom from want]	• Personal security – violence, hazards • Political security – repressive state --- • Economic security - poverty • Food security – famine, contamination • Health security – injury, disease • Community security – cultural integrity • Environmental security – scarcity, waste	• Preventive diplomacy • Disaster planning • Humanitarian support • Aid investment

Source: Hearne, 2009, adapted from Liotta, 2005; Liotta and Owen, 2006a; UNDP, 1994

Environment and Security

"Climate change, energy, global health and environmental security are often intertwined, and while not traditionally viewed as threats to U.S. national security, they will affect Americans in major ways."

Annual Threat Assessment of the Intelligence Community for the Senate Select Committee on Intelligence

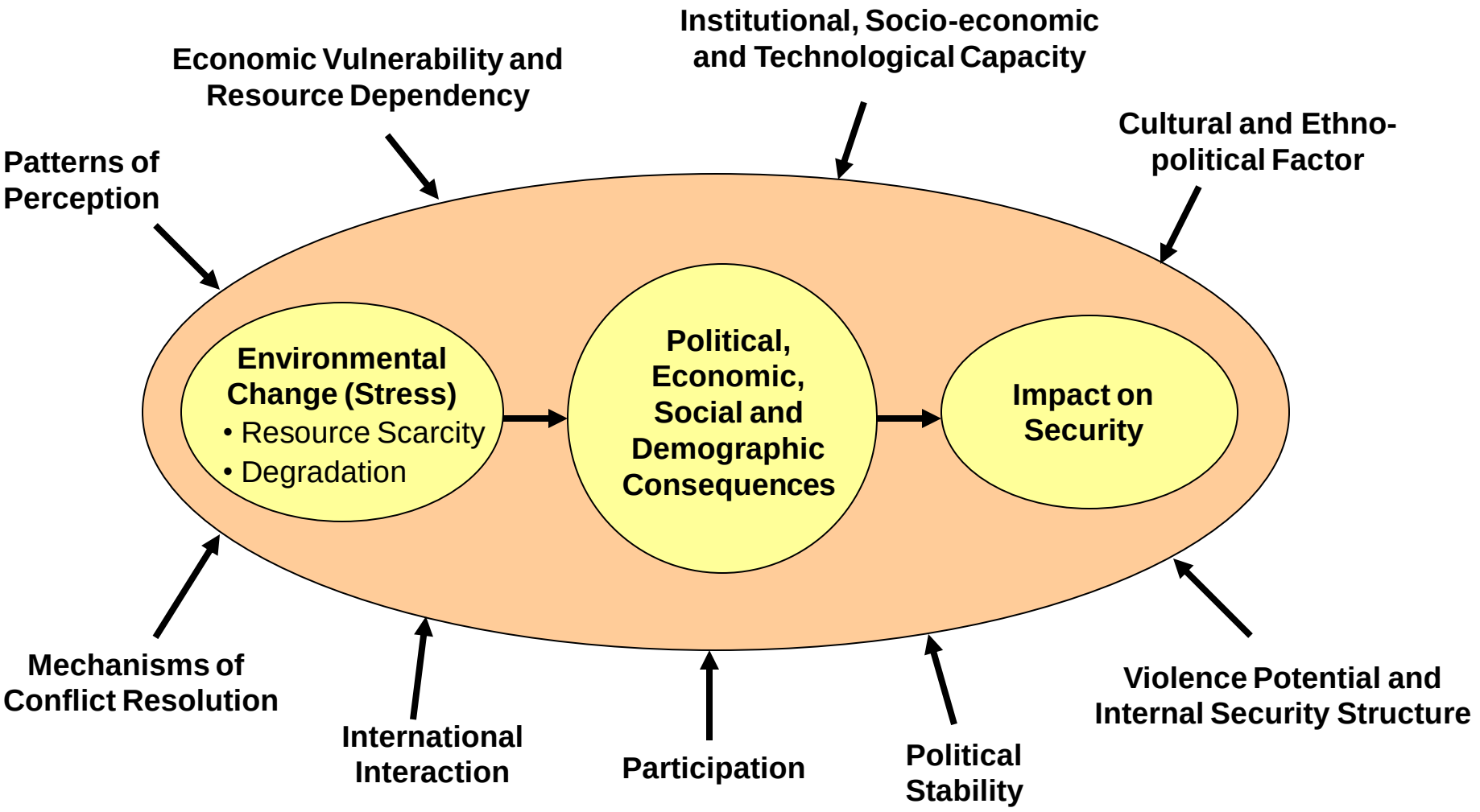
12 Feb 2009

" *the greatest danger may arise from the convergence and interaction of many stresses simultaneously … such a complex and unprecedented syndrome of problems could cause outright state failure, or weaken pivotal states counted on to act as anchors of regional stability."*

Source: Annual Threat Assessment of Intelligence Community for the Senate Select Committee on Intelligence, 2009

Environment and Security Relationship

NATO Model: Influence of Contextual Factors



Source: NATO, 1999 – NATO CCMS Final Report 232

Conceptual Dimensions Covered

	Security	Political	Economic	Social	Environmental
✓ CIFP Fragility Index	x	x	x	x	x
Index of African Governance	x	x	x	x	
✓ Index of State Weakness	x	x	x	x	
Peace and Conflict Instability Ledger	x	x	x	x	
Failed States Index	x	x	x	x	
✓ State Fragility Index	x	x	x	x	
Country Policy and Institutional Assessment / IRAI		x	x	x	
Political Instability Index		x	x	x	
BTI State Weakness Index	x	x			
Global Peace Index	x				
WGI Political Stability and Absence of Violence	x				

Source: Mata and Ziaja, User's Guide on Measuring Fragility, 2009

Project Methodology

Four Parts

1. **Extensive Literature Review**: Frameworks and Indices
2. **Stakeholder Identification**: USG, Academia, Non-Profit
3. **Exploratory Analysis**: Fragility-Environment Nexus
4. **Early Warning Architecture Screening**

