Chapter 2
Systems Failure in Disasters

Abstract This chapter explains why deaths in disasters occur by taking two overarching perspectives: risk and vulnerability. Risk or the traditional perspective gives the advantage of understanding the dynamics of geohazards and their effect on humans. Vulnerability perspective on the other hand, helps in explaining why some groups of people are more vulnerable to disasters than others due to their class, gender, age, and race identities. This chapter also adds on an additional perspective to explain deaths in disasters. This is a complex perspective. In this perspective, deaths occur due to the vulnerabilities that exist in the seams of disaster management system. This system is a conglomeration of different professional groupings and actors designed for specific tasks and goals. It is also a system that is highly reliant on technology. As such, loose coordination and communication between actors can lead disaster management system to fail. To showcase, how the disaster management system can fail to save lives, an analytical tool for systems failure is presented with its three inter-connected components: coordination, communication and world views.

Keywords Complex perspective · Coordination failure · Communication failure · Disaster climate · Risk · Vulnerability · Socio-technical system · Systems failure · World views · Wicked problem

The central question of this book is: why do avoidable deaths occur in disasters? Research that scrutinises the causes for human deaths in disasters are rather limited, but they indicate, broadly speaking, two perspectives: traditional (or risk) and vulnerability (Kapur 2010). Both perspectives are analytically distinct but in practice they are related. This chapter also provides a complex perspective to explain avoidable deaths in disasters.

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2.1 Traditional Perspective

The traditional perspective is the mainstream or dominant perspective. According to this perspective, natural hazards[1] originate from natural systems and they can cause harm and loss. One way of mitigating the effect of nature is through technology or a 'technical fix' (Ariyabandu and Wickramasinghe 2003; Bryant 2005; Gilbert 1998; Ray-Bennett 2009a; Wisner et al. 2004). This line of thinking was dominant in the UN's General Assembly Resolution 44/236, adopted on 22 December, 1989. Four out of five of its goals underlined the importance of the dissemination of technical information and the transfer of scientific and engineering knowledge for the mitigation of disasters in developing countries (Bankoff 2001; de Senarclens 1997). As a result, structural mitigation measures, such as building concrete houses, flood levies, ocean wave barriers, cyclone shelters, embankments and dams, attained primary importance over non-structural mitigation measures, such as policies, laws, training, raising public awareness and aid—amongst many (Davis and Gupta 1991; Haque and Zaman 1994; Kaiser et al. 2003; Zaman 1999). This technical perspective has evolved due to the mid-term evaluation of the International Decade for Natural Disaster Reduction (IDNDR) (1990–2000) in 1994 (known as Yokohama Strategy) followed by the Hyogo Framework for Action (2005–2015) and most recently the Sendai Framework for Disaster Risk Reduction (2015–2030) (UN 2005, 2015). Now there is widespread acknowledgement that hazards can include "latent conditions that may represent future threats and can have different origins: natural (geological, hydrometeorological and biological) or induced by human processes (environmental degradation and technological hazards)" (UNISDR 2015a: 3/25).

Despite these changes, governmental organisations often use natural causes or the geophysics of a hazard to explain deaths in disasters. This is noted by Kapur (2010) whilst reviewing the effects of 16 natural hazards[2] in India from 1977 to 2002. Geophysics of a hazard can be understood in three ways: First, higher the intensity of a hazard, the more likely it is to kill people. Intensity is classified as moderate or severe for 11 hazards out of 16. Since the focus of the case study is on cyclones, the intensity of a cyclone is determined by its wind speed (such as moderate or severe). Of the 11 hazards cyclones have killed more people in India. Second, hazards are seasonal and so are human deaths. In India, the month of November is cyclone-prone, May is prone to gale and dust storms, April for hailstorms, June for lightning, and January and February for cold snaps. It was noted that 32% of cyclones occurred in the month of November and 36% of all deaths due to disasters were in this month. Third, the effect of hazard is spatially determined and so are the deaths due to disasters are spatially varied. India is

[1]The Sendai Framework for Action defines hazard as "A potentially damaging physical event, phenomenon […] that may cause the loss of life or injury, property damage […]" (UN 2015: 3/25).

[2]The 16 natural hazards are: cloudburst, cold wave, drought, dust storm, earthquake, flash flood, gale, hailstorm, heat wave, lightning, snowfall, squall, thunderstorm (Kapur 2010).

diverse and different regions are exposed to different types of hazards. For instance, the coast of Bay of Bengal is exposed to severe cyclonic storms, whereas the north–west is exposed to droughts. Almost one half of all deaths in the Bay of Bengal were due to cyclones compared to the west coast of India (Kapur 2010). The coast of Bay of Bengal has also experienced highest death toll compared to the other coasts in the world. As mentioned earlier, in the 1970 cyclone more than 500,000 people died. In 1991 cyclone almost 140,000 people died in Bangladesh (Haque et al. 2011).

This perspective provides an excellent insight into the dynamics of geohazards and their effect on humans. As a result, national and international organisations are investing heavily to build the capacity of the experts and practitioners by embracing state-of-the-art technologies, such as space technology and multi-hazard early warning systems in order to promote effective disaster management system to reduce deaths (UNISDR 2015b). However, in the context of this research, this perspective explains little as to why more women die in disasters than men or vice versa.

2.2 Vulnerability Perspective

The vulnerability perspective, on the other hand, aims to explain why some people are more vulnerable to disasters than others. Vulnerability is often used in different ways (Bacon et al. 2017) but in this instance, it is understood as "*the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard* (an extreme natural event or process)" (original emphasis by Wisner et al. 2004: 11). According to this perspective, the impacts of natural disasters are not entirely 'natural'; rather they are determined by people's unequal exposure to risks which are a consequence of the socio-economic systems (Cannon 1994; Neumayer and Plümper 2007). The significance of natural hazards as trigger-events is not denied by this perspective, but emphasis is placed on the various ways in which social and economic systems can render people more vulnerable to disasters (Cannon 1994; IPCC 2012; Varley 1994; Winchester 2000; Wisner et al. 2004). In this perspective, the normal daily lives of some vulnerable groups are often difficult to distinguish from disaster conditions. Proponents assert that disasters only act as an interface between an extreme physical environment and a vulnerable group of the population, due to a "combination of hazards, conditions of vulnerability and insufficient capacity or measures to reduce the potential negative consequences of risk" (Sivakumar 2005: 2).

According to this perspective, differences in mortality to natural disasters are explained due to biological vulnerability, social and cultural vulnerabilities (caste, race, gender, and age), economic vulnerability (class) and physical vulnerability (housing structures). These vulnerabilities are not distinct; they often are conjoined and reinforce each other during the time of disasters. This is evident in the discussion below.

Biological and physiological differences between men and women put women at high risk during disasters (Ariyabandu 2009; Neumayer and Plümper 2007; Ariyabandu 2009). Men in general are physically stronger than women and therefore they are likely to withstand the impact of a disaster better than women. For instance, a physically robust man has a better chance to swim or climb up a tree in order to survive against an emerging storm surge. However, biological and physiological differences may also be socially determined (Eklund and Tellier 2012; Neumayer and Plümper 2007).

Social and cultural norms related to role behaviour put women, more than men, at a greater risk when it comes to rescue efforts (Neumayer and Plümper 2007). Dress codes such as *saree* or *burqa* were found inhibiting women's mobility during the 1991 cyclone in Bangladesh. Learning to climb a tree or to swim are socially not permissible in some societies. In Sri Lanka, a study conducted by the Centre on the Epidemiology of Disaster (CRED) noted that only 12–20% of women were able to swim compared to 75–85% of men (Eklund and Tellier 2012).

In the response phase, the lack of lifesaving skills along with the responsibility of looking after young children often put women at a greater risk to disasters (Eklund and Tellier 2012; Neumayer and Plümper 2007). A report by the WHO (2002) noted that although the Indian Ocean Tsunami in 2004 claimed 300,000 lives across 13 nations; 80% of these lives were women and children. The Indian Meteorological Department found that a large proportion of women (34%) and children (45%) were killed in disasters in comparison to men (21%) between 1977 and 2002 (Kapur 2010). Neumayer and Plümper's (2007) research of 141 countries between 1981 and 2002 showed that natural disasters lower the life expectancy of women more than that of men. In other words, natural disasters (and their subsequent impact), on average, kill more women than men and kill women at an earlier age than men. This study also observed:

> The stronger the disaster (as approximated by the number of people killed relative to population size), the stronger this effect on the gender gap in life expectancy. The higher women's socio-economic status, the weaker this effect on the gender gap in life expectancy (Neumayer and Plümper 2007: 1).

Disproportionate numbers of women's deaths were also reported in Mexico City in the 1985 earthquake and the Bhuj earthquake in Gujarat in 2001, and more elderly women's deaths in the Kobe 1995 earthquake (Hewitt 2013; Kapur 2010). In 2005, the earthquake in Pakistan killed three times more women than men (Trust Org 2013). Women accounted for 61% of deaths in Cyclone Nargis in 2008 in Myanmar (Aus Aid 2014) and 67% in Banda Aceh in the Indian Ocean Tsunami in 2004 (GFDRR, quoted in Bradshaw and Fordham 2013). Death rates were almost four times higher amongst women than men in the 1991 Bangladesh cyclone (Aus Aid 2014). Women's mortality rates are also much higher in developing countries in comparison to their developed counterparts (Lass et al. 2011; Neumayer and Plümper 2007).

