Thesis report

“Crisis and conflict prevention with an Internet based early warning system”

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This thesis corresponds to the effort of 20 full-time working weeks. Version 1.00.

1 Abstract

Early Warning is an important concept in conflict prevention since early and accurate warning allows for effective responses in order to stop further conflict escalation.

This thesis tries to solve the problems associated with three major elements of early warning systems: a) the collection of trustworthy and accurate information b) the selection of a precise prediction model and c) the prediction of negative developments itself.

SIPRI's project "An Internet-Based Early Warning Indicators System for Preventive Policy" aims to build an Internet based Early Warning System incorporating solutions of these problems and thus capable of issuing accurate conflict warnings. This thesis attempts a theoretical foundation for such a system and creates a prototype of it.

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3 Introduction

3.1 Problem statement

Conflict prediction is a central concept in conflict prevention. If alerted to an upcoming crisis situation, the chances in preventing the situation from escalating into a serious crisis are highly increased. A crisis is often the result of a number of negative events which ideally can be monitored. If monitored, information about these events (called events data), combined with background data (called structural data) about the country, can be analysed resulting in predictions and warnings.

In order to make predictions on negative/positive developments in a country, it is necessary to consider both short-term and long-term trends. Short-term trends can be analysed by continuously monitoring local and regional events data. Long-term trends can be analysed by looking at a country's structural data over a period of a several years.

The problem statement of this thesis is

- to identify all the necessary elements and building blocks of a prediction system which with some accuracy and in good time issues warnings on negative developments in a country
- to construct a prototype of such a prediction system which is based both on short-term event data and long-term structural data and uses the tools of existing information technology thus incorporating a certain degree of inbuilt automatisation.

3.2 Background

3.2.1 About SIPRI

SIPRI, the Stockholm International Peace Research Institute, conducts research on questions of conflict and international security. All SIPRI research is based exclusively on open sources.

In 1964, Prime Minister Tage Erlander of Sweden put forward the idea of establishing a peace research institute to commemorate Sweden's 150 years of unbroken peace. A Swedish Royal Commission chaired by Ambassador Alva Myrdal proposed in its 1966 report to establish an institute, later named the Stockholm International Peace Research Institute, SIPRI.

"The Institute's research should seek to contribute to 'the understanding of the preconditions for a stable peace and for peaceful solutions of international conflicts' and the Commission recommended that research be concentrated on armaments, their limitation and reduction, and arms control". The Swedish Parliament decided that the Institute be established on 1 July 1966 with the legal status of an independent foundation. [SIPRI 04]

3.2.2 About the project

In the end of 2002 SIPRI launched the pilot project, "An Internet-Based Early Warning Indicators System for Preventive Policy", aiming to create a system capable of generating a set of measurements for early warning which reflect negative social, political and economic developments in a country.

The project is funded by the Swedish Ministry for Foreign Affairs and has co-operations partners at academic institutions in Canada, South Africa, Ghana and Nigeria. It also has a network of experts in the West African region.

During the spring and summer of 2003, a considerable work has been done to identify a set of suitable measurements of country development (called indicators), survey questions to be used to monitor events, and contributors and sources of structural data. The research has been conducted by the SIPRI project leader and Head of Information Technology Gerd Hagmeyer-Gaverus, and (at that time research assistant) Mikael Weissmann, now Program Coordinator of the Program for Contemporary Silk Road Studies at Uppsala University.

The next step is to use these results to construct a prediction model and to implement this model in an Internet based information system prototype. This thesis aims to construct this prototype and provide the groundwork for the further improvements.

Once the prototype is operational, a one-year trial period will begin (planned to start in September 2004). During this period, a group of test users and researchers will evaluate the system and the predication model. At the end of the trial period, adjustments will be made based on the comments and suggestions from the test group. When all adjustments are complete, the system website will be made available to the general public and the project

will move on to it's final operational phase.

3.3 Purpose

The purpose of the project is to build and operate an Early Warning System which provides accurate warnings on upcoming crises situations in -to start with- the countries of West Africa and present these warnings to regional actors for further actions. The purpose of this project is also to build an early warning system prototype with a prediction model which can easily be adapted to new findings in the Early Warning research field. As with all SIPRI projects, the model, the indicators and all data sources are completely transparent and are made available to the general public.

The purpose of this thesis is to decide on the technology in use, to define the characteristics of the prediction model, to construct a prototype system and a website to be used in the coming test period.

It is important to emphasize that this project is a practical attempt, not a new theoretical concept.

3.4 Building blocks and methodologies

The project can be divided into three building blocks:

I. Constructing the prediction model.
II. Building the website for entering surveys, generating reports and provide an interface for adjusting the model.
III. Supply the model with initial indicator values based on findings from past and present conflict research. Continually adjust the indicator values according to new findings.

This thesis is mainly concerned with phase I and II. Phase III applies at a later stage exceeding the time frame of this thesis.

3.4.1 Constructing the prediction model

The first step in constructing the prediction model is the definition of its elements and characteristics. We need to decide what is important and what is not. The next step is to scan the Early Warning research field in order to identify similar projects and research as well as to ascertain if there is any existing model we can use or build upon. Last not least the model needs to be discussed with experts in the field of applied statistics. For that purpose a first contact has been established with Gebrenegus Ghilagaber, associate professor, at the Department of Statistics of the University of Stockholm.

3.4.2 Building the website

Building the website requires several sub-steps:

- Write a system requirements specification covering the public website, the survey interface and the administration interface.
- Choose the technology and the products to use.
- Choose the skill level required by SIPRI to maintain the system.
- Implement the system according to the requirements specification.
- Launch the system on a server at SIPRI.

3.4.3 Supply the model with initial indicator values

Supplying the model with initial indicator values is as mentioned above a step which first applies at the end of the building process. It requires much research and analysis and is a task which runs continuously throughout the operational phase of the project since new findings should always be adapted to the system. At least the following elements are part of this effort:

- Look for research results with data on the relationship between specific indicators and conflicts.
- Extract/import these relationships into the Early Warning system.
- Conduct our own analysis of these relationships with our own events and structural data applying among others factor-, regression- and cluster analysis procedures using statistical software packages like SPSS.

4 Overview of the Early warning research field

There is a vast amount of research on conflict, causes of conflict and early warning. It is beyond the scope of this thesis to present it all in detail. Therefore, this chapter focuses on the description of Early Warning basics as well as the presentation of some research trends and some prediction models.

Davies and Gurr [Davies & Gurr 98] describe the goal of Early Warning as being "proactive engagement in the earlier stages of potential conflicts or crises, to prevent or at least alleviate their more destructive expressions". Therefore, I will use the term Early Warning System (EWS) for any system that analyses data in order to give recommendations or warnings, regardless of methodology or topic.

4.1 Brief Early Warning history

The first Early Warning systems appeared in the 1950's and were used by the military intelligence community to predict possible attacks. Later, different Early Warning systems were developed for managing disease control and to be used for other humanitarian aid purposes.

The first EWS which implements a theoretical model into practise was the United Nations Humanitarian Early Warning System (HEWS) [Verstegen 99]. The HEWS project focuses on drought and famine problems by using over 100 indicators. Results are published in country reports.

As computing capacity increased, several large and quantitative oriented EWSs were launched in the 1980's and 1990's. With the introduction of the Internet, it became even easier to collect data and it facilitated automatic event data coding, thus enabling cost-effective event input to Early Warning systems. The event data of that period consisted mainly of news wire information.

4.2 Approaches to Early Warning

There are at present a large number of early warning models available, often designed however for different purposes. In order to get a general overview, I categorized the models according to their characteristics and intentions.

4.2.1 Early warning of what and for whom

What does an Early Warning model warn of? Ethnopolitical conflict, genocide or conflicts in general? Warning for whom? It is necessary to specify the intended audience of the model output – the research community, decision makers, journalists or the private sector. What is the objective and what are the expected results of the model? Finding causality, prevention etc.

4.2.2 Long term versus short term warnings

Davies and Gurr [Davies & Gurr 98] argue that there are at least three broad stages in the evolution of a crisis: (1) structural tensions, (2) escalation and finally (3) crisis. A prediction model can target the first or the second or both

of these stages.

In this report I refer to long term predictions for periods longer than two years and short term predictions for periods less than two years.

4.2.3 Quantitative versus qualitative methodologies

Another important characteristic is the approach used to collect and analyse data in Early Warning models: the quantitative and the qualitative approach.

According to [Rüegg 02] a "Qualitative" researcher:

- rejects the idea that social sciences (such as education and training) can be studied with the same methods as the natural or physical sciences
- feel that human behaviour is always bound to the context in which it occurs; therefore, behaviour must be studied holistically, in context, rather than being manipulated
- employs an "insider's" perspective; this makes qualitative research an intensely personal and subjective style of research

A "Quantitative" researcher however:

- argues that both the natural and social sciences strive for testable and confirmable theories that explain phenomena by showing how they are derived from theoretical assumptions
- reduces social reality to variables in the same manner as physical reality
- attempts to tightly control the variable in question to see how other variables are influenced

[Burkhard & Schlichte 00] define the objective of quantitative analysis in early warning to "isolate 'factors' that contribute to the outbreak of war or make warfare more likely" and to "reveal a direct link between them and the outbreak of war".