Analytical Approach

- Selected Fragility Indices for analysis:
  - Carlton University, CIFP, Failed and Fragile States Index (2007)
  - The Brookings Institution, Index of State Weakness (2008)
  - GMU & UMD Polity IV Project, State Fragility Index (2007)
  - USAID, Fragility Alert List (2008)
- Used Fragility Indices as the dependent variables
- Compiled data on independent variables by Sector:
  - Security, Political, Economic, Social, and Environmental
- Employed statistical regression to evaluate relationships

Fragility vs. Conflict Models

- ***Conflict*** **as dependent variable:** logistic regression

$$\text{Logit}[P(y=1)] = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 \ \ldots + \beta_k x_k + \varepsilon$$

[binary outcome where y=1 generally denotes violent conflict, e.g., in terms of failure]

Project Focus

- ***Fragility*** **as dependent variable:** ordinary least squares

$$\text{Fragility} = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 \ \ldots + \beta_k x_k + \varepsilon$$

[fragility viewed along a continuum, e.g., to anticipate earlier turning points and intervention]

Sources: Adapted from Carment *et al.*, Security, Development, and the Fragile State, 2010; Agresti and Finlay, Statistical Methods for the Social Sciences, 2009.

Independent Variables by Sector

Security:
- State conflict intensity ✓
- Neighboring state conflicts
- Contiguous neighbor conflict
- Militarization

Political:
- Exponential of Polity Score ✓
- Rule of Law
- Log of Political Rights
- Log of Civil Liberties
- Government Effectiveness

Economic:
- GDP Growth ✓
- Trade Openness
- Log of Trade Ratio
- Current Account Balance
- Log of GDP per capita
- Log of GDP PPP
- Log of Gini coefficient

Social:
- Kcal/person/day ✓
- Log of Infant Mortality
- Log of UN Development Goals Child Mortality
- Square of life expectancy avg.
- Square of Human Development Index value, 2005

Base Model

Security; Political; Economic; Social Factors

+

Environmental Factors: EPI, Individual Variables

Fragility Model

$$\text{Fragility} = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 \ \ldots + \beta_k x_k + \varepsilon$$