Gender based division of labour could be equally detrimental to the effect of some hazards. For instance, more women were killed in the Latur Earthquake in

1993 because during the time of the earthquake women and children were at home, whereas men were out working in the field (Kapur 2010). In contrast, more fishermen and male labourers were killed in the district of Jagatsinghpur in Odisha during the Super-Cyclone 1999 (Samal et al. 2003). The coastal livelihoods in Odisha are reliant heavily on fishing and prawn cultivation. Prawn cultivation is a labour-intensive activity and employs largely male labourers. When the Super-Cyclone made its landfall, most men were either fishing in the sea or were involved in rearing of the prawns near to the coast. Consequently, they were directly on the pathway of the Super-Cyclone. This is consistent with the research findings. In this light, social norms and roles provides an additional layer to the biological and physiological reasons for the gendered nature of disaster vulnerability. Women are physically weaker than men but men may be more vulnerable to certain types of disaster risks than women (Neumayer and Plümper 2007).

Social stratification based on class and race can be highly detrimental in putting some lives at risk during disasters (Barnshaw and Trainor 2007). An individual's class and race often determines the choice one can make and the social capitals they can acquire in their everyday lives. Social choices and capitals are critical assets to build individual's agency and social network. Vulnerable groups often lack agency due to structured inequalities and lack of social resources that exist in their everyday lives. In this vein, communities which are better placed with social networks will be in a better position to evacuate and even survive a disaster. In contrast, communities which are not will be more susceptible to the impacts of the disaster. For example, higher numbers of poorer African–Americans were the victims in Hurricane Katrina compared to their white middle class counterparts because they lacked social capital in their everyday lives (Barnshaw and Trainor 2007).

Caste and class is an equally important determinant in the Indian Subcontinent for gender differences in disaster mortality. In fact, the relationship between caste, class and gender in Indian society cannot be understood outside a consideration of their mutual impact (Chakravarti 2003); they are intertwined and interlinked, creating and reinforcing inequality (Sen 2003). According to Sen (2003: 207):

> Class does not act alone in creating and reinforcing inequality, and yet no other source of inequality is fully independent of class. Consider gender. […]. Gender is certainly an additional contributor to societal inequality. […]. Similarly turning to caste, even though being lower caste is undoubtedly a separate cause of disparity, its impact is all the greater when the lower-caste families also happen to be very poor.

Caste, class and gender issues were noted by the author (Ray-Bennett 2009a, c) in the Super-Cyclone of 1999 in the village of Tarasahi, Odisha. She found women-headed households from the upper and middle castes were better able to survive the Super-Cyclone than their low caste counterparts. This was because the low caste women lacked social support. Their houses were also not made from concrete and were located in the low-lands which were the first to get flooded. Lack of evacuation shelters further exacerbated the predicament of the low caste women. The low caste respondents survived the impact of the Super-Cyclone by tying onto a coconut tree, squatting for more than 10 h by holding hands tightly with their neighbours under a plastic sheet, whilst others survived by sitting on the veranda of a rich upper caste household and of the public school buildings.

In addition to the social and cultural vulnerabilities, physical vulnerability can also lead to gender differences in mortality. Kapur (2010) argued that greater numbers of women's deaths occurred in the 1993 Latur Earthquake in India due to the nature of house structures. Higher numbers of deaths were recorded in stone and mud houses (86.32%) compared to shacks (0.40%) and brick and mortar (1.15%). Although poor households owned mostly the stone and mud houses and therefore bore the severe brunt of the Earthquake, it is important to note that not all of the poor suffered, because the households living in shacks were the least affected. This indicates that poverty and disaster vulnerability are linked but that they are not the same (Cannon 1994; Jaspars and Shoham 1999; Ray-Bennett 2009a). The correlation of vulnerability and poverty is highly significant, but concomitantly failure to distinguish vulnerability from poverty has severe policy implications because poverty is endemic and defined by professionals in terms of flows of income and consumption (Chambers 1989). Anti-poverty programmes tend to concentrate on raising incomes or consumption and progress is measured according to these flows, which are then often taken as indicators of other dimensions of deprivation, including vulnerability (Chambers 1989). Poverty is largely a consequence of class and social position and in itself provides an inadequate explanation of the differential impact of hazards (Cannon 1994; Ray-Bennett 2009a). Men and women's deaths in disasters when attributed to their class and social vulnerabilities cannot be accepted uncritically—other vulnerabilities play a part too.

2.3 Complex Perspective

It can be argued that human deaths can occur not only due to the vulnerabilities that exist in the natural and social systems, as discussed above, but also due to vulnerabilities that exist in human built organisations[3] (Perrow 1999; Weick 1990), such as the disaster management system. A disaster management system is a conglomeration of different professional groupings and actors designed for specific tasks and goals. It is a system that is highly reliant on technology. Also, actors[4] within this system adopt different frames of reference. As such, weak forms of organisation between actors could potentially lead to systems failure causing deaths

[3]"Organisations are social designs directed at practice" (Wenger 1998: 241). In other words, organisations are combination of institutions (social design) and constellation of practices by different actors which gives life to the organisation (Wenger 1998).

[4]Actors are "the agents who carry out or cause to be carried out the main activities of the system, especially its main transformation" (Checkland 1981: 224). There are also victims or beneficiaries in these soft systems. In this study, they are the vulnerable groups of men, women and children who are indirectly involved in this research.

Table 2.1 Typology of organisations and actors

Organisations	Actors
Primary	Category 1 responders and affected community
Secondary	Category 2 responders
Tertiary	Global responders

in disasters. This is discussed through the analytical tool of systems failure later in this chapter.

Vulnerabilities at the seam of a disaster management system can emerge due to the internal vulnerabilities of actors, which can manifest in the form of inaction, human errors, mismanagement, lack of coordination, hierarchy, communication—to mention a few. This is because disaster management involves multiple agencies and actors across the public, private and voluntary sectors at local, regional, national and global levels. These organisations are diverse, hierarchical and interdependent. A typology of these organisations and actors is provided in Table 2.1. In the case of an external threat such as natural disaster or political disaster, these internal vulnerabilities come to the fore causing the systems to fail.

Primary organisations are the first responders. They are also known as Category 1 responders by the Civil Contingency Act in the UK (Walker and Broderick 2006). They have specified responsibilities—"risk management, emergency planning, business continuity of the responder itself, and warning and informing the public" (Walker and Broderick 2006: 81). Although much of the 'communication, co-operation and information sharing' falls within the remit of the Category 2 responders or secondary organisations—responders are also expected to share information with other local responders to enhance co-ordination and co-operation. Communities who are directly affected may also be seen as first responders (Kolen and Helsloot 2012; Quarentelli 1977).

Secondary Organisations are decision making organizations at national and state levels. They undertake a myriad of roles and responsibilities which can be categorised as auxiliary, alleviating and collateral. Auxiliary organisations have some form of interactive contact with the primary organisation prior (Toft and Reynolds 2005) to a disaster climate. They make decisions, raise disaster funds, coordinate relief activities and share information with primary organisations to enhance response. Examples include the Ministry of Rural Development, the Ministry of Home Affairs and the Disaster Mitigation Authority in India who work closely with the state level disaster management authorities (Srivastava 2009). Alleviating organisations (Toft and Reynolds 2005) complement the primary and auxiliary responders, businesses and the public by generating valuable early warnings for decision making and by planning for response. Examples include the Indian Meteorology Department, the Meteorology Office in the UK and the Pacific Tsunami Warning Centre in Hawaii, to name a few.

Collateral organisations (Lalonde 2011: 450), are "new form of [secondary] organisations that do not replace the usual operational structure but co-exist and contribute to the problems that are non-routine". For example, the Odisha State

Disaster Management Authority, Gujarat State Disaster Management Authority and the Disaster Mitigation Authority under the auspices of the Prime Minister in New Delhi—all exist solely to address disaster management and mitigation issues. Other examples include the Environment Agency in the UK and the Federal Emergency Management Authority in the United States.

Tertiary organisations are multi-lateral or global organisations formed between "three or more nations to work on issues that relate to all of the countries in the organization" (Global Energy Network Institute (GENI) 2014). Examples include the UN, and the International Strategy for Disaster Risk Reduction (ISDR)—a dedicated secretariat established by the UN General Assembly in December 1999 for disaster risk reduction. Global financial institutions, such as the World Bank, are also tertiary organisations.