The qualitative approach is often used by "watch group organisations" [Austin 03] such as Amnesty International, Human Rights Watch and the International Crisis Group (ICG). They usually monitor events trough in-country representatives or field studies. Results are then lobbied at key decision and policymakers.

According to Davies and Gurr [Davies & Gurr 98] and [Austin 03] there are three broad approaches to quantitative analysis of information gathered for early warning:

- **Structural models**. These models aim to identify the conditions and structural contexts under which conflict will erupt. This is accomplished by reviewing the magnitude of selected structural indicators in previous conflicts.
- **Processual/accelerator models**. Processual models are based on the assumption that all conflicts proceed through certain stages of development, where each stage has a threshold [Harff 98]. The accelerator model is a processual model which aims to identify the accelerators and triggers that lead to conflict, emphasizing the critical role of dynamic factors and time-sensitivity. This is accomplished by

monitoring events in order to identify sequences that accelerate the situation into the crisis stage.
- **Pattern analysis**. In this approach large data sets of conflict data are examined using pattern-matching algorithms in order to find signs of negative developments. The data is usually divided into structural and event indicators as well as multiple dimensions such as "contentiousness" and "conflict carrying capacity".

4.2.4 Data sources and data categories

Davies and Gurr [Davies & Gurr 98] list information sources for early warning:
- In-country situation studies.
- Screening and analytical coding of public news sources.
- Field reports and analyses from governmental, inter-governmental and non-governmental institutions.
- Coded assessments by country experts of current situations and trends.
- Country or group profile, or databases of structural indicators.
- Episodic databases profiling past crises.

There are today two main approaches to gathering events data: (I) to use the global newsfeed or (II) to use an expert survey. Both approaches have advantages and drawbacks.

When gathering events data from the global newsfeed (e.g. Reuters) each event is automatically categorized and classified by a coding system (e.g. [GEDS]) according to specific words in the text. An early warning system can then count the number of events in a period for the given country and event class. There are several advantages with this approach:
- Near-real-time coverage with automatic coding.
- Cost-effective.
- World wide coverage, including classification of all major ethnic groups.
- It is easy to test new theories retrospectively; you simply query the events database with different parameters.

The drawbacks are:
- The global news monitoring often has "westernized" perspective on what's important and what's not.
- The news focus varies from time to time depending on current news trends, affecting the continuity of data.
- Automatic classification, although sophisticated, cannot replace human coding.

The second approach, expert surveys, can be used to complement the first approach, or as a substitute to it. When using a survey, regional experts answer a survey with constant questions at regular intervals. The main advantage with this approach is continuity; the same questions are used in every survey, regardless of the current news focus. This enables effective monitoring of changes in tension.

The drawbacks of the survey approach are

- Large costs in keeping a network of experts.
- It is difficult to objectively compare countries since each expert's judgement is subjective.
- You are stuck with the questions in the survey and cannot test new theories on data not covered by the questions.

4.2.5 Indicators, accelerators and triggers

The term *structural data* refers to slow changing information about a country, such as the financial state, military expenditure, trade, corruption level or quality of life. Long term risk assessment studies rely heavily on structural data, usually looking at trends over three to five years.

The term *events data* refers to reports of events concerning the county's stability, such as acts of political violence.

Indicators are specific measurements (variables in order words) describing a country or region's state and structure in early warning models. There are two types of indicators:

- *Structural indicators*: indicators representing the country's structure. Structural indicators are usually computed from structural data on an annual basis.
- *Event indicators (or dynamic indicators)*: indicators representing the state of the country through recent events (e.g. number of border shootings in the previous month). Event indicators are computed from events data several times per year, or even weekly.

According to Harff there are certain events, called *accelerators*, which are likely to worsen a situation and that these events cluster prior to the outbreak of geno/politicide [Harff 98]. Harff also states that accelerator events resemble the last stage of a crisis before open conflict occurs. *De-accelerators* are events which tend to lessen the risk of conflict.

Since there are many definitions of accelerators, I will use Harffs and Gurrs definition [USAID 03]:
"Events that typically increase the level or significance of the most volatile of the background and intervening conditions; moreover, they often develop a momentum of their own capable of escalating a crisis."

Triggers are events which, in the presence of background events, recent events and accelerators, escalate the situation to the final stage of the conflict (the spark that lights the fire) [Harff 98].

Any event that escalates a conflict from a pre-conflict stage into a conflict is a trigger - e.g. the assassination of a political leader or massive demonstrations. Triggers are context-sensitive and therefore difficult to predict or monitor.

Accelerators differ from triggers in the sense that accelerators, together with other events and the general state of the country, worsen the situation, but do not actually move the process into the final conflict stage. A trigger on the other hand, moves the situation from the pre-conflict stage into the final conflict stage.

Since triggers occur just before the outbreak of conflict, they are not suitable for early warning purposes. Accelerators, on the other hand, can be monitored and used for early warning since they increase tension months or weeks before outbreak.

4.3 Theoretic models

This chapter presents some of the research done in the field of Early Warning modelling. It is a selection of projects which I found interesting and helpful in the effort to build a SIPRI Early Warning System for Preventive Policy. All selected models are of quantitative nature.

4.3.1 Minorities at Risk Project

The Minorities at Risk project by Gurr (University of Maryland) [Gurr 94] aimed to find conditions where certain ethnic groups, within existing states, would be drawn into rebellion and repression. The model hypothesis assumed that the concepts grievances, mobilization, rebellion and repression where linked. Using statistical analysis on historic cases to identify correlation between the concepts, links were found (e.g. a link between mobilization and rebellion). These links were then used to create a number of structural indicators.

This model is important in a methodology/model-sense since it uses a quantitative approach with structural indicators and allows for statistical validation through correlation analysis. Although limited to structural indicators, Gurr acknowledges that in order to move from risk assessment to early warning, one must add dynamic indicators/accelerators.

Objective	Explanation, finding causality in conflict factors
Timing	Long-term risk assessment
Topic	Communal (ethno-political) conflict
Approach	Quantitative with structural indicators

Table 1; Summary Minorities at Risk Project

4.3.2 State Failure Project

The State Failure Project by the State Failure Task Force [Goldstone et. al. 00] was established in 1994, aiming to find the key reasons for state failure. In a large data-driven study of conflicts from 1955 to 1998, covering some 1300 variables, "failed" countries where compared to "control" countries that did not fail. Using these comparisons, a number of significant variables, and relative importance between them in the form of odds, were computed. With the resulting set of variables, applied to historical data, state failure within two years was correctly predicted with 70 - 80 % accuracy.

The State Failure Project also defines different models for different regions, e.g. a "Global Model", a "Sub-Saharan Africa Model" etc and thus increases accuracy from 72 % (in the Global Model) to 80 % (in the Sub-Saharan Africa Model).

The methodology of the State Failure Project is significant for early warning model development:

- The project uses a systematic quantitative approach on a comprehensive database of historical events.
- Multivariable analysis was used to reduce the number of variables.
- The project demonstrates the validity of using indicator categories,

instead of individual indicators, since variables can be measured in various ways.
- The project points out the importance of individual models for different regions.

Objective	Identify key factors and critical thresholds, signalling high risk of political crisis in countries some 2 years in advance
Timing	Long-term risk assessment
Topic	State failure
Approach	Quantitative with structural indicators

Table 2; Summary State Failure Project

4.3.3 Accelerators of Genocide Project

In the Accelerators of Genocide Project [Harff 98], Harff discuses the importance of accelerators in the conflict process. By retrospective testing of a number of accelerator events in comparative cases, she shows how certain events cluster prior to the outbreak of conflict.

Harrf's work is important since it provides an argument for the processual accelerator/de-accelerator approach and demonstrates the use of an event data system (Harrf uses the GEDS, Global Event Data System) to monitor events and to classify accelerators and de-accelerators.

Objective	Anticipation, trace development of progress leading to onset of geno/politicide
Timing	Medium to short term warning
Topic	Geno/politicide
Approach	Quantitative with event data/accelerators

Table 3; Summary Accelerators of Genocide Project

4.4 Practical attempts

This chapter presents practical early warning attempts and frameworks, guidelines and data sources for practical use.

4.4.1 HEWS

HEWS – Humanitarian Early Warning System – was established in 1993 and is now a part of UN Department of Humanitarian Affairs (UN DHA). Using an extensive amount of sources, including UN field offices, HEWS provides background reports and analyses of developing situations [Verstegen 99].

HEWS uses a large database of country information, gathered from a number of organisations and sources, from which more than a hundred structural indicators are extracted. Using statistical analysis as well as subjective judgement, "risk"-countries are moved to a watch-list. Countries on the watch-list are monitored on the latest events reported by media or field offices. These event reports are then used in a qualitative analysis along with country specific indicators to produce country reports.

HEWS is important in the sense that is one of the few operational early warning systems combining quantitative and qualitative analysis. It also uses a scale of conflict intensity – processual theory – in order to decide which countries to monitor more closely on the watch-list.