Environmental Performance Index 2008

Index (Level 1)	Objectives (Level 2)	Subcategories (Level 3)	Indicators (Level 4)
EPI	Environmental Health	Environmental burden of disease	Environmental burden of disease (DALYs)
		Water (effects on humans)	Adequate sanitation
			Drinking water
		Air Pollution (effects on humans)	Urban particulates
			Indoor air pollution
			Local ozone
	Ecosystem Vitality	Air Pollution (effects on nature)	Regional ozone
			Sulfur dioxide emissions
		Water (effects on nature)	Water quality
			Water stress
		Biodiversity & Habitat	Conservation risk index
			Effective conservation
			Critical habitat protection*
			Marine Protected Areas*
		Forestry*	Growing stock change
		Fisheries*	Marine Trophic Index
			Trawling intensity
		Agriculture*	Irrigation Stress*
			Agricultural Subsidies
			Intensive cropland
			Burnt Land Area
			Pesticide Regulation
		Climate Change	Emissions per capita
			Emissions per electricity generation
			Industrial carbon intensity

Source: Adapted from: Yale Center for Environmental Law and Policy (YCELP) and Center for International Earth Science Information Network (CIESIN), Columbia University, with the World Economic Forum, and Joint Research Centre (JRC) of the European Commission (2008). 2008 Environmental Performance Index. Downloaded from http://sedac.ciesin.columbia.edu/es/epi/

Explaining Model Variability

Adjusted R-square

- R-square (R^2) measures the strength of association between the dependent variable and the set of explanatory (independent) variables acting together as predictors in the model

$$R^2 = \frac{(TSS - SSE)}{TSS}$$

Where, TSS represents the total amount of variation, and SSE represents the amount of variation that has not been explained

- The larger the value of R^2 [range 0 to 1] the better the set of explanatory variables collectively predict the dependent variable

- **Adjusted R-square** is a modification of R^2 that adjusts for the number of independent variables – and is always less than or equal to the original R^2 - and it only increases if a new term improves the model more than would be expected by chance

Adjusted R-square = R^2 - [k(1- R^2)]/[n-k-1]

Where, n is number of cases and k is number of terms in model (not including constant)

Source: Agresti and Finlay, Statistical Methods for the Social Sciences, 2009

Exploratory Analysis – Results

EPI variables and Fragility Indices

		CIFP 2007	ISW 2008	SFI 2007	USAID 2008
Level 1	No. of countries	104	83	104	103
	Base Model	0.8216	0.7805	0.7547	0.8116
	EPI 2008 Value	0.8924	0.8552	0.8406	0.8793
Level 2	No. of countries	104	83	104	103
	Base Model	0.8216	0.7805	0.7547	0.8116
	Environmental Health	0.8728	0.8683	0.8591	0.8941
	Ecosystem Vitality	0.8384	0.7781	0.7528	0.8102
Level 3	No. of countries	76	57	76	75
	Base Model	0.8163	0.7621	0.7498	0.8023
	Environmental burden of disease	0.8658	0.8312	0.8313	0.8575
	Water (effects on humans)	0.8613	0.8264	0.8312	0.8917
	Air Pollution	0.8525	0.7865	0.7791	0.8505
	Air Pollution (effects on nature)	0.8189	0.7747	0.7516	0.8075
	Water (effects on nature)	0.8426	0.7579	0.7681	0.8147
	Biodiversity & Habitat	0.8205	0.7578	0.7464	0.7995
	Forestry	0.8164	0.7583	0.7472	0.8041
	Fisheries	0.8137	0.7581	0.7464	0.7998
	Agriculture	0.8376	0.7689	0.7601	0.8131
	Climate Change	0.8292	0.7592	0.7491	0.8001