2.4 A 'Wicked' Problem—Deaths in Disasters

According to the complex perspective, it is argued that actors and organisations involved in disaster management belong to linear systems. They are linear because these systems are spatially segregated (Perrow 1999). They have dedicated connections, and have extensive understanding of the nature of risk (such as cyclones/flooding) (Perrow 1999). They are also highly complex in their structures and processes of work. At the outset, they may look like separate entities but in reality, they are highly inter-dependent to each other (Weick 1990). In this context, deaths in disaster are a complex problem. Their complexity arises because the decision to save lives during disasters sits across different governmental departments and institutions (Grint 2008; Rittel and Webber 1973). Some institutional arrangement for disaster management and decision making in Odisha was introduced in Chap. 1—a compilation of this is presented in Table 2.2. As such, deaths in disasters are understood as 'wicked problems' because they are unique with no prior precedents (Rittel and Webber 1973). They involve (or are perceived to involve) poorly understood problems, and require examination at the seams of

Table 2.2 Disaster management institutional arrangements in Odisha (Compiled by author)

- Revenue and Disaster Management Department (Secondary/Category 2)
- Special Relief Organisation (Secondary/Category 2)
- Odisha State Disaster Management Authority (Secondary/Category 2)
- State Disaster Management Authority (Secondary/Category 2)
- The State Executive Committee; Natural Calamity Committee (Secondary/Category 2)
- District Disaster Management Authority (Primary/Category 1)
  - – Block Disaster Management Committees
  - – Gram Panchayat Disaster Management Committees
  - – Village Level Task Force Committees
- Indian Meteorology Department (Secondary/Category 2)
- UNDP (Tertiary/Global)
- International NGOs, International Federations (Tertiary/Global)

multiple disciplines (Midgley 2014), including the sociology of risk and crisis, geography, management, development, violence/conflict, disaster risk reduction, justice and gender (some of which are discussed in this and the previous chapter) to understand the high degree of complexity in order to reduce deaths.

Wicked or complex problems have their roots in systems thinking[5], particularly a soft systems thinking (Bunge 1977; Midgley 2014; Rittel and Webber 1973). "Soft systems typically have properties that are difficult to quantify and measure e.g. viewpoints, conflicts, vested interests and other qualitative aspects" (Waring 1989: 11). In soft systems, human activity is the key. This view has its roots in Weber's interpretive social science (phenomenology and hermeneutics), Dilthey's *Weltanschauung* (W) (world view), Husserl's 'idea of phenomenology' and Vicker's appreciative system.[6] As such, wicked problems can be explained in numerous ways, but the choice of explanation will determine the nature of the problem's resolution (Rittel and Webber 1973). Wicked problems involve a level of uncertainty and ambiguity which requires political collaboration and 'adaptive leadership' as opposed to scientific processes only (Grint 2008). Wicked problems have no right or wrong solutions (Grint 2008; Rittel and Webber 1973). Also, "problems are not characterised by linear causal chains, rather they are circular, emergent and continuously changing in a messy, ill-structured, real-world" (Checkland 1985: 298). Accordingly, in such systems, human problems tend to be persistent ones. They are influenced by humans' world views, and different points of view, where the only way to resolve issues is to seek 'accommodation' rather than 'solutions' (Checkland 1985). This is discussed at length in the ensuing sections through the analytical tool of 'systems failure'.

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[5]Systems thinking can be understood in terms of 'three tightly interrelated discourses: general systems theory (GST), cybernetics and complexity (Midgley 2003: xxii). These theories emerged in the mid and late twentieth century. All the three discourses are highly interlinked and favour mathematics and modelling as their systems language (Checkland 1981; Midgley 2003). As a result, organisational and management theorists have applied only a 'partial systems approach' because of the nuances and dynamics that underpin a human system (for detailed discussion see Kast and Ronsezweig 1972; Midgley 2003; Mingers 1980).

As an alternative to the aforementioned theories, Checkland (1981, 1985) conceives systems as one of two types: hard and soft. A hard system is a 'goal seeking' engineered system. Checkland (1981, 1985) views general systems theory and cybernetics as hard systems. Hard systems have quantifiable and measurable attributes (Checkland 1981, 1985; Waring 1989). Soft systems, on the other hand, are not goal seeking engineered system, rather they deal with 'soft' problems in social systems where goals are often obscured, ambiguous or non-existent (Checkland 1981, 1985). Soft systems deal with the complex problems of an ill-structured and poorly understood real world.

[6]Max Weber's interpretive social science became popular with the emergence of phenomenological sociology in the 1960s. Phenomenology like positivism is also a philosophy, which was made popular by Edmund Husserl in the early part of twentieth Century (McNeill and Chapman 1985). For Husserl, 'the basic reality lies in our thinking' and 'the everyday we take as given is in fact constructed through human activity' (Checkland 1981: 274). Alfred Schutz also applied Husserl's idea of phenomenology to the study of social life or *Lebenswelt* (lived-in-reality) (McNeill and Chapman 1985). According to Checkland (1981) Vicker's appreciative system is based upon Schutz's *Lebenswelt*.

2.5 Systems Failure

Studies on systems failure stem from cognitive psychology, organisational culture, risk management and systems engineering theories. These studies examine the internal vulnerabilities of actors and organisations as a contributing factor for systems failure broadly under three approaches (Dekker 2006); namely the normal accident approach, the human error approach, and the systemic approach. A short review of these approaches is provided below in order to make the case for 'systems failure'.

The normal accident approach: Organisational theorist Perrow (1999) challenged the traditional causal factors of 'operator error' in system accidents. He did this in the context of high-risk technologies or 'risky enterprises[7]'. High risk systems are especially complex because they work in human-technology interface. Perrow offered two special characteristics of high risk systems: 'interactive complexity' and 'tight coupling'. In the conditions of interactive complexity:

> when x failed, y would also be out of order and the two failures would interact so as to both start a fire and silence the fire alarm. Furthermore, no one can figure out the interaction at the time, and thus know what to do. […] This interacting tendency is a characteristic of a system, not of a part or an operator (Perrow 1999: 4).

'Tight coupling', on the other hand, exists when:

> processes happen very fast and can't be turned off, the failed parts cannot be isolated from other parts, or there is no other way to keep the production going safely (Perrow 1999: 4).

System accidents include multiple factors or a chain of events (concatenation) that may not initially seem to be the 'root causes' of the failure. These chains of events are connected either through linear or complex interactions which could be tightly or loosely coupled (Perrow 1999; Weick 1990). This is also termed 'the sequence-of-events' model (Dekker 2003, 2006).

The human error approach: Reason (1990), a cognitive psychologist, also examined system accidents in risky enterprises, but focussed more on 'human error[8]' than technology. Reason offered two categories of human errors: active and latent. Active errors are those "whose effects are felt almost immediately", whereas latent errors are those "whose adverse consequences may lie dormant within the system for a long time, only becoming evident when they combine with other factors to breach the systems" (Reason 1990: 173). This approach is also known as an 'epidemiological' one in which latent errors act as resident pathogens (Dekker 2006).

[7]Risky enterprises include nuclear power plants, chemical plants, the energy sector and the mass transportation sector (including road, rail, sea and air).

[8]According to Reason (1990: 17), the term error can only be "meaningfully applied to planned actions that fail to achieve their desired consequences without intervention of some chance or unforeseeable agency".

In 1997, Reason proposed 'organisational culture' as another important tenet of systems failure. Organisational culture, in general, is a problematic concept. This is because there is no single culture but rather subcultures often formed around the interests of particular professional groups. According to Reason, organisational culture is "shared values (what is important) and beliefs (how things work) that interact with an organisation's structures and control systems to produce behavioural norms (the way we do things around here)" (Uttal is quoted in Reason 1997). To avoid organisational accidents, Reason advocated a 'safety culture', a culture which is flexible, just and promotes reporting. "Together they interact to create an *informed culture*" (Reason 1997: 196, original emphasis).

The concept of 'safety culture' was further extended by risk specialists Toft and Reynolds (2005). They viewed organisations as socio-technical systems, and socio-technical failures as a combination of human and technical failures. They understood safety culture as key to reducing socio-technical disasters but noted that it is often not prioritised by the organisation. This is partly because safety culture can be obstructed by politics and a 'culture of blame'. The 'culture of blame' is rife in businesses and organisations. Proponents of organisational and risk management studies demonstrated this by understanding organisations as highly political and politicised spaces (Blockley 1996; Douglas 1966; Grey 2009; Horlick-Jones 1996; Weir 1996).

Systems accidents often involve human loss. Instances include the Challenger space shuttle (seven deaths), Zeebrugge ferry sinking (193 deaths) (BBC 2014), King's Cross underground station fire (31 deaths) (Fennell 1988), and Bhopal gas tragedies (3,800 deaths) (Broughton 2005)—to mention a few. This engages human sympathy as well as socio-political consequences (Weir 1996). As a result, these involve a perceived necessity to apportion blame. In this light, organisations instantaneously pursue after-the-event explanations in terms of operator error (Weir 1996) because it is a cheap and easy approach in comparison to inviting systemic investigation in a resource constrained environment, which might encounter time, money and political constraints (Dekker 2006). Also, admission of systems failure opens up the organisation to the charge of corporate manslaughter. In this way, 'blaming operators and protecting the interests of designers' also becomes a cause of future system failures (Horlick-Jones 1996). One direct consequence of the blame game is that it hinders organisational learning and increases the likelihood that human errors and mistakes will occur in future. To counteract this, Horlick-Jones (1996) proposes a 'no blame culture', much like Reason's 'safety culture'.

