Early warning coordination centres: a systemic view

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Abstract

Following the tsunami disaster in 2004, the General Secretary of the United Nations (UN) Kofi Annan called for a global early warning system for all hazards and for all communities. He also requested the ISDR (International Strategy fort Disaster Reduction) and its UN partners to conduct a global survey of capacities, gaps and opportunities in relation to early warning systems. The produced report, "Global survey of Early Warning Systems", concluded that there are many gaps and shortcomings and that much progress has been made on early warning systems and great capabilities are available around the world. However, it may be argued that an early warning system (EWS) may not be enough to prevent fatalities due to a natural hazard; i.e., it should be seen as part of a 'wider' or total system. Furthermore, an EWS may work very well when assessed individually but it is not clear whether it will contribute to accomplish the purpose of the total disaster management system; i.e., to prevent fatalities. There is a need for a systemic approach to early warning centres. Systemic means looking upon things as a system; systemic means seeing pattern and inter-relationship within a complex whole; i.e., to see events as products of the working of a system. A system may be defined as a whole which is made of parts and relationships. This paper proposes a preliminary model for an early warning coordination centre from a systemic point of view.
Keywords: risk, disaster, early warning, tsunami, systemic, SDMS, coordination centres, disaster management system.

WIT Transactions on Engineering Sciences, Vol 58, © 2007 WIT Press
www.witpress.com, ISSN 1743-3533 (on-line)
doi:10.2495/EN070121

1 Introduction

Natural disasters may be defined as events that are triggered by natural phenomena or natural hazards (e.g. earthquakes, hurricanes, floods, windstorms, landslides, volcanic eruptions and wildfires). Throughout history, natural disasters have exerted a heavy toll of death and suffering and are increasing alarmingly worldwide. During the past two decades they have killed millions of people worldwide, adversely affected the life of at least one billion more people. It has been estimated that the annual economic losses associated with such disasters averaged US $75.5 billion in the 1960s, US $138.4 billion in the 1970s, US $213.9 billion in the 1980s and US $659.9 billion in the 1990s [1].

In the late 1990s several natural disasters have occurred worldwide. However, on 26 December 2004 the biggest earthquake in 40 years occurred between the Australian and Eurasian plates in the Indian Ocean. The quake triggered a *tsunami* (i.e. a series of large waves) that spread thousands of kilometers over several hours. It is believed that several waves of the tsunami came at intervals of between five and 40 minutes. For instance, in Kalutara (a tourist resort in Sri Lanka) the water reached at least 1 Km inland, causing widespread destruction and death. The disaster left at least 165,000 people dead, more than half a million more were injured and up to 5 million others in need of basic services and at risk of deadly epidemics in a dozen Indian Ocean countries [2].

Following the tsunami disaster in 2004, the General Secretary of the United Nations (UN) Kofi Annan called for a global early warning system for all hazards and for all communities. He also requested the ISDR (International Strategy fort Disaster Reduction) and its UN partners to conduct a global survey of capacities, gaps and opportunities in relation to early warning systems. The produced report, "Global Survey of Early Warning Systems", concluded that there are many gaps and shortcomings and that much progress has been made on early warning systems and great capabilities are available around the world [3].

However, it may be argued that an early warning system may not be enough to prevent fatalities due to a natural hazard; i.e., it should be seen as part of a 'wider' system. Furthermore, an early warning system may work very well when assessed individually but it is not clear whether it will contribute to accomplish the purpose of the total disaster management system; i.e., to prevent fatalities. In other words, there is a need for a systemic approach and this will be discussed in the next section.

2 The need for a systemic approach

It has been argued that had a *tsunami* early warning system (EWS) been operational in the Indian Ocean, like the international tsunami warning system that covers the Pacific Ocean, the human toll might only have been a fraction of what it was [4]. However, it may be argued here that an early warning system should be seen as part of a 'wider system'; i.e. a total disaster management system. Furthermore, an early warning system may work very well when

assessed individually but it is not clear whether it will contribute to accomplish the purpose of the total system; i.e. to prevent fatalities. For instance, a regional EWS may only work if it is well co-ordinated with the local warning and emergency response systems that ensure that the warning is received, communicated and acted upon by the potentially affected communities. It may be argued that without these local measures being in place, a regional EWS will have little impact in saving lives. Researchers argued that unless people are warned in remote areas, the technology is useless; for instance McGuire [5] argues that:

"I have no doubt that the technical element of the warning system will work very well,"…"But there has to be an effective and efficient communications cascade from the warning centre to the fisherman on the beach and his family and the bar owners."