NOTE: Adjusted R-square values are depicted by decimals in table

Preliminary Findings

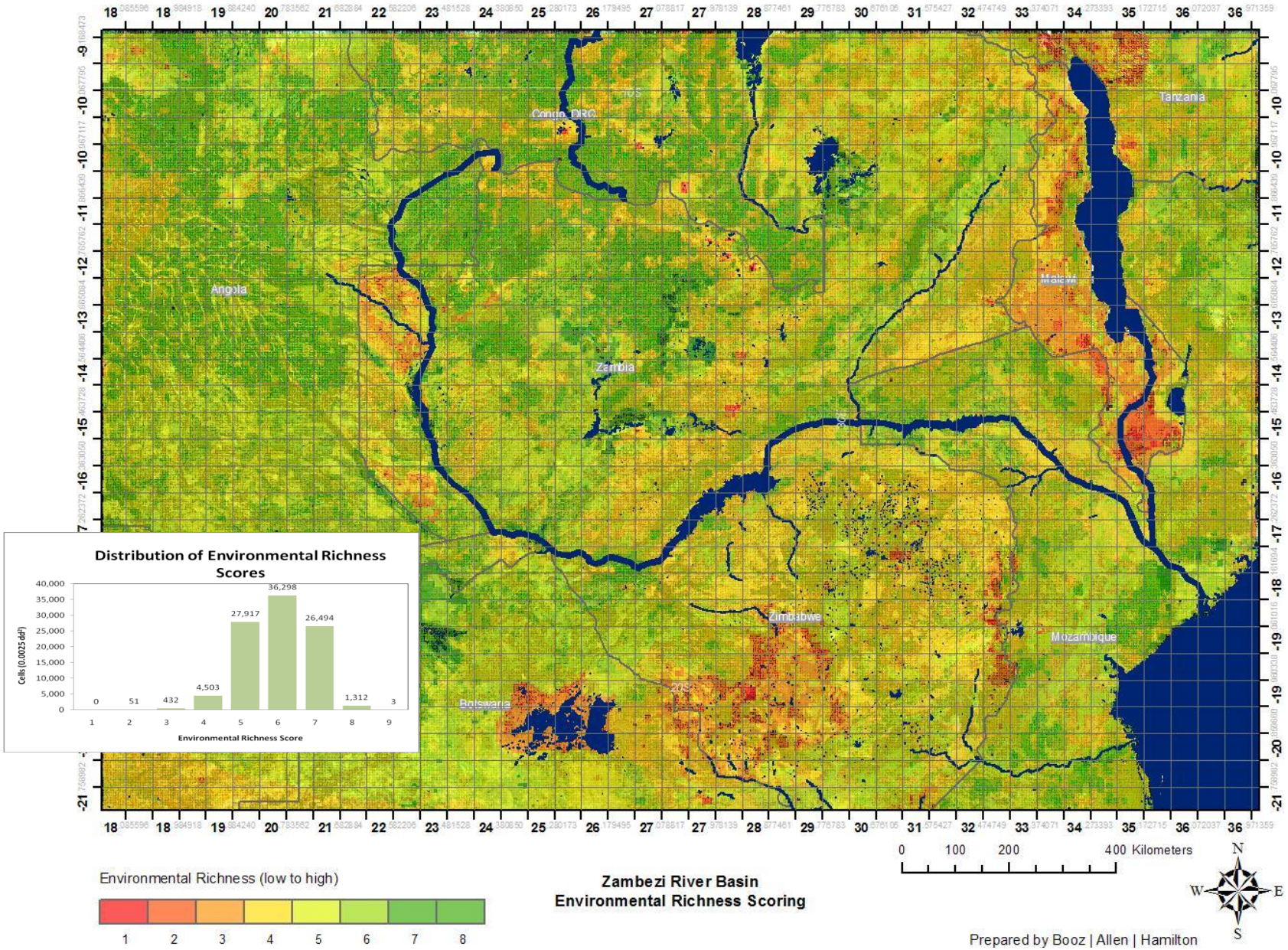
- Fragility provides a means to look further out to identify the factors that eventually may lead to instability or conflict
- Existing instability and fragility approaches do not generally address environmental factors as a specific sector
- Environmental health factors affect fragility - their inclusion could improve the predictive capacity of fragility models – but it is difficult to deduce impact from other environmental factors
- Pairing of instability and fragility approaches can provide for stronger and more robust evidenced-based decision making
- Alternative architectures can be leveraged to provide added context to fragility analysis
- Environmental factors become increasingly meaningful with geospatial/seasonal resolution - less reliance on national data
- Use of a “hybrid” [quantitative and qualitative] approach can increase the predictive confidence in fragility early warning