Objective	Prepare for crisis, a lesser degree of prevention
Timing	Medium to short term warning
Topic	Drought and famine
Approach	Quantitative structural indicators, qualitative event/accelerator monitoring

Table 4; Summary HEWS

4.4.2 FAST – Early Recognition of Tension and Fact Finding

"(FAST) is a political early-warning system introduced in 1998 for the Swiss Agency for Development and Cooperation (SDC) to support decision-makers in policy, administration, and business." [FAST 03].

FAST is an early warning system that uses both structural data and events data to produce monthly/quarterly country reports. These reports are presented, along with policy options, to policy-makers. The FAST-methodology includes quantitative analysis of events data as well as qualitative analysis by experts. To monitor events data, FAST uses the Kansas Event Data System [KEDS 03] with event coding provided by the Virtual Research Associates [VRA 03], a Harvard-based group of academic analysts.

FAST is the first operational early warning system which mainly relies on an event data system, based on the global newsfeed, for its events data. However, FAST has realized that there are drawbacks to the neewsfeed approach, and now also uses a "local information network" to gather events data.

The FAST methodology is important since there is a focus on the integration of the system in the political decision making process - e.g. by providing policy recommendations to key decision makers.

Objective	Early warning and policy recommendations
Timing	Medium to short term warning
Topic	Ethnopolitical conflicts, genocides, inter- and intrastate conflicts
Approach	Quantitative events analysis and general qualitative analysis

Table 5; Summary FAST

4.4.3 The FEWER Early Warning Early Response Methodology

FEWER (Forum on Early Warning and Early Response) is a "is a global coalition of organisations that provides early warning and promotes early, co-ordinated responses to violent conflict" [FEWER].

FEWER has developed the "FEWER Early warning and early response methodology" [FEWER Methodology 03]. In this, FEWER divides the model into two parts: (I) Early Warning and (II) Early Response. In the early warning part, focus lies on situation monitoring through structural indicators, accelerators and triggers, then analysis of key indicators and finally to identify the opportunities for peace. The second part of the methodology, Response Development, focuses on the identification of suitable instruments and options for conflict prevention.

FEWER does not provide a generic model, the methodology they provide is more of a framework than a model. It provides valuable information about the whole early warning early response process of events, actors, suitable structural indicators etc.

Using the FEWER methodology, different organisations can implement part of the framework and make these efforts available for FEWER coordination and management. FEWER is currently participating in/managing several operational projects, for the most part together with FAST.

Objective	To provide early warning and early response through its member organisations
Timing	Long to short term warning
Topic	Ethnopolitical conflicts, genocides, inter- and intrastate conflicts
Approach	Methodology/framework for early warning and early response

Table 6; Summary FEWER

4.4.4 CIFP – Country Indicators for Foreign Policy

The CIFP project, of the Norman Paterson School of International Affairs at Carelton University, provides structural indicators for 196 countries [CIFP 03].
The current database contains indicator values from 1985 to 2000 and is updated annually.

In the CIFP methodology, indicators are given a value between 1 and 9. The indicators provided by CIFP are useful for long term risk assessment, and are also an excellent source for early warning systems.

Objective	To provide structural data for risk assessment
Timing	Long term
Topic	Wide range of topics
Approach	Methodology/framework for structural indicators

Table 7; Summary CIFP

5 Theoretical results: The prediction model

This chapter presents results on the requirements and intended characteristics of the SIPRI prediction model.

There is, to the best of my knowledge, no existing Early Warning model which meets SIPRI's requirements, or can be adjusted to meet these requirements. A new model is needed, a model which combines different theoretical approaches used in existing models (as described in the previous chapter).

To construct a new model, and to validate it statistically, is an extensive task which is beyond the scope of this thesis. I can, however, present and discuss the characteristics of the required model and how it can be validated.

5.1 The SIPRI Early Warning model idea

The general idea behind the project is to achieve accurate short-term early warning on conflicts and humanitarian crises, including ethno-political conflicts, genocides, inter- and intrastate conflicts. To accomplish this, we believe the following model characteristics to be important:

1. To use a quantitative approach that enables the use of statistical methods to validate the results.
2. To use a processual model with a few well defined conflict stages.
3. To effectively combine structural data with events data in a statistical model in order to get the complete picture for short-term early warning.
4. To effectively use accelerators and de-accelerators (but not triggers).
5. To use individual models for each country (or even for regions within a country/across countries). Future improvements may also include specific models for different kinds of conflict, e.g. an inter-state model and an intra-state model.
6. To make the model robust as well as adjustable and extendable in order to keep up with new findings.

5.1.1 Quantitative approach

Of the two methodologies described in 4.2.3 (the quantitative and the qualitative approach) I consider the quantitative approach to be the more suitable for SIPRI's purposes - short term early warning. By describing the state of a country with variables in a statistical model one can create a prediction model less dependant on subjective judgement, although errors due to conversion from subjective judgement into a quantitative model can not be removed completely. With a quantitative approach, it is also possible to validate and improve the model by "teaching" the system which predictions that turned out to be correct and vice versa – in other words a self-learning system.

Qualitative investigations are necessary complements to a quantitative early warning system and there are today a number of such organisations (e.g. the International Crisis Group [ICG 03]) focusing on conflict prevention and early warning. SIPRI's EWS is not intended to be an alternative to qualitative Early Warning, it is intended to be a complement to existing qualitative efforts to make sure that no situations are left out/ignored before it is too late.

5.1.2 Using a processual model

What is the best way to present an early warning for a country in a quantitative system? Since the intended audiences of a warning are policy makers and journalists, it is important that warnings are easy to understand. A too technical presentation of a warning, such as a mathematical probability will make the results more difficult to understand and thus reduce the impact of the warning.

A country's position on a scale of conflict stages is on the other hand easy to understand – details are hidden and the presentation can focus on the reasons for a country's placement on the scale.

Using a processual model made up of conflict stages is also consistent with the research of Harff [Harff 98] who argues that using processual stages is the best way to incorporate accelerators into the model; accelerators/de-accelerators move the conflict to the next/previous stage and triggers move the conflict from the last stage on the scale into open conflict.

I suggest a conflict scale of 5 – 6 stages, ranging from a stable situation trough political/ethnical tension to a volatile state that can erupt into full blown conflict. Future improvements may include specific stages for specific conflict types, e.g. special stages for a refugee crises-scenario.

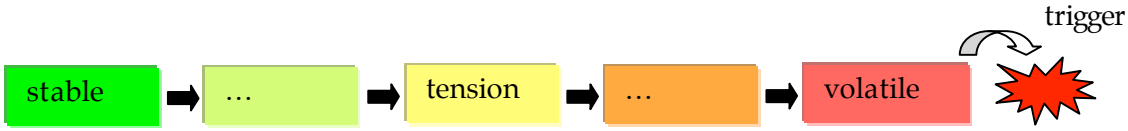

Figure 1. The general conflict process stages.

5.1.3 Combining structural data and events data

In order to describe the state of a country it is crucial to combine structural data with events data. A model depending only on structural data (e.g. long-term risk assessment) is not suitable for short-term early warning. This concept, combining structural data with events data to get the complete picture, is central in the FEWER methodology [FEWER Methodology 03]).

In addition to describing the state of a country, events data are also used to monitor and identify accelerators and de-accelerators. I therefore argue that the model which SIPRI chooses to use must combine structural data with events data.

As described in 4.2.4 there are two approaches to gathering events data; through the global newsfeed or/and through regular expert surveys. When describing the state of a country, I consider the survey approach to be the more valuable:

- With regular reporting, using the same questions, one can achieve continuity of data. Using a newsfeed, there is always the risk of a change in the news value of the country – a crisis elsewhere could draw away attention resulting in less coverage.
- The large newsfeeds of the world have a "westernized" perspective on

what's important and what's not. Using local hand-picked experts, in our case African, to answer surveys, one gets a more neutral coverage.
- Many of the signs of an upcoming crisis, such as worsened conditions for minority groups or an increase in human rights violations, are rarely reported by the global newsfeed. In order to monitor such changes in country state, one needs continuous reports by local experts.

There are however, as described in 4.2.4, several problems with of the survey approach to monitor country state. The key problem is how to compare reports from different experts, since each expert's judgement is more or less subjective. If one expert reports increasing human rights violations, and another expert report of an unchanged situation, how can one assess the current state? The most obvious measure is to have a larger number of experts covering the same country. Another measure is training in methods and situation monitoring.

One can also design the survey itself to better support reporting of change. How much worse is the situation? Is it worse enough to actually report a worsened level or is it within the boundaries of the current level? SIPRI's approach is to use a scale ranging from 1 (good) to 9 (bad) in the survey. Using this scale, and with proper training, experts should get a better feel for how much the situation has changed, thus lessening the problem of subjective reporting.

5.1.4 Using accelerators and deaccelerators

One of the reasons for using a processual approach was to include accelerators and deaccelerators in the model. Harff's research [Harff 98] shows the potential of using accelerators to predict conflict and gives us an idea of what accelerators to look for. There are however many practical and theoretical uncertainties when using accelerators – e.g. which accelerators to use and what importance they should be given in the model.