The systemic approach: Dekker (2003, 2006), a cognitive systems engineer, argues that so-called human error flags an opportunity to investigate systemic problems. According to Dekker, systems are not safe, but people make them safer through their practices, experiences and reflection. Accidents are not seen as abnormal in this approach, rather they are "structural by-products of a system's normal functioning" (Dekker 2006: 17). Therefore, system failures deserve systemic investigation in order to draw relevant lessons and become more resilient.

All these studies shed new light on this research. In the context of this research it is argued, systems can also fail due to the *problems of coordination, communication* (Weick 1990) and *conflicting world views*. Unlike high risk systems discussed above, the components of systems failure are built in the context of linear systems, such as disaster management to understand deaths in disasters. These components are discussed after presenting three interconnected assumptions for systems failure which are: interdependencies of systems, disaster management as a socio-technical system, and a disaster climate is an opportune time to observe the manifestation of these two.

Interdependencies of systems: According to systems thinking the domain of disaster risk management can be understood as natural,[9] human[10] and technological systems[11] (Smith and Petley 2009; Tanaka 2015). In reality, these systems are interconnected. Human activities such as rapid population growth, especially in disaster-prone areas and continued mass urbanisation, much of which is unplanned and unsafe (Department for Foreign and International Development (DFID), 2013) both exacerbate the effects of natural weather phenomena by contributing to global warming and climate change (Gillies 2014; Intergovernmental Panel for Climate Change (IPCC) 2007, 2012; Smith and Petley 2009; UNDP 2007; UN 2015). Human systems are then an integral part of ecological or natural systems (Vickers 1983).

The state-of-the-art technologies for weather forecasting, engineering structures to contain hydro-meteorological risks and international strategies and national policies/programmes for disaster risk management are the combinations of hard and soft systems developed by the human minds to minimise disaster risks. In the 'hierarchy of systems complexity' (Checkland 1981; Jenkins 1969), Human Activity Systems (H.A.S) or human systems are at the apex (Checkland 1981). Therefore, natural, social and technological, "are human systems since they are distinguished by human minds and judged to be acceptable by their correspondence with human standards" (Vickers 1983: 210).

[9]According to Checkland (1981: 110), natural systems are: "Physical systems [which] apparently make up the universe. These range from the subatomic systems of atomic nuclei as described by physics and the living systems observed on earth to galactic systems at the other extreme. All these are natural systems, systems whose origin is in the origin of the universe […]".

[10]Human systems are part of social systems. According to Vickers's (1983: 216), human systems are relationship maintaining systems that come "into being by their actions and their experiences". These systems are highly political, another man-made element (Tanaka 2015; Vickers 1983). They are also by far the most complex systems (Vickers 1983).

[11]Engineered systems, on the other hand are technological systems. Examples include forecasting and early warning systems and structural mitigation measures. Technological systems are constructed by humans through science (Waring 1989), but technology cannot exist on its own. Both human activity and engineered systems exist in conjunction with each other. Emery (1993) explains this phenomenon as socio-technical systems. Socio-technical systems comprise the 'technological', which is the work and procedural activities that are undertaken, and the 'social', which relates to the "social structure consisting of the occupational roles that have been institutionalized in its use" (Emery 1993: 296).

Socio-technical disaster management system: Traditionally disaster management is understood as a continuum of interlinked activity; it is not a series of events which start with each disaster occurrence, rather it involves the composition of post disaster review, results of exercises of simulations, prevention, mitigation, preparedness, disaster impact, response, recovery (restoration, rehabilitation, reconstruction), and development (Carter 1999). "Disaster management processes are enacted once the immediacy of the disaster event has become evident and resources and capacities are put in place with which to respond prior to and following impact. These include the activation of early warning systems, contingency planning, emergency response (immediate post-impact support to satisfy critical human needs under conditions of severe stress), and, eventually, recovery" (IPCC 2012: 35). Due to the Hyogo Framework for Action and currently the Sendai Framework, the concept of disaster management has changed—from traditional disaster management (top down, technical, exclusion of communities at risk) to an alternative disaster risk management (inclusive of all aspects of risk reduction, disaster preparedness, immediate relief, rehabilitation and long term construction) and most recently disaster risk governance (UN 2005; 2015). However, there still exists ideological gaps in conceiving disaster management as a socio-technical disaster management system, one in which humans and technology interface. See Fig. 2.1 on Socio-Technical Disaster Management System.

In socio-technical disaster management system actors, organisations and technology are interdependent but these interdependencies are less understood in linear systems because they are spatially separated (Weick 1990). This is illustrated whilst developing the components of systems failure, which are coordination, communication and world views related to early warnings and their dissemination. When the system's interdependencies are not understood fully by the relevant actors, the system fails (Weick 1990) in a 'disaster climate' with a devastating consequence of human losses. This leads into the third assumption of a 'systems failure'.

Disaster climate: Of all the climatic hazards,[12] tropical storms/cyclones and coastal flooding[13] are notorious for taking more human lives (Dilley et al. 2005; Haque et al. 2011; Kapur 2010; Nathan 2009). Most of the causalities in these hazards occur at the last phase of disaster preparedness and early phase of response (Prizza 2007). Any deaths[14] caused by the direct impact of these disasters are called

[12]Climatic hazards include flood, cyclone, drought and localised storms (Burton et al. 1993).

[13]Tropical storms are "heavy rains followed by tropical storms. They are also one of the most common causes of floods. Storms form over the warm waters of the tropics. These storms are full of moisture. Under the right conditions these giant storms move towards the land, causing a heavy rainfall. This heavy precipitation causes the streams and rivers to overflow leading to inland floods […]. Coastal flooding usually occurs as a result of severe storms, either tropical or winter. Ocean waves intensify on the open ocean, and these storms make surface water much choppier and fierce than normal. Raging winds can create huge waves that crash on unprotected beaches" (Modh 2010: 6).

[14]Death is defined as 'number of people who lost their life because of the event happened' (Integrated Research on Disaster Risk 2015: 9). 'The number of deaths is the sum of direct and the

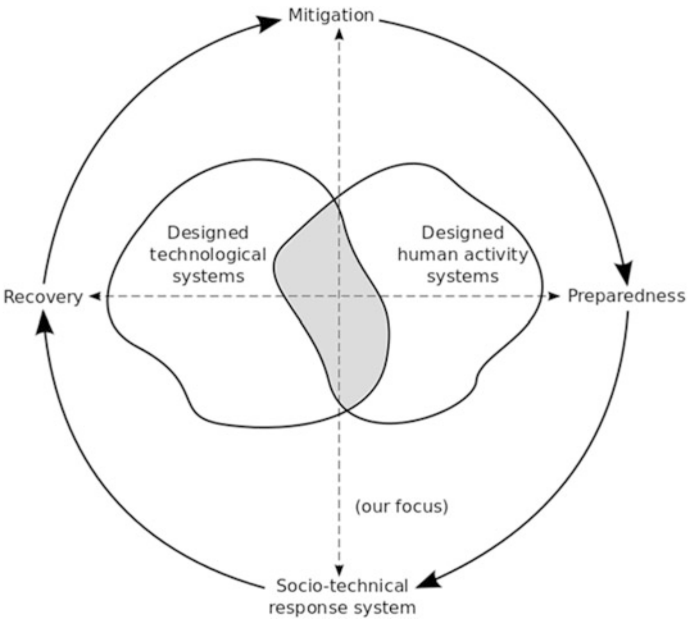

Fig. 2.1 Socio-technical disaster management system. (Produced by author)

'primary deaths' and as evident in the case of Odisha, these deaths are far more widely reported than 'secondary deaths' (Integrated Research on Disaster Risk 2015; Ray-Bennett 2010). Secondary deaths are a consequence of injury or morbidity arising from the impact of disasters. These are the most contentious deaths (Ray-Bennett 2010).

Although disaster management is a continuum of interlinked activity, disaster managers and practitioners understand this involving four phases of mitigation, preparedness, response and recovery[15] (see Fig. 2.1) (Comfort et al. 2004; Miles 2012). Since most of the casualties occur at the last phase of preparedness and early

(Footnote 14 continued)

indirect deaths. The number of delayed indirect deaths is generally excluded. The number of deaths does not include missing persons' (Integrated Research on Disaster Risk 2015: 9).

[15]Mitigation is understood as "The lessening or limitation of the adverse impacts of hazards and related disasters" (UNISDR 2009a: 19); preparedness is understood as "The knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions" (UNISDR 2009a: 21); recovery as "The restoration, and improvement where appropriate, of facilities, livelihoods and living conditions of disaster-affected communities, including efforts to reduce disaster risk factors" (UNISDR 2009a: 23); and response [our emphasis] as "The provision of emergency services and public assistance during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected" (UNISDR 2009a: 24).