Alternative Architectures

- Leverage to augment fragility/instability approaches, statistical analysis, advances in new technologies

- Examples include:
  - Interactive web [Web 2.0] applications (e.g., DTWS)
  - Social media analysis (e.g., information-sharing sites)
  - Subject matter expert input and surveys
  - Content [events] analysis (e.g., FSI, Cline SID project)
  - Computational modeling (e.g., MASON agent-based system)
  - Geospatial analysis/GIS (e.g., FEWS NET, Google Earth)

Geospatial Analysis



Hybrid Early Warning Approach

Quantitative and Qualitative Components

	Quantitative	Qualitative
Strengths	• High Predictive Capacity (especially political crisis and instability) • Immediate Policy Value (useful for priority setting and "watch listing")	• Rich Contextual Information (simple for desk officers to absorb) • Strong Planning Applications (evaluation applications built in)
Weaknesses	• Incomplete Data - Reliability (e.g., crisis-affected countries) • Limited "On-the-Ground" Insight (graphs, charts, country lists may not be useful to determine what has to be done) • Less Sensitive to Short-Term (shifting conditions below the surface)	• Often "One-On Snapshots" (may become quickly outdated) • May Oversimplify Situations (conflict and fragility complexities) • Basis is Personal Judgment (more subject to personal bias)

Sources: OECD Preventing Violence, War and State Collapse: The Future of Conflict Early Warning and Response, 2009; Goldstone, Special Report: Using Quantitative and Qualitative Models to Forecast Instability, 2008

Preliminary Recommendations

- Use fragility as an early warning tool - incorporating both qualitative and quantitative data in a hybrid approach
- Apply geospatial methods in state fragility analysis to address data challenges, e.g., country-level based, missing
- Assess the effect environmental factors may have on fragility using sub-national, seasonal, geospatial data
- Promote transparency/multiple open sources, focus on next generation systems and future threats, e.g., climate change
- Engage applicable stakeholders to better document and share good practices and to better leverage resources

Contact Information

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BACKUP SLIDES

Relative Performance of Indices

	Concept Measured	Purpose		Reliability		Coverage	Replicability	
		Predictive	Descriptive	Transparency on uncertainty	Overall reliability		Data availability	Documentation
BTI State Weakness Index	State weakness		x	o	-	o	+	o
CIFP Fragility Index	State fragility	x	x	o	o	+	-	-
Country Policy and Institutional Assessment / IRAI	State fragility (development orientation)		x	-	o	-	-	o
Failed States Index	State failure	x	x	-	o	o	-	-
Global Peace Index	Negative peace		x	-	o	o	-	-
Index of African Governance	Governance		x	o	o	-	+	+
Index of State Weakness	State weakness		x	-	o	o	-	+
Peace and Conflict Instability Ledger	State instability	x		+	+	o	o	+
Political Instability Index	Social and political unrest	x		-	o	o	-	-
State Fragility Index	State fragility		x	-	o	o	-	+
WGI Political Stability	Political stability and absence of violence		x	+	+	+	-	o