Why use accelerators? Common sense tells us that we need to closely monitor the events in a country in order to predict a worsening situation. Of all the thousands of events occurring every month - which ones are significant? Can one actually categorize events according to risk, impact etc? Harff has shown, with good results, that there are a few certain types of events, accelerators, which cluster prior to conflict escalation. Harff then argues that of all the events that occur, one needs only to look at these accelerators to predict conflict escalation.

Ideally the impact of accelerators in the prediction model is a function of the number of accelerator events, the significance of each accelerator and the current conflict stage (an accelerator event occurring to soon or too late in the process may not have any impact at all). Adding up the accelerator impact then signals whether the conflict has escalated over the threshold to the next stage in the process. There is however very little research on which accelerators to use, in what stage accelerators tend to have the greatest impact, and the relative importance of accelerators compared to other events data and structural data. I therefore suggest that SIPRI build a model capable of using accelerators but start off giving accelerators little or no importance in the model, to be increased later as new research tells us more about

accelerators and their use in conflict prediction.

Why not use triggers? Triggers are events which trigger the situation from the last conflict stage into open conflict – e.g. the spark that lights the fire. In SIPRIs point of view, when a trigger has occurred it is already too late and there is no point in issuing a warning. The objective is instead to warn when a conflict has escalated to such an extent that a trigger could make the situation erupt into open conflict.

5.1.5 Country specific models

Every country is unique with its own history, conditions, political tensions and ethnical groups. It therefore makes sense to use different models, indicators and accelerators for different countries. The State Failure Task Force has realized this and uses a number of different structural models for different regions [Goldstone et. al. 00] – e.g. a Sub-Saharan model.

5.1.6 Robust, adjustable and extendable

The model must be easy to adjust and extend, concerning indicators and relationships between indicators. As new research reveals new conflict causes, it is crucial that the system can be updated with new suitable indicators which represent these causes.

It is also important that the model is not too dependable on individual indicators. To make the model more robust, representative indicator categories can be used instead of individual indicators. In the Clingendale report "Conflict Prognostication: Toward a Tentative Framework For Conflict Assessement" [Verstegen 99] it is held that using indicator categories instead of indicators is a valid approach, since variables can be measured in various ways because of the intercorrelation between concepts. Example: Infant mortality is an indicator which signals the quality of life. This indicator can however be switched to any other quality of life indicator.

5.2 Model structure

The basic structure of the suggested prediction model is illustrated below.

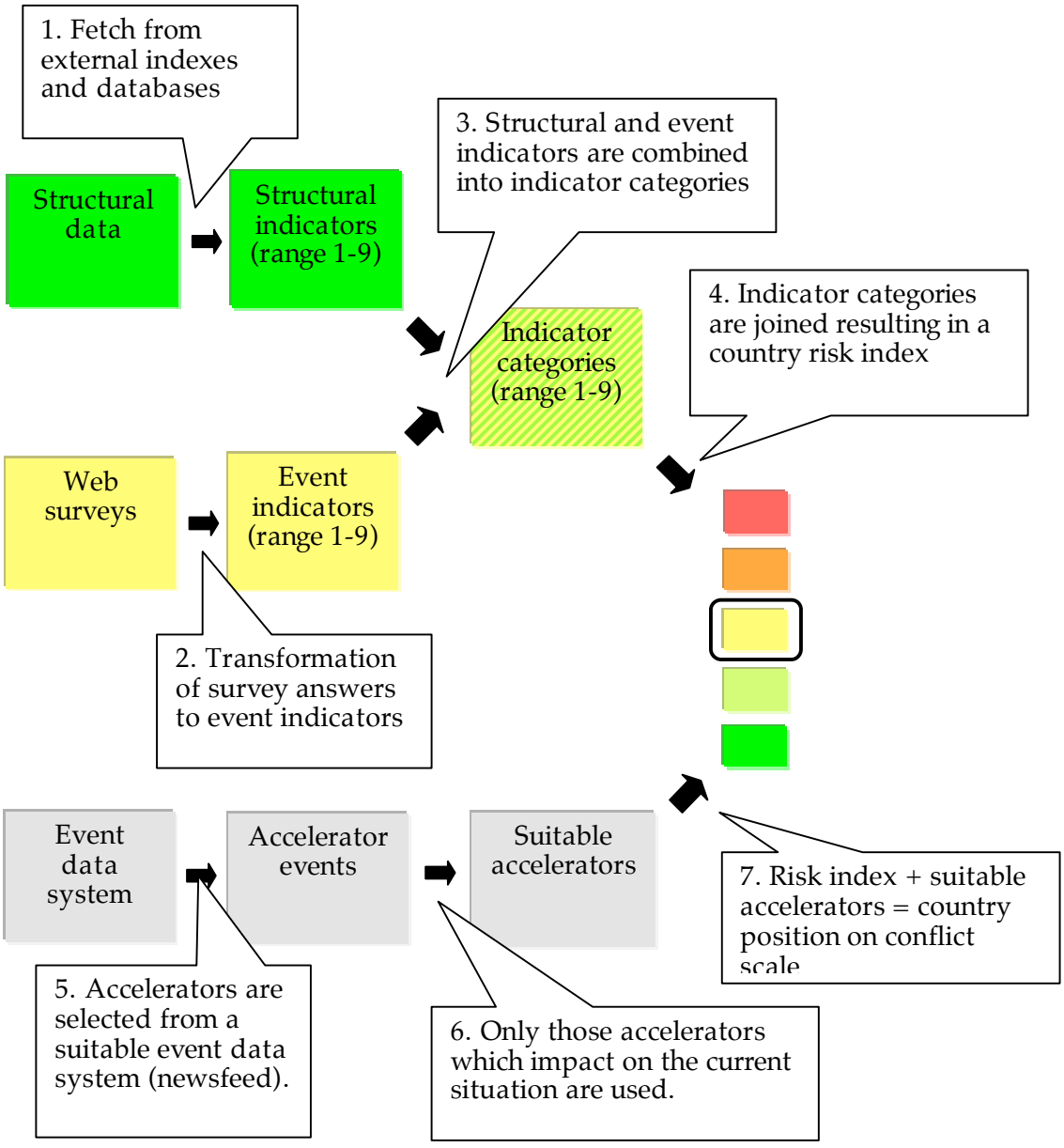

Figure 2. Structure of the prediction model.

In step 1, structural indicators are created by importing data from external databases and indexes, e.g. the World Bank Group, Transparency International. Many indexes will be imported directly from the FIRST database (first.sipri.org), which contains more than 720 structural indexes. In the import process, all indexes will be converted to a 1-9 scale. A list of suggested structural indicators is included in Appendix 3 [Structural

indicators].

In step 2, event indicators are created when selected experts answers an online web survey, available at ews.sipri.org. A list of suggested event indicators is included in Appendix 2 [Event indicators].

In step 3, the structural and event indicators are joined into the following indicator categories:

1. Justice and human rights.
2. Socio-cultural factors.
3. Internal security setting.
4. Geopolitical setting.
5. Military and security.
6. Environment and resource management.
7. Governance and political stability.
8. Socio-economic factors.
9. Regional and country specific variables.

In step 4, the indicator categories are joined into a risk index (0 – 100).

In step 5, recent events (from an event data system) are analysed according to county specific accelerator definitions. All events which match the definition are imported as accelerator/de-accelerator events.

In step 6, the imported accelerator events are analysed according to the country's current position on the conflict process scale. Only those accelerators which might have an impact given the current position are selected.

In step 7, relevant accelerators and de-accelerators are combined with the country risk index resulting in a higher, lower or unchanged position on the conflict process scale.

In all the steps described above, it has not yet been decided which statistical method to use when joining and combining indicators and accelerator events. I do not think that just using an average is good enough – it tends to smoothen out the effect of drastic changes. Instead, a function which takes drastic changes into account should be used. Also, in step 3 and 4, some indicators and indicator categories are more important than others, thus some kind of indicator weighting system is needed.

5.3 Validating the model

How can the results of the above suggested prediction model be validated? There is a vast amount of research on the importance of structural indicators in conflict situations (e.g. The State Failure project [Goldstone et. al. 00]). These results can be used to compute the weighting of structural indicators and indicator categories.

When it comes to event data, there is unfortunately very little research on which indicators and events that are important, and what the importance of these are compared to structural indicators.

In my opinion, the best way to validate the importance of event data is to begin with a trial-and-error period, where indicator weightings are set via a common-sense approach. After the trial-and-error period has ended, one needs to compare what actually happened, which conflicts escalated and de-escalated etc, to the results of the prediction model. Obviously, the data to compare with cannot be the same data that was originally used to construct the prediction model. This approach, looking at historical data and compare it with the result of the prediction model, is also the basis of a self learning system which is the next logical step in Early Warning prediction models. In the future, this kind of comparison could be done automatically with an event data system.

6 Practical results: The system prototype

The main purpose of the system prototype is to provide an interface for experts to start entering survey answers. After the test period, SIPRI will use these answers to adjust and validate the prediction model, create specific country models etc.

The prototype website is divided into three sections:

1. Public section.
2. Expert section (or survey section).
3. Maintenance section.

The public section is available to the public and contains country reports, warnings, news and information about SIPRI.