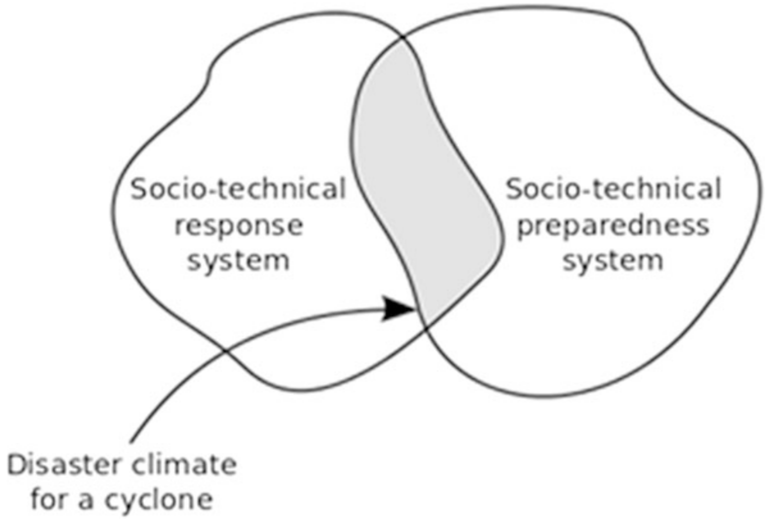

Fig. 2.2 Disaster climate for a cyclone. (Produced by author)

phase of response for the chosen hazards, preparedness and response phases are conjoined. The intersection of these phases make that particular moment in time the most dynamic phase. This phase involves *uncertainties* about the nature of the hazard, as well as conditions conducive to poor decision making. Human actions, decisions for evacuation and the like, communications (strengths and limitations of organisational vulnerability and resilience) and the early warning systems all play a crucial role in avoiding deaths in this dynamic phase. Leadership, timing and readiness are other important factors in this phase. The conditions in this dynamic phase are referred as the 'disaster climate'. See Fig. 2.2 on disaster climate.

The disaster climate occurs as the hazard appears with the potential to affect not just the people who are at risk, but also actors, organisations, infrastructure, ecosystems and communication. The extent of these impacts will also vary both locally and spatially. In such a climate, the first responders begin to operate under an incident management system (Comfort et al. 2004; GoO 2014a, b; Miles 2012). This phase is typically 48 h prior to the landfall of a cyclone (Kolen and Helsloot 2012). During the landfall of a cyclone, response is usually very difficult (Kalsi 2003; Kolen and Helsloot 2012). In such a context, the chances of safety failure are also high. This is illustrated through the mode of coordination and communication failures later in this chapter.

Disaster management is then a highly complex socio-technical system. The complexity of this system is played out through the network space (Latour 2005) of actors and organisations in a disaster climate. This network space includes disaster management organisations, actors, doctrines, policies, culture, and world views at the interface with technology.

2.6 Components of Systems Failures

Having discussed a few assumptions of systems failure, this section discusses the three inter-connected components of systems failure.

2.6.1 Coordination Failure

Disaster management organisations, such as primary, secondary and tertiary, undertake a myriad of activities; it is not possible to track them all. For the purpose of this research, the focus is on coordination problems in a disaster climate.[16] Disaster climate, offers a 'window of opportunity' to identify uncoordinated activities and greater opportunities to learn lessons. Coordination studies have focussed on coordinating human personnel, the division of labour by function (Prizza 2007) and stakeholder partnerships (Chatterjee et al. 2010). In the context of this research, coordination of a flow of 'core information' in order to save lives during disasters, is focussed upon.

Core information is early warning information and constitutes the near-real-time information about the impact of an event. This information is largely generated by meteorologists and meteorology offices using early warning systems.[17] The interpretation of this core information involves a complex interaction of humans and technology (Alexander 1993). Meteorologists use many different tools to generate early warnings for different types of hazards. For climatic hazards (such as cyclone and flooding), geographic information systems (Boehnert 2009) and remote sensing are widely used (Herrmann 2009). These tools are a product of the information age[18] (Alberts and Hayes 2003) and are able to predict the formation of cyclonic depressions as well as provide almost real time tracking of the landfall of a cyclone inland (Kalsi 2003; Srivastava 2009). Core information is valuable to avoid unnecessary deaths and also increase the efficacy of the response system (Comfort et al. 2004).

In this context, problems of coordination can occur when there is a lack of core information. For example, prior to the Indian Ocean Tsunami in 2004, there was no early warning system in place to monitor the Indian Ocean water surface. As such,

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[16]The author is inspired by Hayek's idea of inter-temporal discoordination (Garrison and Kirzner 1987). Whilst exploring the coordination problem, he emphasised looking at inter-temporal discoordination of economic activities in crisis. This was because it is not possible to track the myriad economic activities that individuals and organisations undertake in everyday life.

[17]UNISDR (2009a) defines early warning systems (EWSs) as: "The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss".

[18]According to Alberts and Hayes (2003), information age is the successor to industrial and post-industrial ages.

there was no core information for the Category 1 and 2 responders to rely on. The consequence of this was a death toll of more than 225,000 people (Channel 4 2015; Romo-Murphy et al. 2011). In the words of Kofi Annan in 2006:

> If an early warning system had been in place when the tsunamis of 26 December 2004 struck the Indian Ocean region, many thousands of lives could have been saved. That catastrophe was a wake-up call for governments and many others about the role early warning can play in avoiding and reducing the human and physical impacts of natural hazards (UNISDR 2009b: 62).

The lack of core information can blind a response system with the potential to hamper efforts to save lives (Comfort et al. 2004).

The problem of coordination is also closely connected to decision making. Decision making is both a cognitive and social process at the interface of technology in a disaster climate. It is a social process because the knowledge of core information can be a political tool for some interest groups (Alberts and Hayes 2003; Herrmann 2009). The early warning systems are often nestled in bureaucratic units; "embedded within larger bureaucratic units which are themselves embedded within even larger bureaucratic units" (Herrmann 2009: 23). Lifesaving information can be power and information received by one special interest group such as a government ministry for instance since receiving such information ahead of others can be politically very rewarding (Herrmann 2009). For example, the US AIDs Famine Early Warning Systems Network (FEWS Net) warned of an impending crisis in the Horn of Africa as early as August 2010. This was about seven months prior to the drought crisis in 2011, yet the decisions and actions were still delayed for political reasons (Aalst et al. 2013; Global Emergency Group undated). In this context, the core information was available but the decision to develop the response system was hampered by bureaucracy and a lack of political will (Herrmann 2009).

The decision to coordinate 'core information' can also be hindered by a culture of complacency (Carnegie Foundation expert panel members, Acton and Hibbs 2012), poor administrative structures (Chatterjee et al. 2010; UNISDR 2006) and a lack of adaptive leadership amidst the convoluted roles and many actors present in a DRR climate (multi-stakeholder and multi-sectoral approach) (Aalst et al. 2013; Global Emergency Group undated; Lalonde 2011; Prizza 2007).

Second, looking at decision making from a cognitive perspective, coordination problems can arise under conditions of 'uncertainty' (Kolen and Hesloot 2012). Uncertainties and ambiguities are inevitable when dealing with complex problems (Grint 2008). For example, although early warning systems have greatly advanced, it is still not possible to provide exact forecasts of the landfall of a tropical cyclone or exact predictions of flooding.

> Although the development from a tropical depression into a tropical cyclone usually occurs in 12 to 24 hours, 15 percent required more than 48 hours, and other are reported to undergo formation in less than 12 hours […] [based on temporal disturbances] (Kalsi 2003: 49).

In such uncertainties, decision makers and practitioners could be left without "a reliable warning of a potential threat with enough lead-time to take appropriate evasive action" (Herrmann 2009: 14). In such a dynamic situation, decision makers

(Category 1 and 2) have to cope and react with limited information and uncertainties about potentially fatal conditions.

Some key uncertainties may include assessing potential impacts once the disaster has been predicted, assessing who should be warned, about what and how (Alexander 1993), assessing whether to order a mass evacuation, where to, how, when and using what mode of transport (Kolen and Hesloot 2012), assessing the health, safety and security of evacuees in emergency shelters (Rashid and Michand 2000; Ray-Bennett 2009b) and assessing when to cease warnings (Kalsi 2003; Kolen and Hesloot 2012). In the recovery phase, decisions are made about whether to review, test and modify the system's functionality (both hardware and personnel) in order to address lessons identified (Alexander 1993).

2.6.2 Communication Failure

It is also argued that systems can fail due to deficient communication. According to Anderson and Goolishian (1988), human systems are communicative systems. This communicative sub-system is socio-cultural and is organised 'according to role and structure', that exist in the 'domain of meaning' (Anderson and Goolishian 1988: 187). Human systems are "language-generating, meaning-generating systems engaged in an activity" (Anderson and Goolishian 1988: 188). One can view the early warning systems as language-generating and meaning-generating systems whose objectives include "detection and warning, communication and response" (Kalsi 2003: 68). The relevant actors in a socio-technical disaster management system generate core information at the interface with technology. This technical information is then interpreted in order to communicate across actors and organisations with the aim of supporting a response system. The relevant actors are then generating, as well as communicating, core information between and across actors in order to minimise deaths in the at-risk communities. Through this process, the first responders make sense of this core information and develop an appropriate disaster response (Arnoldi 2001). As such, core information and the disaster response are tightly coupled. Loose coupling (either due to the non-availability or miss-interpretation of the core information) will lead to an ineffective response (Hanai 2014).