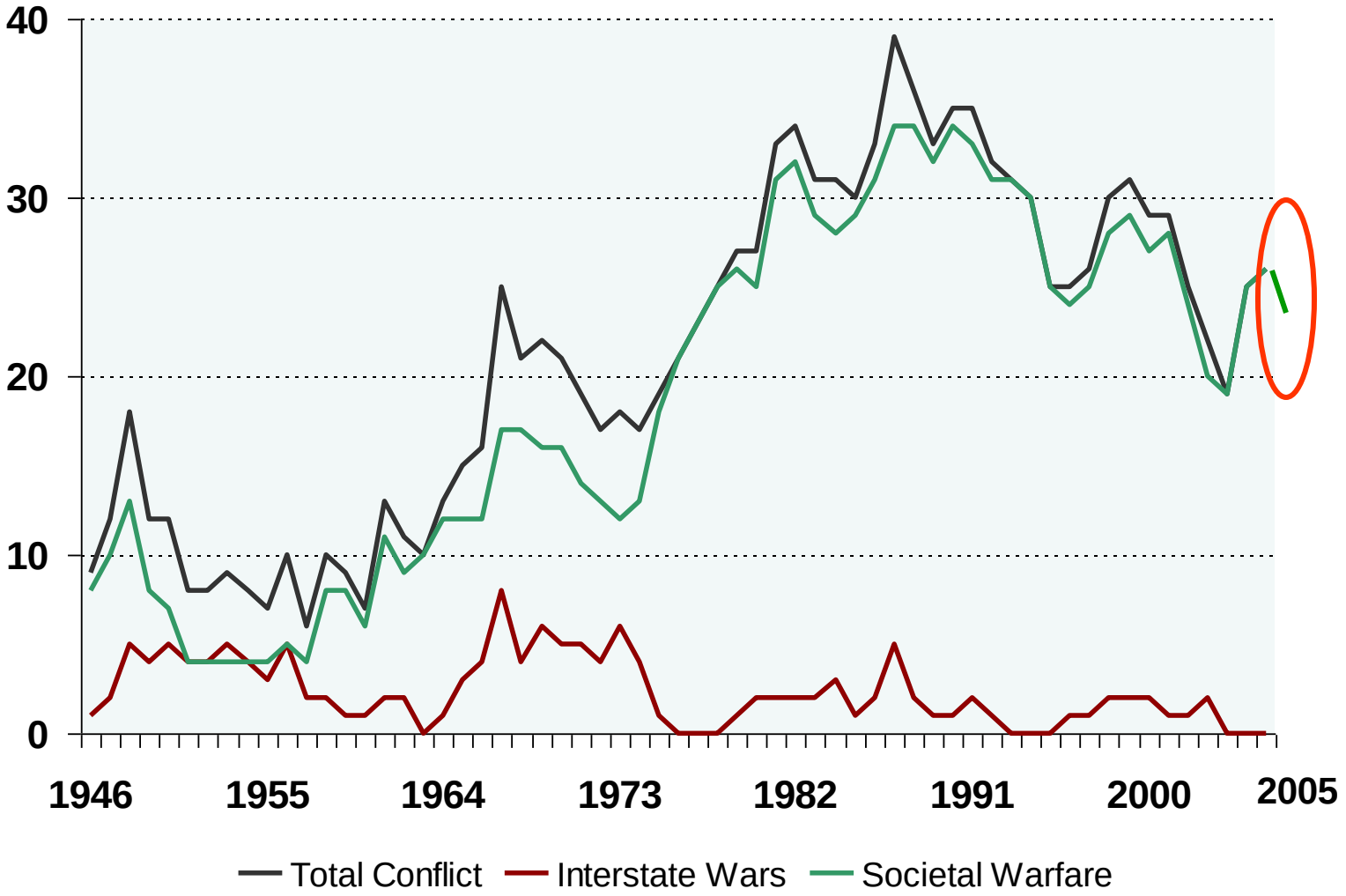
X: Yes;
-: Negative; o: Neutral; +: Positive

Source: Mata and Ziaja, User's Guide on Measuring Fragility, 2009

Top 20 Fragile Countries By Index

	SFI 07	ISW 08	CIFP 07
1	Somalia	Somalia	Sudan
2	Sudan	Afghanistan	Somalia
3	Afghanistan	Congo, Dem. Rep.	Afghanistan
4	Myanmar (Burma)	Iraq	Burundi
5	Chad	Burundi	Iraq
6	Dem. Rep. of Congo	Sudan	Congo, Dem. Rep.
7	Iraq	Central African Rep.	Yemen, Rep.
8	Rwanda	Zimbabwe	Haiti
9	Burundi	Liberia	Liberia
10	Liberia	Cote D'Ivoire	Ethiopia
11	Nigeria	Angola	Angola
12	Sierra Leone	Haiti	West Bank and Gaza
13	Central African Republic	Sierra Leone	Cote d'Ivoire
14	Ethiopia	Eritrea	Eritrea
15	Guinea	North Korea	Nigeria
16	Angola	Chad	Chad
17	Guinea-Bissau	Burma	Sierra Leone
18	Zambia	Guinea-Bissau	Pakistan
19	Burkina Faso	Ethiopia	Guinea
20	Cameroon	Congo, Rep.	Nepal