The survey section is reached by logging in with a username and password. Here, experts can enter survey answers, one survey per month.

The maintenance section is where SIPRI's project staff handles users, countries, survey questions, adjust the model and publish news on the public section and the expert section.

A detailed content description is presented in Appendix 1 System Requirements Specification.

6.1 An implementation of the prediction model

The prediction model described in chapter 5 is too complex to fit into this thesis work. Therefore a simplified prediction model has been implemented in the prototype. In this model, structural indicators and event indicators are used to calculate a risk index. Accelerators are not used in the simplified prediction model.

The basic structure of the simplified prediction model is illustrated below.

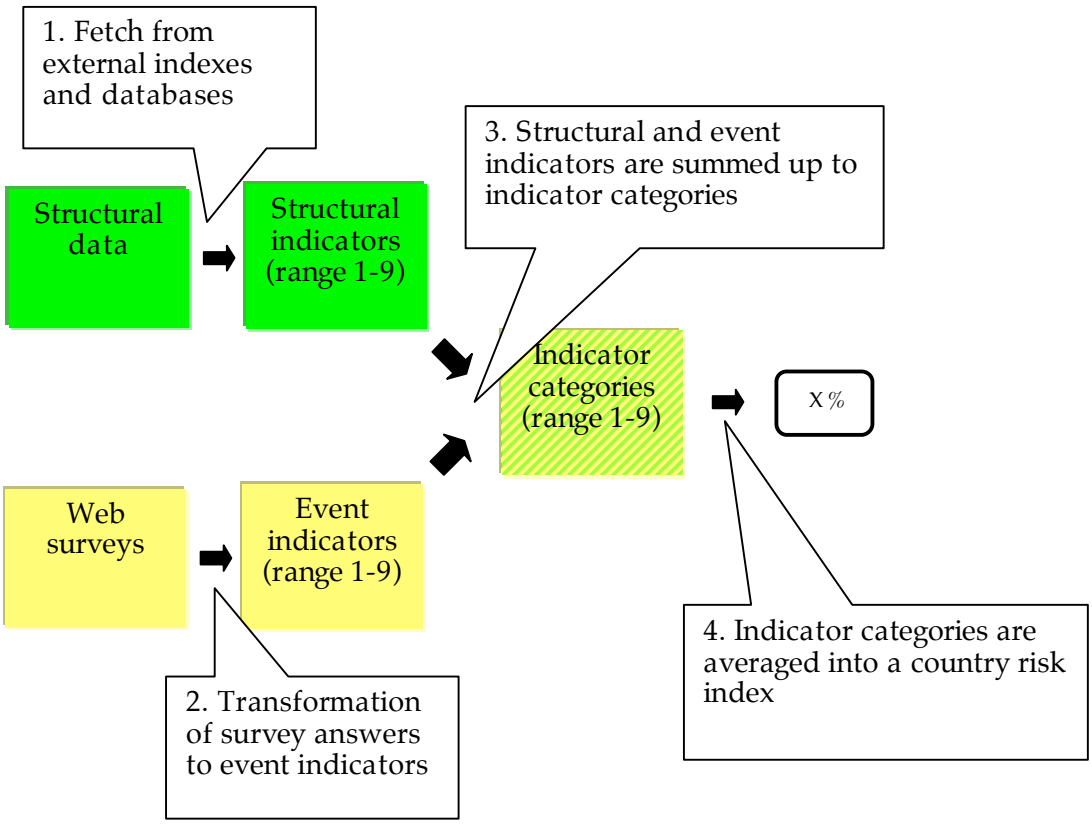

Figure 3. Structure of the simplified prediction model.

In step 1, structural indicators are created by importing data from the FIRST database (first.sipri.org). In the import process, all indexes will be converted to a 1-9 scale.

In step 2, event indicators are created when selected experts answers an online web survey, available at ews.sipri.org.

In step 3, the structural and event indicators are summed up to indicator categories: $Indicator\ category = \frac{\sum_n^1 (indicator_n * weight_n)}{\sum_n^1 weight_n}$, where n are the number of indicators for a category and *weight* is the relative weighting within the category for an indicator (between 0 and 1).

In step 4, the indicator categories are averaged into a risk index (0 – 100). The simplified prediction model therefore assumes that all categories are equally important, which is not the case in the theoretical prediction model.

6.2 Technology

Java Enterprise Edition 1.4 with the Tomcat Servlet Engine is used on the server together with the Apache web server and the MySql database. The

application runs on a Linux system.

The client side is made of HTML and simple JavaScript.

The system uses Java's Internationalization feature (one text file per language) to provide English, Spanish and French language support.

6.3 Actors

An actor is a person or a system, internal or external, which can interact with this system.

The general public
The general public can access reports in the public part of the web site but cannot log on to the system.

SIPRI admin user
The SIPRI admin user is used by the SIPRI project staff to log on to the system. The admin user has all available privileges and is used to maintain the system.

Expert users
Experts are persons who use the system to enter survey answers about their country or region. Each expert is given an account to log on to the system. Most expert users will use the system on a slow modem connection.

6.4 Content

The entry point of the system is the website's start page. From there, users can use the left-hand menu to navigate around on the site. Expert users and SIPRI's administrators use the login page to enter the expert/maintenance section. When logged in, the left-hand menu is updated with the new menu choices made available by the login.

6.4.1 Website structure

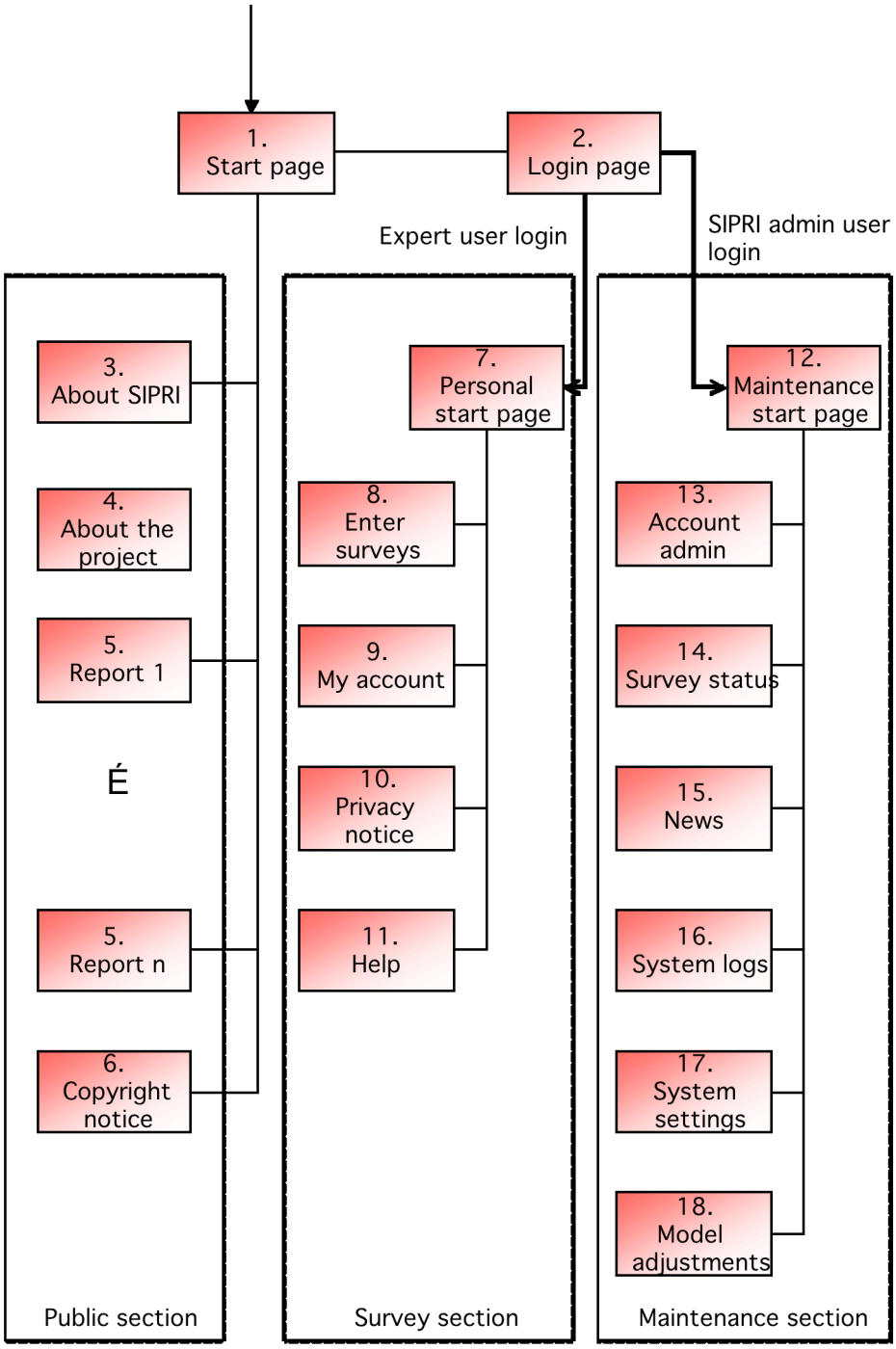

Figure 4. Website structure.