Luhmann (1993, 1999) also emphasised the importance of communication in social systems. To him, communication is not just 'a direct transmission of meaning or information between persons', rather it is a closed system in relation to which the persons communicating belong to the environment. According to Luhmann (1999), society and its sub-systems consist of communication only and there is nothing 'social' outside this. The domain of sub-systems also consists of communication and the boundary of these sub-systems 'is the boundary of its observation' (Arnoldi 2001). In this light, the language-generation and meaning-generation of the early warning systems happen within the boundary of disaster risk management.

Communication is then *everything* in a disaster management system. Without communication between the relevant actors, actors to technology and likewise, the function of this sub-system to reduce societal loss and damage from disasters will collapse. This is explained once again through the flow of the 'core information' generated by the early warning systems. The flow of core information can fail for a number of reasons. The most relevant in the context of this research are physical disruption of the early warning systems and the communicating devices, hierarchy and the (in)accuracy of the information.

Physical Disruption: In the information age, disaster management organisations, including the meteorological offices, use a number of information and communication tools or devices and social media to communicate, exchange and share core information amongst themselves and with the at-risk population (Alberts and Hayes 2003; Moore and Verity 2014; Srivastava 2009). Some of these include telephone, e-mail, satellite phone, mobile, TV, radio, newspaper, paging devices, twitter and the Internet. These communication devices are central to improving the capacity of the first level responders (Comfort et al. 2004), as well as that of the at-risk population (GIZ 2012; Harun-Al-Rashid 1997; Moore and Verity 2014; UNISDR 2006). However, a random failure of the communications networks or of power supply caused by a disaster could significantly damage the flow of information between organisations and with the people at-risk (Srivastava 2009).

Disaster management systems are underfunded worldwide. The first level responders often lack in human resources, budgets and communication devices which are essential for developing effective response systems. According to Aid Data, of the total US$4.5 trillion for developmental assistance, only 2% was spent on disaster related activities between 1980 and 2009 (Aalst et al. 2013). Of that 2%, only 3.6% was spent on disaster prevention and preparedness. Even when core information can reach the first responders, budgetary constraints mean they may lack the resources to respond. As such, core information can be constricted by both structure and context (Comfort et al. 2004).

Hierarchy: Communication can fail in a disaster climate due to rigid hierarchical systems. "In rigidly hierarchical systems, there are overt barriers to the free flow of information, even when that information is of a kind that is crucial for effective managerial decision-making" (Weir 1996: 119). These overt barriers can manifest due to a system's reliance on traditional chain of command (C) structures where decision making is centralised and the leader in charge is effectively responsible for:

> using available resources, planning the employment of, organizing, directing, coordinating, and controlling [military forces] for the accomplishment of assigned missions. It also includes the responsibility for health, welfare, morale, and discipline of assigned personnel (Joint Chiefs of Staff Publication 2003; quoted in Alberts and Hayes 2003: 14).

Such a system creates a 'mind-set' which disables imagination, dynamism and foresight (Masys et al. 2014; Weick 1990). Rigid hierarchical systems also enable the possibility of core information either evaporating or getting delayed in the structures of human built organisations. For example, in the case of Fukushima nuclear accident, The National DIET of Japan reported (2012: 38):

> The accident was the result of Tokyo Electric Power Company's (TEPCO) failure in preparing against earthquakes and tsunamis, despite repeated warnings about the potential for such catastrophes. Although TEPCO had reviewed possible countermeasures for the kind of events that subsequently transpired, it postponed putting any measures into place for the other events, using the scientific improbability of such events as an excuse.

Inaccuracy of information: Inaccuracy of the core information can lead to systems failure. This inaccuracy can stem from different frames of reference used by professional groups (Weick 1990; Weir 1996). Professional groups use specialist jargons which are often the outcome of strong vertical divisions between themselves. Some of these divisions between the professional groups are discussed in the next section on world views. Government, non-government and popular media use different forecasting terminology when warning the public and private businesses (GIZ 2012; 2015; Herrmann 2009). These warnings are often confusing. They also differ distinctly from the indigenous early warning systems and practices (GIZ 2012; Herrmann 2009; Romo-Murphy et al. 2011). The early warning systems can also lack in providing "a reliable warning of a potential threat with enough lead-time for recipients to take appropriate evasive action" (Herrmann 2009: 14). In such a context, the "problem with early warnings boils down to the common difficulty of perception versus reality" (Herrmann 2009: 14).

Of equal importance is the matter of 'trust' (Morgner 2013) between the secondary organisations who are generating and cascading the core information and the end users. If the core information generated is often inaccurate, this will lead to mistrust in the system and potentially fatal consequences. Also, communication that does not specify the actions required to save lives will be futile. Likewise, a response without core information will be blind in response. Both of these problems can cause deaths and systems failure in a disaster climate.

2.6.3 World Views

Systems can also fail due to conflicting world views. Under the aegis of UN's disaster risk reduction (DRR) framework, disaster management is a combination of early warning practitioners, Category 1 and 2 responders, gender and disaster risk reduction specialists at international, national and local levels—to mention a few. These actors have their own world views or *Weltanschauung* as how best to avert disaster risks. Some of the world views of the disaster risk reduction, vulnerability and gender studies were discussed earlier in this chapter in order to explain why deaths occur. Strategies and targets emanate from the world views that these actors adopt. As such, examining the world views of actors is extremely important in this research.

A world view is a "complex set of perceptions, attitudes, values and motivations that characterise an individual or group" (Waring 1989: 12). It is also a kind of perceptual 'window' or 'tinted spectacles' through which each of us interprets the world (Checkland 1981; Waring 1989). It encapsulates the "notion that our experiences of the world are mediated or interpreted in terms of our purposes, knowledge, values, and expectations etc., which have developed in particular ways through our previous experiences" (Mingers 1980: 6). Past experiences and world views shape mental models (Mingers 1980) which could either be detrimental (as we saw in the case of Fukushima) or an enabler for an organisation to learn (Senge 1990).

It is argued here that the problems of coordination and communication are tightly coupled with the conflicting world views of the different actors and organisations of the disaster management system. One of the consequences of these subjective world views is a lack of an 'overall objective' or a 'goal' (Jenkins 1969) to avoid deaths. In the context of this research, lack of an objective is rather a lack of input into the system to reduce 'deaths' and this is demonstrated below.

Category 1, 2 and Early Warning Practitioners: Currently the generation and dissemination of core information by meteorologists is done in a gender neutral way. They do not target 'at-risk' community as their primary end user. Instead their target group includes decision makers (Category 1 and 2), media, businesses such as insurance companies, the aviation sector and grain producers—to mention a few (Glantz 2009). The purpose is to communicate effective warnings for current and future threats. This research in Odisha had similar findings. However, some discretion is left with the Category 1 and 2 responders to decide who they want to warn and how—as observed in the case of Odisha which will be discussed in the subsequent chapters.

Disaster Risk Reduction Advocates: Much like its predecessor the Hyogo Framework for Action, the Sendai Framework emphasises the importance of early warnings 'that are people centred' (UN 2005: 4–5, iid.9; UN 2015; UNISDR 2006). People centred approaches are highly useful but at the same time the concept of 'people' raised by the UN requires further examination. Emphasis on people or humans has the potential to assume gender-neutrality, which can "often be an expression of the masculine in which the gender dimension can be overlooked, hence providing only a partial understanding of [human security] issues", according to Hudson (2005: 157).

People centred approaches may also be dubbed as the 'whole community approach' or 'risk reduction approach' and they can often overlook the needs of vulnerable groups, including women and men during disasters (Ikeda 2009; Ray-Bennett 2016a). In this light, this can be considered as an *omission* in the disaster risk reduction framework. Omissions are the by-product of latent errors. They are "the failure to carry out some of the actions necessary to achieve a desired goal" (Reason 1990: 184).

Gender and Disaster Advocates: In January 2005, the Hyogo Framework mainstreamed gender into all "disaster risk management policies, plans and decision making processes, including those related to risk assessment, early warning, information management, education and training". More concretely it mainstreamed gender into two Priorities for Action including Early Warning (Priority 2) and Knowledge Management and Education (Priority 3) (UN 2005). This event is considered as a hallmark for the gender and disaster advocates. It also marked a process of converging two world views—one of the disaster risk reduction community and the other of the gender and disaster community. Currently, there is a paucity of research in assessing whether gender mainstreaming has actually succeeded in reducing men and women's disaster risks and vulnerability.

Gender mainstreaming studies, in general, pursue two agendas. The first agenda is integrating a gender approach into existing policies/programmes through gender equality and equity. This is known as integrationist approach. The second agenda is to assess women's empowerment inside and outside an organisation through structural change. This is known as transformative or agenda setting approach (Jahan 1995; Moser and Moser 2005; Porter and Sweetman 2005; Riley 2004; Tiessen 2004). Nevertheless, this approach has limitation in the context of this research. Although the current agendas (equality/equity and empowerment) are highly important in everyday life of the poor and vulnerable, they lack in prioritising the agenda of avoiding deaths of the vulnerable groups in disasters. As such, they too commit a latent error of not prioritising the agenda of directly avoiding women, men and children's deaths in disasters.