Similarly, McFadden [6] states that:

"There's no point in spending all the money on a fancy monitoring and a fancy analysis system unless we can make sure the infrastructure for the broadcast system is there,"… "That's going to require a lot of work. If it's a tsunami, you've got to get it down to the last Joe on the beach. This is the stuff that is really very hard."

Given the above, the paper argues that there is a need for a systemic approach to early warning centres. *Systemic* means looking upon things as a system; *systemic* means seeing pattern and inter-relationship within a complex whole; i.e., to see events as products of the working of a system. *System* may be defined as a whole which is made of parts and relationships. Given this, 'failure' may be seen as the product of a system and, within that, see death/injury/property loss etc. as results of the working of systems. This paper proposes a preliminary model of early warning coordination centres from a systemic point of view.

3 Early warning coordination centres

A Systemic Disaster Management System (SDMS) model has bee constructed by adopting a systemic approach and this will be described briefly in section 3.1. Section 3.2 describes a preliminary model for an early warning coordination centre which is seen as part of the SDMS model.

3.1 A Systemic Disaster Management System (SDMS) model

The SDMS model is intended to maintain disaster risk within an acceptable range in an organization's operations in relation to natural disaster management. The model is proposed as a *sufficient* structure for an effective disaster management system. It has a fundamentally *preventive* potentiality in that if all the subsystems and connections are present and working effectively the probability of a failure should be less than otherwise. Table 1 summarises the fundamental characteristics of the SDMS model.

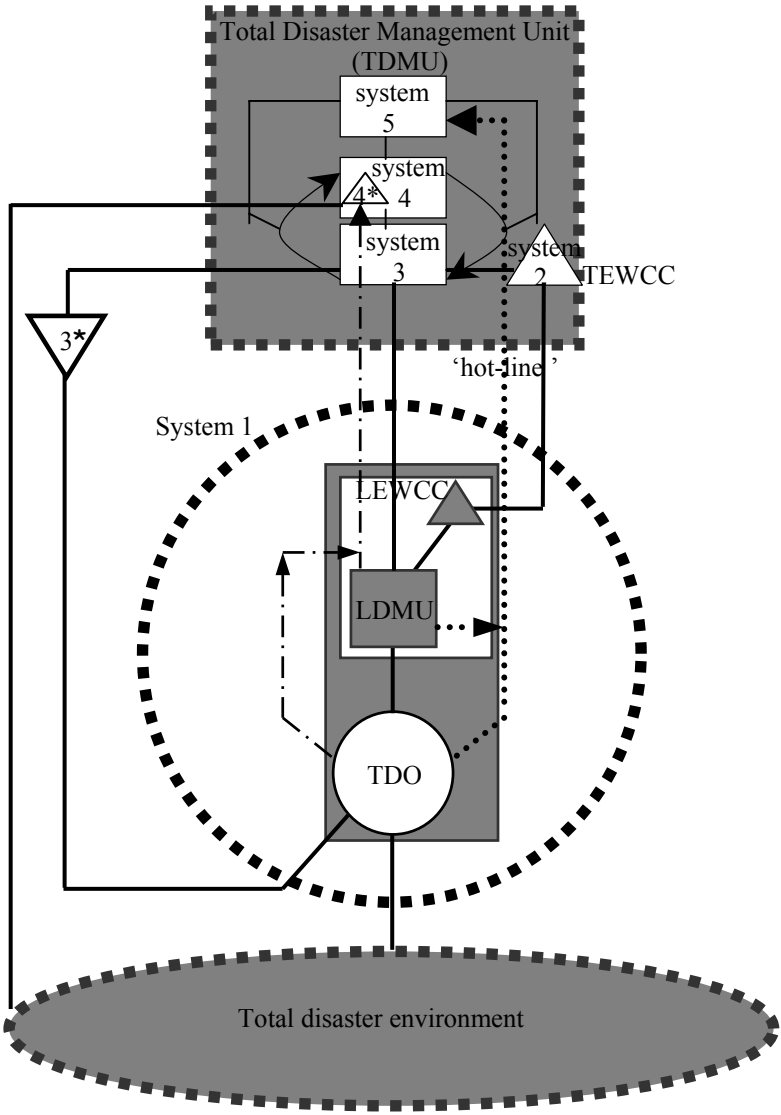
Table 1: SDMS' characteristics.