6.4.2 Public section

The start page of the public section is designed to be the systems headline-page with news and current conflict warnings. By clicking on a headline, the requested country report is shown. There are also two "article spaces" available, see picture below.

From the start page, users can also display information about SIPRI, the project and read SIPRI's copyright notice.

During the test period, the start page won't contain any country reports or conflict warnings, only progress reports from SIPRI. After the test period, updated country reports and warnings will be published monthly.

Figure 5. Public start page layout.

6.4.3 Survey section

The start page of the survey section is "personalized" in that it shows all currently unfinished surveys for the current user. By clicking on the survey headline the user can start/continue entering answers for that survey.

The SIPRI staff can also publish news visible only to logged in expert users ("Project news" in the picture below).

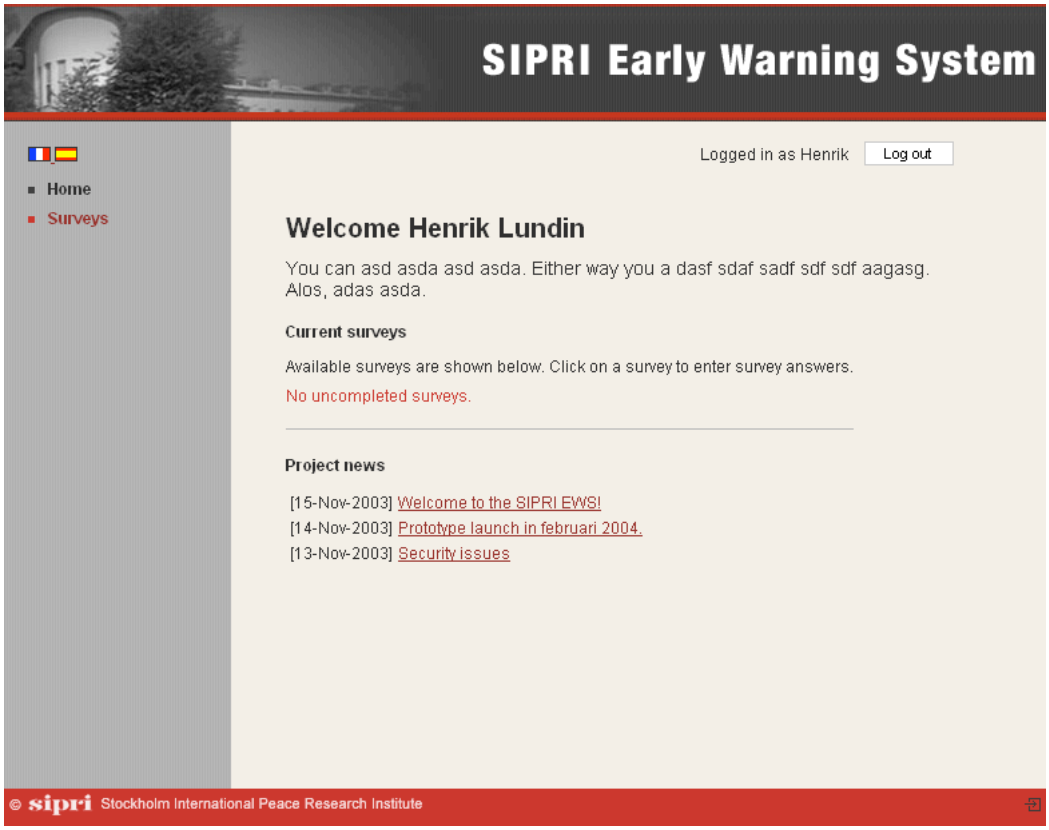

Figure 6. Expert start page layout.

When entering surveys, the expert user answers each question by selecting a radiobutton from 1 (good) to 9 (bad). Last months answer is highlighted in bold. Every question also has a longer description which is available by clicking on the question mark icon.

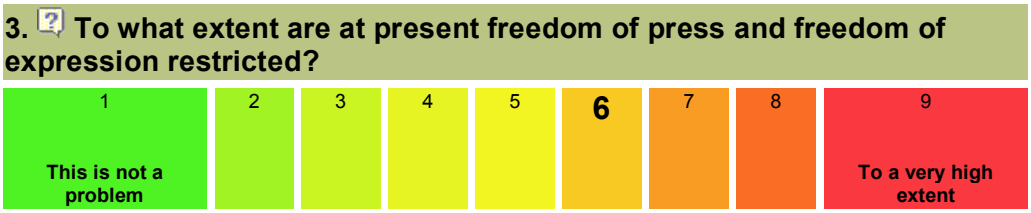

Figure 7: Question design.

Since many of the expert users will be connected through an unstable modem connection, it is important that the system can handle disconnections. Therefore, the expert user does not have to enter all questions (there are 30 questions per survey) during the same session. If disconnected, the expert user can continue at a later time.

6.4.4 Maintenance section

The maintenance start page is designed to give SIPRI's staff an overview of recent system activities and errors.

Using the links on the menu, SIPRI's staff can edit news, indicators, users, countries and questions. With the visit statistics function, expert and public logins for the last 6 months are shown.

The system logs function displays important events and errors. All errors are written to this log as well as emailed to the system administrator.

With the System setting page, the system administrator can change system settings such as time out values, error reporting etc.

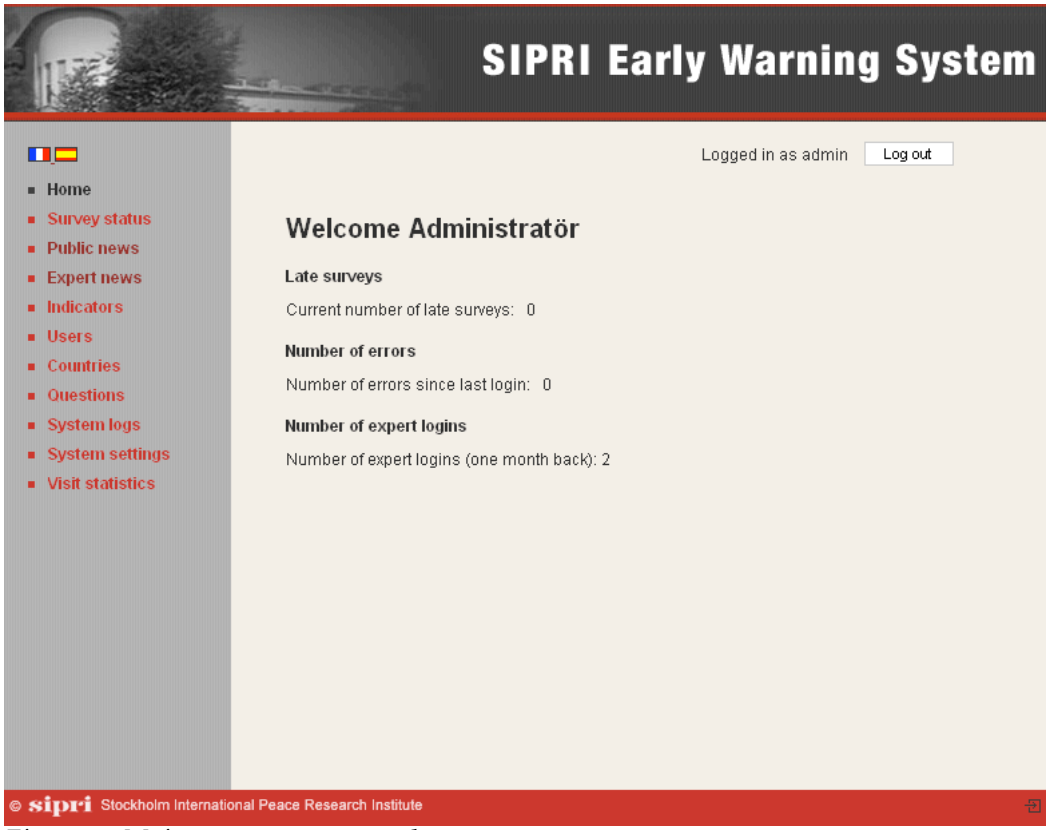

Figure 8. Maintenance start page layout.

6.5 Security

It is important that the names of the expert users who enter survey answers are kept secret. Reporting information about the situation in politically unstable countries is often a dangerous task as information about negative developments are sometimes considered as criticism of the current regime or of a specific ethnical group.

All usernames in the system will be randomly generated, with the real names visible only to the system administrator. It will not be possible, even for the system administrator, to see which answer belongs to whom. However, if one has access to the database, it is possible to figure this out.

The IP-numbers of expert users will not be stored in system logs, nor will any specific visit statistics on an individual level be stored.

The system runs on a dedicated Linux server, stored behind SIPRIs firewall. There will be no other applications running on this server, thus lessening the risks of other applications accidentally endangering the security.

7 Discussion: what's next?

Providing warnings on negative developments is really only the most basic usage for a quantitative early warning system like the SIPRI EWS. The prediction model, together with all the stored data, should be used not only to monitor and warn about upcoming crisis, but also to prevent and find solutions. Or as FEWER puts it: "Early Warning and *Early Response*".