Having presented the framework for systems failure, the next two chapters present the case of the Super-Cyclone of 1999 and Cyclone Phailin of 2013. In doing so, the analytical advantages of systems failure are discussed.

References

Aalst MV, Kellett J, Pichon F, Mitchell T (2013) Incentives in disaster risk management and humanitarian response: background note for world development report. Overseas Development Institute, London

Acton JM, Hibbs M (2012) Why Fukushima was preventable. The Carnegie Papers. http://carnegieendowment.org/files/fukushima.pdf. Accessed 6 Jan 2014

Alberts DS, Hayes RE (2003) Power to the edge: Command, control in the information age. CCRP Publication Series. www.dodccrp.org. Accessed 6 Feb 2014

Alexander D (1993) Natural disasters. UCL Press, London

Anderson H, Goolishian HA (1988) Human systems are linguistic systems: preliminary and evolving ideas about the implications for clinical theory. Fam Process 27:371–393. doi:10.1111/j.1545-5300.1988.00371.x

Ariyabandu MM (2009) Sex, gender and gender relations in disasters. In: Enarson E, Chakrabarti PGD (eds) Women, gender and disaster: global issues and initiatives. Sage Publications, New Delhi

Ariyabandu MM, Wicramasinghe M (2003) Gender dimensions in disaster management: a guide for South Asia. ITDG South Asia Publication, Colombo

Arnoldi J (2001) Niklas Luhmann: an introduction. Theory Cult Soc 18(1):1–3. doi:10.1177/02632760122051607

Aus Aid (2014) Women's and children's health in emergencies. Aus Aid. www.ausaid.gov.au. Accessed 17 Feb 2014

Bacon CM, Sundstrom W, Stewart IT, Beezer D (2017) Vulnerability to cumulative hazards: Coping with the coffee leaf rust outbreak, drought, and food insecurity in Nicaragua. World Dev. 93(May):136–152. http://dx.doi.org/10.1016/j.worlddev.2016.12.025

Bankoff G (2001) Rendering the world unsafe: "Vulnerability" as western discourse. Disasters 25 (1):19–35. doi:10.1111/1467-7717.00159

Barnshaw J, Trainor J (2007) Race, class and capital. In: Brunsma DL, Overfelt D, Picou JS (eds) The sociology of Katrina: perspectives on a modern catastrophe. Rowman and Littlefield Publishers Inc, New York, pp 91–106

BBC (2014) Zeebrugge disaster: Seaford's Jane Hind tells of family loss, 18 Aug. http://www.bbc.co.uk/news/uk-england-28785434. Accessed 4 Jan 2016

Blockley DI (1996) Hazard engineering. In: Hood C, Jones C (eds) Accident and design: contemporary debates in risk management. UCL Press, Oxon, pp 31–39

Boehnert H (2009) Geographic information systems. In: Glantz MH (ed) Heads up!: early warning systems for climate-water-and weather-related hazards. United Nations University Press, Paris, pp 7–10

Bradshaw S, Fordham M (2013) Women, girls and disasters: a review for DFID. Department for International Development, London

Broughton E (2005) The Bhopal disasters and its aftermath: a review. Environ Health 4(2005):4–6. doi:10.1186/1476-069X-4-6

Bryant E (2005) Natural hazards, 2nd edn. Cambridge University Press, Cambridge

Bunge M (1977) General systems and holism. Gen Syst 22:87–90

Burton B, Kates RW, White GF (1993) The environment as hazard, 2nd edn. The Guildford Press, New York

Cannon T (1994) Vulnerability analysis and the explanation of "natural disasters". In: Varley A (ed) Disasters, development and environment. Wiley, New York, pp 14–30

Carter WN (1999) Disaster management: a disaster manager's handbook. Asian Development Bank, Manila

Chakravarti U (2003) Gendering caste: through a feminist lens. Stree, Calcutta

Chambers R (1989) Editorial introduction: vulnerability, coping and policy. IDS Bull 20(2):1–7. doi:10.1111/j.1759-5436.2006.tb00284.x

Channel 4 (2015) Tsunami: ten years. ITV broadcast on 10 January 2015

Chatterjee A, Gupta D, Jain N (2010) Coordination of disaster response: potential and challenges from Indian experiences. Knowledge Communication on Children in India. http://www.redr.org.in/uploads/Coordination_of_Disaster_Response.pdf. Accessed 10 Feb 2015

Checkland P (1981) Systems thinking: systems practice. Wiley, Chichester

Checkland P (1985) From optimizing to learning: a development of systems thinking in the 1990s. J Oper Res Soc 36(9):757–767. doi:10.1057/jors.1985.141

Comfort LK, Ko K, Zagoreck A (2004) Coordination in rapidly evolving disaster response systems: the role of information. Am Behav Sci 48(3):295–313. doi:10.1177/0002764204268987

Davis I, Gupta SP (1991) Technical background paper. In: Bank Asian Development (ed) Disaster mitigation in Asia and the Pacific. Asian Development Bank, Manila

Dekker S (2003) Accidents are normal and human error does not exist: a new look at the creation of occupational safety. Int J Occup Saf 9(2):211–218. doi:10.1080/10803548.2003.11076564

Dekker S (2006) The field guide to understanding human error. Ashgate, Surrey

de Senarclens P (1997) How the UN promotes development through technical assistance. In: Rahnema M, Bawtree V (eds) The post-development reader. Zed Books, London, pp p190–p201

DFID (2013) Helping developing countries deal with humanitarian emergencies. DFI, London

Dilley M, Chen RC, Deichmann U (2005) Disaster risk management series. No. 5. Natural disaster hotspots: a global risk analysis. The World Bank Publication, Washington DC

Douglas M (1966) Purity and danger: an analysis of concept of pollution and taboo. Routledge, London

Eklund L, Tellier S (2012) Gender and international crises response: do we have the data, and does it matter? Disasters 36(4):589–608. doi:10.1111/j.1467-7717.2012.01276.x

Emery F (1993) Characteristics of socio-technical systems. In: Trist E, Murray H (eds) The social engagement of social science, vol II. The socio-technical erspective. University of Pennsylvania Press, Philadelphia, pp 157–186

Fennell D (1988) Investigation into the Kings Cross Underground Fire. Department of Transport, Her Majesty's Stationary, London. Available online at: http://www.railwaysarchive.co.uk/documents/DoT_KX1987.pdf. Accessed 4 January 2016

Garrison RW, Kirzner I (1987) Friedrich August Von Hayek. In: Eatwell J (ed) The new Palgrave: a dictionary of economics. Macmillan Ltd, London, pp 609–614

GENI (2014) Multilateral organizations. Global Energy Network Institute. http://www.geni.org/globalenergy/library/organizations/index.shtml#global. Accessed 29 Jan 2015

Gilbert C (1998) Studying disaster: changes in the main conceptual tools. In: Quarantelli EL (ed) What is a disaster? Perspectives on the questions. Routledge, London, pp 11–18

Gillies J (2014) Scientists sound alarm on climate change. New York Times, March 18. http://www.nytimes.com/2014/03/18/science/scientists-sound-alarm-on-climate.html?_r=0. Accessed 18 Mar 2014

GIZ (2012) LFEWS: local flood and early warning system. GIZ Publication, Manila

GIZ (2015) Harmonisation of early warning alert levels. GIZ Publication, Manila

Glantz M (2009) Introduction. In: Glantz M (ed) Heads up!: early warning systems for climate, water and weather-related hazards. United Nations University Press, New York, pp 1–28

Global Emergency Group (undated) IASC real-time evaluation of the humanitarian response to the Horn of Africa drought crisis, Kenya. Interagency Standing Committee, Virginia

GoO (2014a) District disaster management plan 2014–15: Puri District. Emergency Operation Centre, Puri

GoO (2014b) Ganjam disaster district management plan 2014–15. Chatrapur District Emergency Operation Center, Chatrapur

Grey C (2009) A very short fairly interesting and reasonably cheap book about studying organizations, 2nd edn. Sage Publication Ltd, London

Grint K (2008) Wicked problems and clumsy solutions: the role of leadership. Clin Leader I (II):11–15

Hanai T (2014) Landslides hit Japan's Hiroshima, killing at least 36. Reuters, Aug 21. http://www.reuters.com/article/us-japan-landslides-idUSKBN0GK06720140822. Accessed 12 July 2015

Haque E, Zaman M (1994) Vulnerability and responses to riverine hazards in Bangladesh: a critique of flood control and mitigation approaches. In: Varley A (ed) Disasters, development and environment. Wiley, New York, pp 65–79

Haque U, Hashizume M, Kolivras KN, Overgaard HJ, Das B, Yamamoto T (2011) Reduced death rates from cyclones in Bangladesh: what more needs to be done?. Bull World Health Organ 2012(9):150–156. doi:10.2471/BLT.11.088302

Harun-Al-Rashid AKM (1997) The cyclone preparedness programme in Bangladesh. Community based approach in disaster management-I. ADPC, Bangkok

Herrmann S (2009) Remote sensing. In: Glantz M (ed) Heads up!: early warning systems for climate, water and weather-related hazards. United Nations University Press, New York, pp 10–11