1	The SDMS & its 'environment'
2	A recursive structure (i.e. 'layered') and relative autonomy
3	A structural organization which consists of a 'basic unit' in which it is necessary to achieve five functions associated with systems 1 to 5. (See Figure1). (a) system 1: disaster-policy implementation (b) system 2: disaster- total early warning coordination centre (TEWCC) (c) system 2*: disaster-local early warning coordination centre (LEWC) (d) system 3: disaster-functional (e) system 3*: disaster-audit (f) system 4: disaster-development (g) system 4*: disaster-confidential reporting system (h) system 5: disaster-policy Note: whenever a line appears in Figure 1 representing the SDMS model, it represents a channel of communication.
4	The concept of MRA (Maximum Risk Acceptable), Viability and acceptable range of risk.
5	Four principles of organization
6	'Paradigms' which are intended to act as 'templates' giving essential features for effective communication and control.

See Beard [7] and Santos-Reyes and Beard [8] for details of the origin and development of the model; a full account of the above characteristics is described in [9,10]. A brief description of the structural organization of the model will be given in the subsequent paragraphs.

3.1.1 A structural organization which consists of a 'basic unit' (i.e. systems 1-5)

(a) System 1: Disaster- policy implementation, implements safety policies in the organization's operations. System 1 consists of one or more operations (e.g. disaster operations at the level of a country, or zone or region).
(b) System 2: Disaster-TEWCC, coordinates all the activities of the operations that form part of system 1 (see Figure 1) and in relation to the 'total environment'. Furthermore, it also coordinates other local early warning coordination centres (LEWCCs). System 2 along with system 1, implements the safety plans received from system 3.
(c) System 2*: Disaster-LEWCC, is part of system 2 and it is responsible for communicating advance warnings to other early warning coordination centres and to key decision makers in order to take appropriate actions prior to the occurrence of a major natural hazard event. (See section 3.2 for details about this).
(d) System 3: Disaster-functional is directly responsible for maintaining disaster risk within an acceptable range in system 1 on a daily basis. It ensures that system 1 implements the organization's safety policy.



Key:
TDMU = Total Disaster Management Unit
TEWCC = Total Early Warning Coordination Centre
LEWCC = Local Early Warning Coordination Centre
LDMU = Local Disaster Management Unit
TDO = Total Disaster Operations

Figure 1: A Systemic Disaster Management System (SDMS) model.

(e) System 3*: Disaster-audit, is part of system 3 and its function is to conduct audits sporadically into the operations of system 1. System 3* intervenes in the operations of system 1 according to the safety plans received from system 3.
(f) System 4: Disaster-development, is generally concerned with the 'total environment' and its function is to conduct research and development (R&D) for the continual adaptation of the organization. By considering strengths, weaknesses, threats and opportunities, system 4 can suggest changes to the organization's safety policies.
(g) System 4*: Disaster-confidential reporting system, is part of system 4 and it is concerned with confidential reports or causes of concern from any person of the public about any aspects, some of which may require the direct intervention of system 5.
(h) System 5: Disaster-policy, is responsible for deliberating safety policies and for making strategic decisions. System 5 also monitors the activities of system 4 and system 3.
(i) 'Hot-line': Figure 1 shows a dash line directly from system 1 to system 5, representing a direct communication or 'hot-line' for use in exceptional circumstances; for example, during an emergency.