The following sections discuss how Early Warning systems can be used to provide more than just warnings.

7.1 Evaluations and improvements

A successful EWS needs to be subject to continuous evaluations in order to be improved and developed further. It is therefore of immense importance to make these steps an integral part of the system. The evaluation of the system is a difficult task since we need to find an answer to the questions: How do we know when Early Warning and Early Response actually succeed and how do we measure success? The problem is of course that a warning on a situation which doesn't result in a conflict could be either correct (the warning caused a response which prevented the outbreak) or incorrect (even without a response the situation would not have escalated into conflict).

The situation in Macedonia 2002/2003 is one example where an Early Response is thought to have prevented a serious conflict. The structural conditions, ethnical composition and the proximity of the Kosovo conflict made the situation vulnerable to a trigger which could escalate it to a civil war. The response came through a NATO/European Union peacekeeping initiative which stabilized the situation.

When arguing that the Macedonia case is an example of successful Early Response, one can compare the structural conditions of the Albanian population and recent internal and external events (such as the Albanian uprising in Kosovo) to other similar ethnical conflicts. Looking at how these situations developed makes it is easier to judge the results of an Early Response.

The comparison approach is one way to answer the question whether an Early Warning Early Response effort has been successful. Another way is to look at the country position on the conflict process scale – if the country is only a trigger a way from conflict, in other words on the far end on the scale, before a response action, where is it after the action is launched? If the situation has deescalated to a level where it is no longer vulnerable to a triggering incident, one can argue that the response action has been successful. But how does one know that it was the response effort which deescalated the situation and not some other factor? Again, comparisons with previous efforts can give one an idea of the role of the response effort.

An EWS can provide tools and data to support working with these questions. As discussed later, the toolbox-approach with available efforts can be used to predict *and* follow-up on the results of a response effort.

7.2 Coordinating with the conflict research community

Improvements to the system are essential and there are several ways to achieve this. First, it is important to establish a permanent exchange with the research community and the practitioners on the methodology and the interpretation of the system results. It is of equal importance to let the community be part of the data collection of the system.

The data stored in the SIPRI EWS is valuable in it self. SIPRI has a policy of total transparency and - if not endangering the security of the experts answering country surveys - all data will be made available to the general public and the research community.

Data from the SIPRI EWS is valuable to the conflict research community in that it can be used to analyse what actually happened (what the experts reported) prior to conflict escalations or de-escalations. Since all the countries included in the project are monitored in the same way (surveys every month) comparisons between them can be made; of two similar countries, why did one erupt into conflict and not the other?

7.3 An automated policy evaluation and response system

An EWS is a tool for policy actions. In its present shape however there is no direct connection between a EWS system outcome and policy activities. One of the further developments of the system could be the integration of the EWS into an automated policy evaluation and response system.

The European Union Commission has a large number of development aid programs currently running (for 2002 budgeted to 6,5 billion euros). These programs are usually based on 3-year plans. Every year, there is a follow-up on the status of each plan, resulting in major or minor adjustments. These follow-ups are crucial to the success of the programs – many programs depend on predictions on the development in the receiving country, such as the stability over the 3-year period. Any unforeseen negative development could seriously harm the effect of the whole program.

It is therefore valuable to use an EWS to continuously monitor and measure both the

- *Results of the program*. If the objectives of a program can be formulated as measurable units, they can be used by an EWS to provide continuous progress reports on the results.
- *Need to make adjustments to the program*. If the preconditions for a program, e.g. the general country stability or the economic development, can be formulated as measurable units, they can be used by an EWS to provide warnings or possibilities on changes to the program.

7.4 The Toolbox approach

If the situation in a country is worsening, what can the international community do about it? The choices available vary from time to time, but one can generally speak about a *toolbox* of options available to the decision

makers. An early warning system can, using the same prediction model with a few minor adjustments, point out what options would be suitable to use, given the country's history, current state and past experiences of the various tools in the toolbox.

The toolbox approach requires country specific prediction models with detailed information about the country's ethnical composition as well as a historical events database ranging over a few years.

SIPRI are currently discussing how to add toolbox-functionality to the SIPRI EWS. It is likely that a toolbox "add-on" to the SIPRI EWS will be added after 2-3 years of operation.

8 Acknowledgments

First and foremost, I would like to thank my tutor and SIPRI project leader, Gerd Hagmeyer-Gaverus, for his support and patience as well as for letting me have this opportunity to get involved in the project.

I would also like to thank Jacob Palme, professor at the Department of Computer and Systems Sciences, Stockholm University and KTH, for his interest in the project, as well as his comments and suggestions.

Furthermore, I would like to thank my predecessor in the project, Mikael Weissmann of Uppsala University, for his thoughts and ideas and the help he gave me to get started.

Finally, I am very grateful to my family, friends and colleagues at SIPRI who supported me and gave me helpful advice (not to mention reading my report over and over)!

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10 Appendices

[System requirements] Appendix 1, System requirements specification.
[Event indicators] Appendix 2, Event indicators.
[Structural indicators] Appendix 3, Structural indicators.

Appendix 1, System Requirements Specification

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1 Summary

The purpose of the system is to generate “early warnings” on negative security developments and to present these warnings in reports on a public web site.

The system consists of a web site divided into three sections: a public section, a survey input section (also called expert section) and a maintenance section. The survey and maintenance section can only be reached if the user has logged in to the system with an account name and a password.

In the public section the public can take part of published reports. In the survey section authorized users enter survey answers (one survey per month, 30 – 40 questions per survey). Account administration and other maintenance tasks are handled in the maintenance section.

Reports are generated from a simple statistical analysis of the survey data (“event data”) combined with data fetched from a number of external information systems/sources (“structural data”).

2 Actors

An actor is a person or a system, internal or external, which can interact with this system. The following actors have been identified:

2.1 The general public

The general public can access reports in the public part of the web site but cannot log on to the system.

2.2 SIPRI admin user

The SIPRI admin user is used by the SIPRI project staff to log on to the system. The admin user has all available privileges and can

- Add/remove/edit accounts for expert users.
- See survey status.
- Write news.
- View system logs.
- Change system settings.
- Adjust the predication model.

The public part of the web site is used to access reports.

2.3 Expert users

Experts are persons who use the system to enter survey answers about their country or region. Each expert is given an account to log on to the system. When logged in, these users can

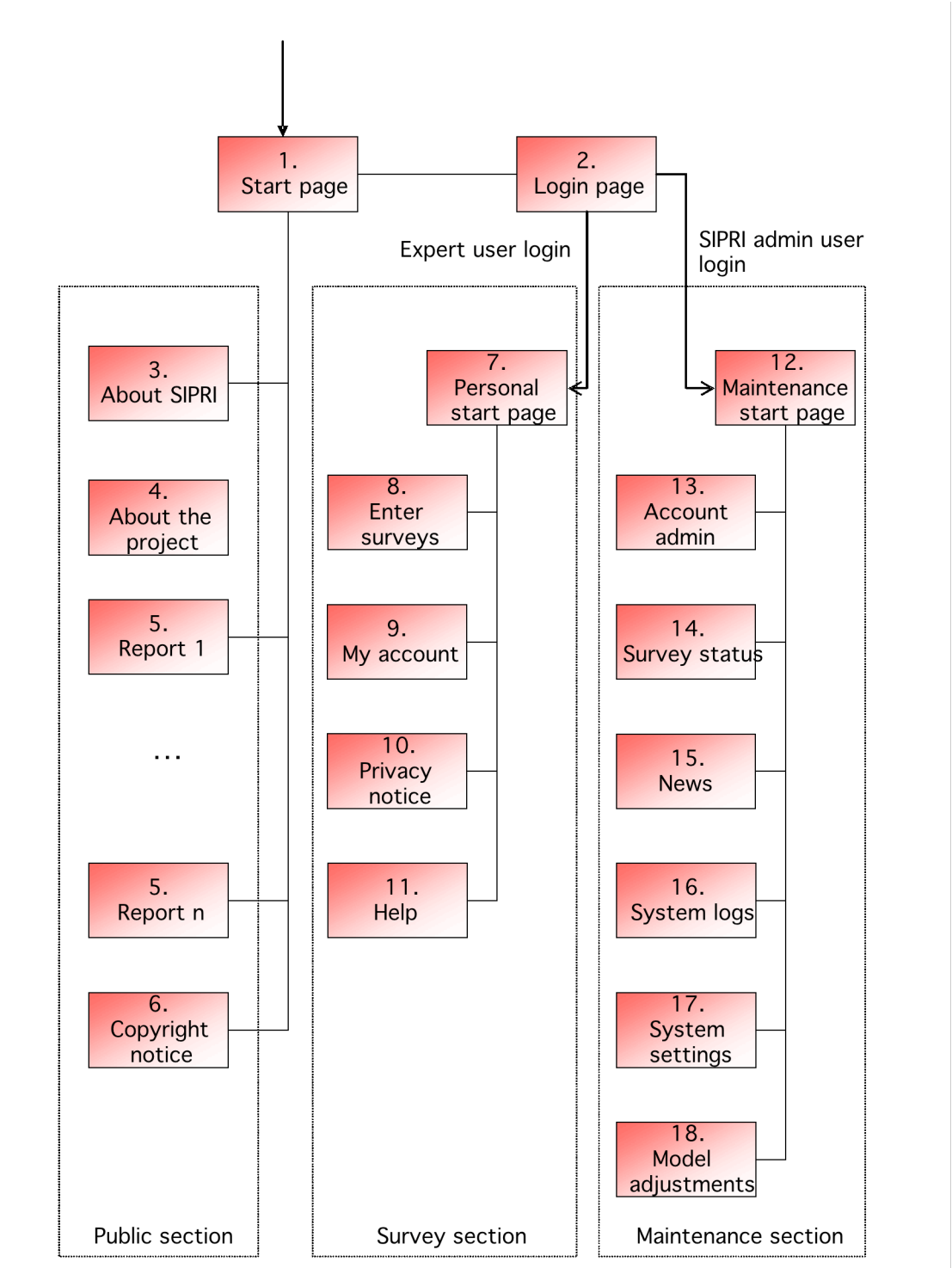
- Enter survey answers.
- Edit their account information.