Global Trends Violent Conflict: 1946-2006



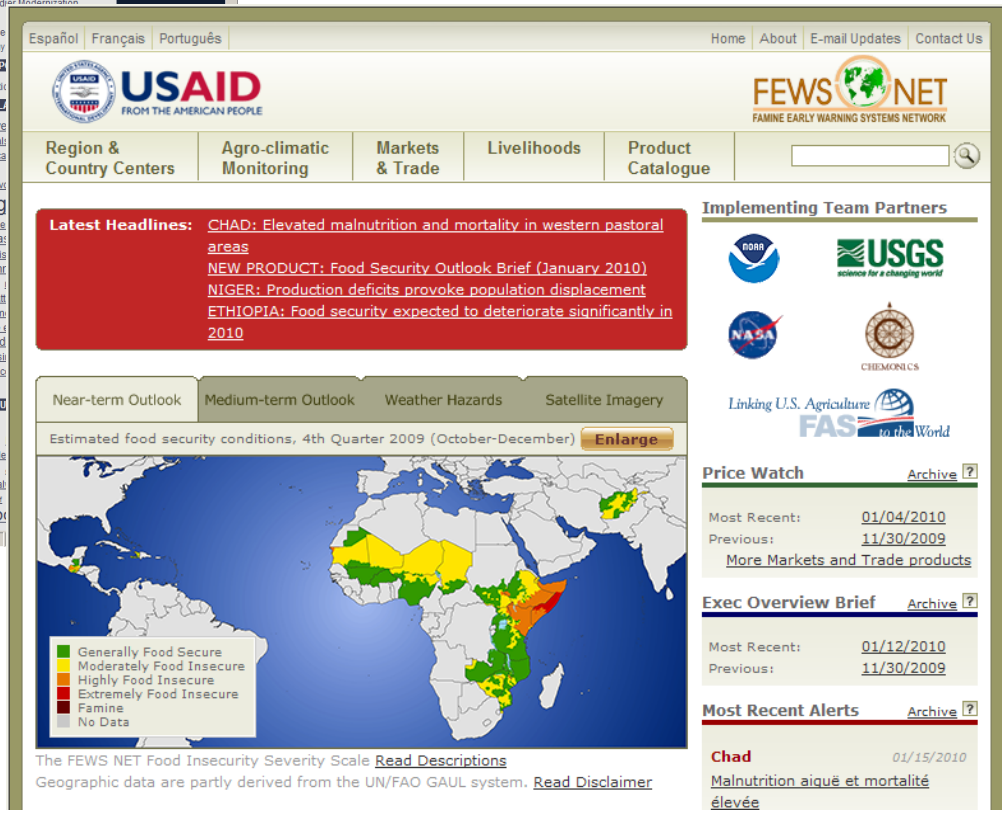
Source: *Peace and Conflict 2008*, CIDCM, University of Maryland, reproduced with permission of Joseph Hewitt, CIDCM;
Note: 2010 report reflects a small dip in total conflicts as shown within red ellipse in above 2008 illustration

FACT III

- Forecast and Analysis of Complex Threats III
- A tool developed by the Center for Army Analysis (CAA) to predict instability
- Looks 15 years into the future with reported 89-91% success rate based on a limited number of variables:
  - Gross national income (per capita)
  - Infant mortality rate
  - Population density
  - Roughness of terrain

Alternative Architectures Cont.

Source: Defense Technology Warning System (DTWS) Website: [http://dtws.ad.ctcgsc.org/.](http://dtws.ad.ctcgsc.org/)



Source: USAID Famine Early Warning System Network (FEWS NET) Website: http://www.fews.net/Pages/default.aspx