3.2 Early warning coordination centres

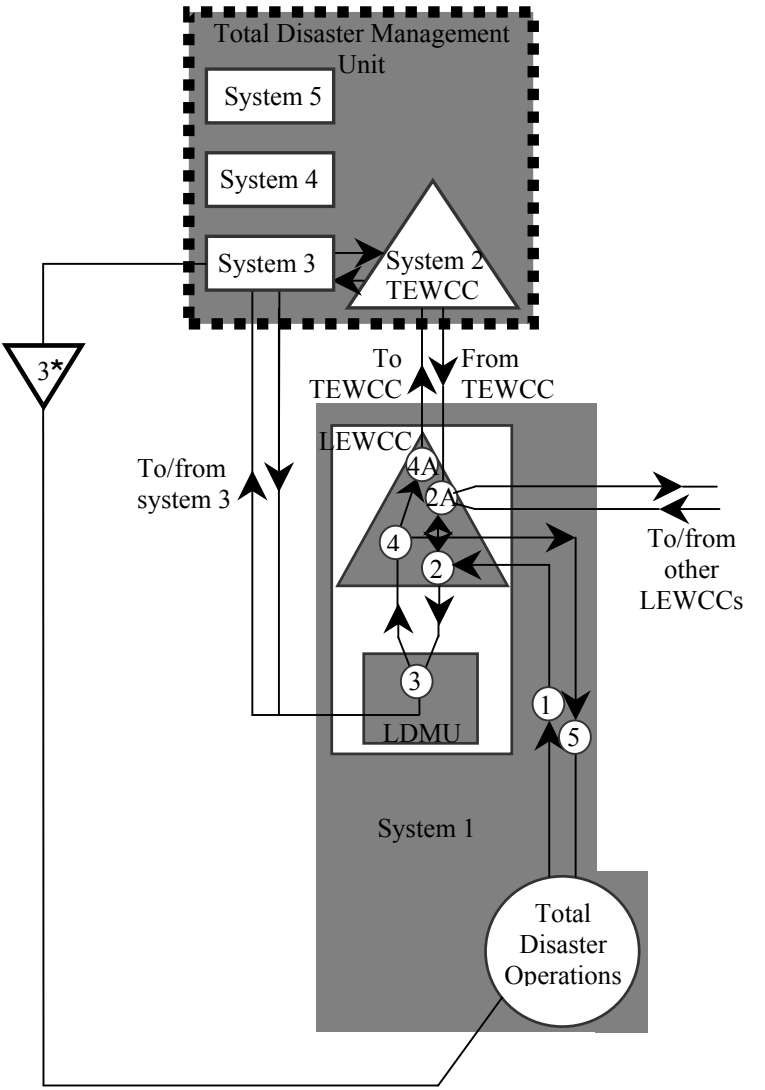
The function of system 2 is to coordinate the activities of the operations of system 1. To achieve the plans of system 3 and the needs of system 1, system 2 gathers and manages the safety information of system 1's operations.

In a relatively well coordinated system the information flows might be according to the arrangement shown in Figure.2. In general, the arrangement indicates that if a deviation occurs from the accepted criteria, then the functions of the LEWCC within system 1 are the following:

Firstly, detect any deviation from the accepted criteria (see action point '2' in Table 2 and Figure 2).

Secondly, issue the disaster warning simultaneously to:
(a) LDMU; so that, it implements the pre-planned 'measures' in the operations; see action points '3', '4' and '5' (e.g. evacuation, search and rescue, emergency medical services).
(b) other LEWCCs through action point '2A'. Similarly, these coordination centres have to assess consequences and implement measures within their operations and make reports quickly to system 2 (TEWCC); see Table 2 & Figure 2.
(c) System 2 (TEWCC) through action point '4A'. By receiving the warning it takes fast corrective action, either through the channels of communication that connects the LEWCC or via system 3 and this is shown in Figure 2. Some of the functions of the TEWCC are: collection and compilation of information from the affected area, supply of information to System 3.

Figure 3 shows a preliminary model for EWCCs at National and Regional levels.