The public part of the web site is used to access reports.

2.4 FIRST

The structural data is provided by the FIRST system (http://first.sipri.org). FIRST contains data from a large number of databases and indexes, e.g. The World Bank, UN and SIPRI. The XML-text format is used to exchange data with FIRST.

3 Web site structure



4 Use cases

The following use cases define the functional requirements of the system.

4.1 Reading reports in the public section

The start page (page nr 1 in the web site structure diagram above) is shown when a visitor enters the web site. The visitor can then navigate within the site using the site menu. The following reports are available (page nr 5):

I. Recent warnings.
II. Country report.

4.1.1 Report: Recent warnings

This page shows a summary of the latest warnings and a link to the respective country report.

4.1.2 Report: Country report

The country report shows a summary of text and graphs for the country.

4.2 Survey input from expert users

The purpose of the survey section is to let experts enter monthly surveys. All experts answer the same survey and the questions do not change from month to month. Each monthly survey has an "answer period" when the expert can answer the survey. This period can be changed by the admin user in the System settings page (page nr 17).

If an expert has not answered the monthly survey within the answer period, a reminder email is sent to the expert (and to the admin user). The expert can however still answer the survey, even tough the answer period has passed. When the expert answers the survey after the answer period, the survey is marked as a "delayed entry" in the system database.

When an experts logs on to the system, a personalized start page (page nr 7) for the user is shown. The personalized start page contains

- Greetings message.
- Latest news from SIPRI.
- Link to the current survey.
- Warning if any surveys have not been answered within the answer period (and a link to those).

Using the menu the user can

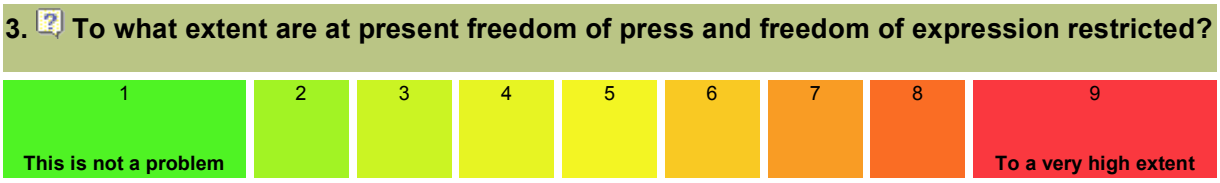
- Start entering survey answers (page nr 8).
- Edit account information (page nr 9).
- Read the privacy notice (page nr 10).
- Read the online help (page nr 11).

4.2.1 Entering survey answers

The Enter surveys page (nr 8) is used by the expert user to enter surveys. There are three different kinds of questions:

- Yes/no.
- Grade from 1 (positive, green) to 9 (negative, red).
- Free text.

Each question has a short description (the question itself) and a longer description. The longer description can be reached by clicking on the question mark icon. If the user has entered an answer for a question the previous month, the previous answer is highlighted with a suitable image.



Example of a question.

The questions are divided into 3 – 6 pages (this is set by the admin user in the System settings page (page nr 17)). The user can move freely back/forward between the pages with the back/forward page-button and does not have to answer the questions in any particular order. On the last page of questions the user has the option of submitting the survey. Until the user has done so, all answers can be changed. Once a survey has been submitted, all answers are read only.

The user also has the option of saving the answers given so far with the Save-button (also done automatically when the user moves between question pages with the back/forward page-button). This enables the user to take a break and continue work at another time.

4.2.2 Edit account information

On the My Account page (nr 9) the expert user can see and edit his/her information, including:

- Name
- Login name and password
- Email address
- Address
- Telephone and fax number

4.2.3 Privacy notice

Page nr 10, Privacy notice, contains a text explaining the projects privacy policy.

4.2.4 Online help

Page nr 11, Online help, contains a general purpose help text.

4.3 System maintenance by admin user

In the maintenance section the admin user can

- Add/edit/remove expert user accounts (page nr 13).
- See the status of ongoing surveys (page nr 14).
- Change the current news text (page nr 15).
- See system logs (page nr 16).
- Edit system settings (page nr 17).

4.3.1 Account admin

On the Account admin page (nr 13) the admin user can add, edit and delete expert user accounts. When a new account is added, the account information (including the login password) is emailed to the expert user.

4.3.2 Survey status

On the Survey status page (nr 14) all surveys are listed and their status displayed. The following information is shown:

- Survey name.
- Survey month and year.
- Number of completed answers of total number of possible answers.

4.3.3 News

On the News page (nr 15) the admin user can edit

- The news text on the start page (nr 1).
- The news on the expert user start page (nr 7).

4.3.4 System logs

On the System logs page (nr 16) the admin user can view system events. Events are shown with

- Event type
- Event description
- Event date and time

4.3.5 System settings

On the System settings page (nr 17) the admin user can change the following system settings:

- Answer period
- Nr of questions per page.

4.3.6 Model adjustments

On the Model adjustments page (nr 18) the admin user make changes to the predication model.

5 Non-functional requirements

5.1 Browser requirements

Netscape/Internet Explorer 4 or later is required (with cookies enabled).

5.2 Database

MySQL will be used as database.

5.3 Operating system

Linux with the Apache web server and the Tomcat Java Servlet Engine.

5.4 Performance

The most often visited pages (reports not included) should be no larger than 45 kB.

5.5 Maintenance

The database needs to be backed up on a daily basis.

5.6 Security

Automatic logout will occur after 20 minutes of inactivity.

Appendix 2, Event Indicators

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1 Political and Leadership

Corruption
Ethnic discrimination/tension
Ethnic violence
Religious/cultural discrimination/tension
Religious/cultural violence
Political discrimination/tension
Political violence
Human rights violation
Freedom of media
Regime transition/change
Incident/conflict at border
Stability of the political system
Adherence to the rule of law
Light weapons supply/Private arming
State legitimacy
State ability to provide security
Efficiency of national/local bureaucracy
Displacements ethnic/religious/political/environmental
External threats
Internal threats
Government performance
State ability/effectiveness to respond to economic/political/environmental crisis
Likelihood of domestic/international conflict
Likelihood of domestic/international/humanitarian crisis
State ability to deliver and maintain infrastructure
Terrorism

2 Demographic and Societal

Ethnic division
Religious division
Ethnic diversity

3 Economic and Environmental

Displacements
Scarcity threat
Population movements caused by economic developments
Environmental degradation risk
Scarcity pressures sustainable livelihood
Food shortage
Access to food, water, fuel and security
Economic decline
Economic crisis likelihood
Environmental collapse likelihood
Resource stocks collapse likelihood
Unbalanced patterns of developments
Low trade openness
Low material well-being
Economic decline threat to stability

Appendix 3, Structural Indicators

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1 Political and Leadership

Democracy
Partial democracy indicator
Change in democracy
Economic discrimination
Political discrimination
Separatist activity
Party fractionalization
Parliamentary responsibility
Party legitimacy
Class character of the ruling elite
Ideological character of the ruling elite
Leaders year in office
Regime type
Regime duration
Freedom House political rights index
Freedom House civil liberties index
Amnesty International political terror scale
US Department of State political terror index
Neighbouring countries in major armed conflict
Neighbouring countries in major civil/ethnic conflict
Membership in regional organizations
Military expenditures as a percentage of GDP
Arms transfers index

2 Demographic and Societal

Youth bulge
Labour force as a percent of population
Infant mortality
Annual change in infant mortality
Life expectancy
Secondary school enrolment ratio
Annual change in secondary school enrolment ratio
Calories per capita
Total population
Population density
Urban population
Urban population growth rate
Ethno-linguistic fractionalization
Ethnic fractionalization
Religious fractionalization
UNDP human development index

3 Economic and Environmental

Trade openness
Trading partner concentration
GDP per capita
Change in GDP per capita
Change in reserves
Government debt
Trade with OECD countries
Annual change in inflation rate
Cropland area
Irrigated land
Access to safe water
Damage due to drought
Famine
Land burden