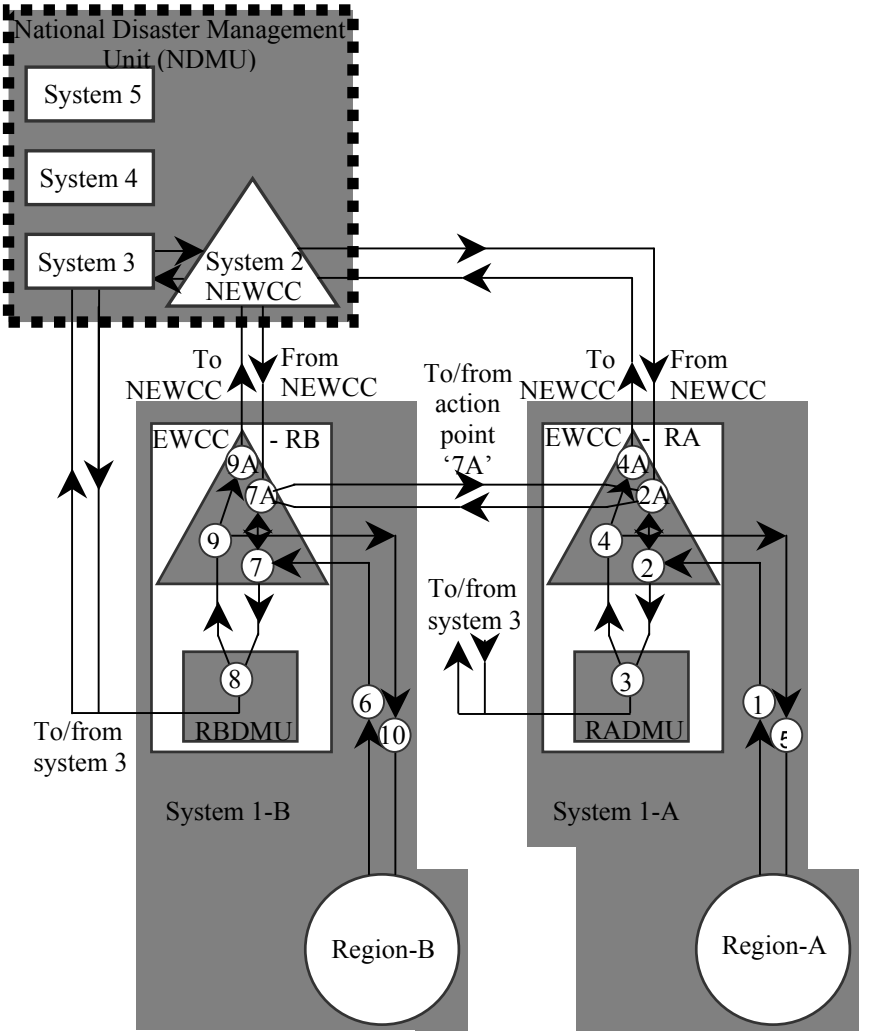


Key:
TEWCC = Total Early Warning Coordination Centre
LEWCC = Local Early Warning Coordination Centre
LDMU = Local Disaster Management Unit

Figure 2: Early warning coordination centres – a preliminary model.

Table 2: 'Action points' - Figure 2.

Action point	Description
1	Flow of data related to any particular sensor system (e.g. those related to an earthquake/tsunami: ocean bottom pressure sensors, buoys, tide gauges, etc.). The communications may be done via wire line, wireless, satellite, etc.
2	Comparison/analysis of the data/information being received. If any deviation from the pre-planned acceptable criteria occurs then it issues the warning to action points '2A' and '3' as indicated in Figure 2.
2A	(a) Communicates the warning to other LEWCCs (see Figures 2 and 3). (b) It also receives information from the TEWCC as shown in Figure 2.
3	The function of the LDMU is to respond to the warning and prevent fatalities due to the natural hazard.
4	Planning and taking measures in order to respond to the warning. For example, preparedness for any emergency, in particular those, which strike without notice, requires a plan; some of the aspects that should be taken into account may be: the identification of possible emergency situations which may occur in a particular area, etc.
4A	Issues the warning to the TEWCC (See Figure 2) and by receiving all this information, the TEWCC enables to take a 'higher' order view of the total consequences. It will report to system 3, which is on the vertical command channel (see Figures 1 and 2).
5	(a) the warning is issued. The public may be informed by public address systems, radio, TV, etc. At present, no early warning can be given for an earthquake. However, some of the conventional ways of early warning may be used; for example, an erratic behaviour of animals just before an earthquake have been used since ancient times as early warning for such events. (b)} Implementation of pre-planned 'measures' to evacuate safely and prevent fatalities due to natural hazards; e.g. provision of medical services, search, rescue and evacuation. The primary concern should be the safety of the public; protection of property by the police and fire fighters.



Key:
NDMU = National Disaster Management Unit
NEWCC = National Early Warning Coordination Centre
EWCC-RA = Early Warning Coordination Centre – Region A
EWCC-RB = Early Warning Coordination Centre – Region B
RADMU = Region A – Disaster Management Unit
RBDMU = Region B – Disaster Management Unit

Figure 3: Early warning coordination centres – at national and regional levels.

4 Conclusions and future work

A preliminary model for an Early Warning Coordination Centre (EWCC) has been put forward. The EWCC is associated with system 2 of a Systemic Disaster Management System (SDMS) model which has been constructed by using the concepts of systems. Further research is needed in order to construct recursive early warning coordination centres; i.e., from, international to national, regional to community level from a *systemic* point of view. It is hoped that this approach will help to provide "…an effective and efficient communications cascade from the warning centre to the fisherman on the beach & his family and the bar owners" [5].

Acknowledgements

This project was funded by CONACYT & SIP-IPN under the following grants: CONACYT: No-52914 & SIP-IPN: No-20071593.

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