Hewitt K (2013) Environmental disasters in social context: toward a preventive and precautionary approach. Nat Hazards 66(1):3–14. doi:10.1007/s11069-012-0205-6

Horlick-Jones T (1996) The problem of blame. In: Hood C, Jones C (eds) Accident and design: contemporary debates in risk management. UCL Press, Oxon, pp 61–71

Hudson H (2005) 'Doing' security as though humans matter: a feminist perspective on gender and the policies of human security. Secur Dialogue 36(2):153–174. doi:10.1177/0967010605054642

Ikeda K (2009) How women's concerns are shaped in community based disaster risk management in Bangladesh. Contemp South Asia 17(1):65–78. doi:10.1080/09584930802624679

Integrated Research on Disaster Risk (2015) Guidelines on measuring losses from disasters: Human and economic impact indicators. Integrated Research on Disaster Risk, Beijing

IPCC (2007) Climate change 2007: synthesis report. IPCC, Switzerland

IPCC (2012) Managing the risks of extreme events and disasters to advance climate change adaptation. In: Field CB, Barros V, Stocker TF, Qin D, Dokken DJ, Ebi KL, Mastrandrea MD, Mach KJ, Plattner JK, Allen SK, Tignor M, Midgley PM (eds) A special report of working

Groups I and II of the intergovernmental panel on climate change. Cambridge University Press, Cambridge

Jahan R (1995) The elusive agenda: mainstreaming women in development. Zed Books, London

Jaspars S, Shoham J (1999) Targeting the vulnerable: a review of the necessity and feasibility of targeting vulnerable households. Disasters 23(4):359–372. doi:10.1111/1467-7717.00125

Jenkins GM (1969) The systems approach. J Syst Eng 1:3–49

Kaiser R, Spiegel PB, Henderson AK, Gerber ML (2003) The application of geographic information systems and global positioning systems in humanitarian emergencies: lessons learned, programme implications and future research. Disasters 27(2):127–140. doi:10.1111/1467-7717.00224

Kalsi SR (2003) Monitoring and forecasting of tropical cyclones and their associated effects. In: Gupta HK (ed) Disaster management. Universities Press, Mumbai, pp 48–84

Kapur A (2010) Vulnerable India: a geographical study of disasters. Sage Publications, New Delhi

Kast FE, Rosenzweig JE (1972) General systems theory: applications for organization and management. Acad Manag J 15(4):447–465. doi:10.2307/255141

Kolen B, Helsloot I (2012) Time needed to evacuate the Netherlands in the event of large scale flooding: strategies and consequences. Disasters 36(4):700–722. doi:10.1111/j.1467-7717.2012.01278.x

Lalonde C (2011) Managing crisis through organisational development: a conceptual framework. Disasters 35(2):443–464. doi:10.1111/j.1467-7717.2010.01223.x

Lass W, Haas A, Hinkel J, Jaeger C (2011) Avoiding the avoidable: towards a European heat waves risk governance. Int J Disaster Risk Sci 2(1):1–14. doi:10.1007/s13753-011-0001-z

Latour B (2005) Reassembling the social: an introduction to actor-network theory. Oxford University Press, Oxford

Luhmann N (1993) Risk: a sociological theory (trans. Barrett R). Walter de Gruyter & Co, Berlin

Luhmann N (1999) Introduction to systems theory (trans. Giligen P). Polity, Cambridge

Masys AJ, Ray-Bennett NS, Shiroshita H, Jackson P (2014) High impact/low frequency extreme events: enabling reflection and resilience in a hyper-connected world. Proc Econ Finan 18 (2014):772–779. doi:10.1016/S2212-5671(14)01001-6

McNeill P, Chapman S (1985) Research methods, 3rd edn. Routledge, Oxon

Midgley G (ed) (2003) Systems thinking: Volume 1: General Systems Theory, Cybernetics and Complexity. London: Sage

Midgley G (2014) An introduction to systems thinking for tackling wicked problems. M.Sc. in Risk, Crisis and Disaster Management Study School, University of Leicester, 29 Sept

Miles R (2012) Empowering emergency responders. In: Bennett S (ed) Innovative thinking in risk, crisis, and disaster management. Gower, Surrey, pp 25–40

Mingers JC (1980) Towards an appropriate social theory for applied systems thinking: critical theory and soft systems methodology. J Appl Syst Anal 7:41–49

Modh RS (2010) Managing natural disasters: hydrological, marine and geological disasters. Macmillan, Delhi

Moore R, Verity A (2014) Hashtag standards for emergencies: OCHA policy and studies brief. United Nations Office for the Coordination of Humanitarian Affairs (OCHA), Geneva

Morgner C (2013) Trust and confidence: History, theory and socio-political implications. Hum Stud 36(4):509–532. doi:10.1007/s10746-013-9281-1

Moser CON, Moser A (2005) Gender mainstreaming since Beijing: a review of success and limitation in international institutions. Gender Dev 13(2):11–22. doi:10.1080/13552070512331332283

Nathan F (2009) Natural disasters, vulnerability and human security: Facing global environmental change. Hexagon Ser Human Environ Secur 4(Part II):103–118. doi:10.1007/978-3-540-68488-6_87

Neumayer E, Plümper T (2007) The gendered nature of natural disasters: the impact of catastrophic events on the gender gap in life expectancy, 1981–2002. Ann Assoc Am Geogr 97 (3):551–566. doi:10.1111/j.1467-8306.2007.00563.x

Perrow C (1999) Normal accidents: living with high-risk technologies, 2nd edn. Princeton University Press, Princeton

Porter F, Sweetman C (2005) Editorial. Gender Dev 13(2):2–10. doi:10.1080/13552070512331332282

Prizza R (2007) The role of coordination in disaster management. In: Pinkowski J (ed) Disaster management handbook. CRC Press, New York, pp 75–96

Quarantelli EL (1977) Disasters: theory and research. Sage Publications, London

Rashid FS, Michand S (2000) Female adolescents and their sexuality: notions of honour, shame, purity and pollution during the floods. Disasters 24(1):54–70. doi:10.1111/1467-7717.00131

Ray-Bennett NS (2009a) Caste, class and gender in multiple disasters: the experiences of women-headed households in an Oriya village. VDM Verlag, Saarbrucken

Ray-Bennett NS (2009b) Multiple disasters and policy responses in pre and post-independence Orissa, India. Disasters 33(2):275–290. doi:10.1111/j.1467-7717.2008.01074.x

Ray-Bennett NS (2009c) The influence of caste, class and gender in surviving multiple disasters in Orissa, India. Environ Hazards 8(1):5–22

Ray-Bennett NS (2010) Multiple disasters and micro-credit: can it reduce women's vulnerability?: the case of Tarasahi in Orissa, India. Disasters 34(1):240–260. doi:10.1111/j.1467-7717.2009.01127.x

Ray-Bennett NS (2016) Exploring the meaning of securitisation for "gender and disaster". In: Racioppi L, Rajagopalan S (eds) Women and disasters in South Asia: survival, security and development. Routledge, New York, pp 277–301

Reason J (1990) Human error. Cambridge University Press, Cambridge

Reason J (1997) Managing the risks of organisational accidents. Ashgate, Aldershot

Riley J (2004) Some reflections on gender mainstreaming and intersectionality. Dev Bull 66:82–86

Rittel HWJ, Webber MM (1973) Planning problems are wicked problems. Policy Sci 4(1973):155–169. In: Cross N (ed) Developments in design methodologies. Wiley, Chichester

Romo-Murphy E, James R, Adams M (2011) Facilitating disaster preparedness through local radio broadcasting. Disasters 35(4):801–815. doi:10.1111/j.1467-7717.2011.01234.x

Samal KC, Meher S, Panigrahi N (2003) Beyond relief disaster mitigation, livelihood rehabilitation and the post-cyclone recovery in Orissa: village level studies in three most cyclone affected districts in Orissa. Nabo Krishna Centre for Development Studies Publication, Bhubaneswar

Sen AK (2003) Forward. In: Farmer P (ed) Pathologies of power: health, human rights, and the new war on the poor. University of California Press, California

Senge P (1990) The leader's new work: building learning organizations. Sloan Manag Rev 32 (1990):7–23

Sivakumar MVK (2005) Impacts of natural disasters in agriculture, rangeland and forestry: an overview. In: Sivakumar MVK, Motha RP, Das HP (eds) Natural disasters and extreme events in agriculture: impacts and mitigation. Springer, New York, pp 1–22

Smith K, Petley DN (2009) Environmental hazards: assessing risk and reducing disaster, 5th edn. Routledge, New York

Srivastava SK (2009) Making a technological choice for disaster management and poverty alleviation. Disasters 33(1):58–81. doi:10.1111/j.1467-7717.2008.01062.x

Tanaka A (2015) Toward a theory of human security. JICA-R1 Working Paper, No 91. JICA Research Institute Publication, Tokyo

The National Diet of Japan (2012) The official report of the Fukushima nuclear accident independent investigation commission. Fukushima Nuclear Accident Independent Investigation Commission (NAIIC), Japan, Tokyo

Tiessen R (2004) Re-inventing the gendered organization: staff attitudes towards women and gender mainstreaming in NGOs in Malawi. Gender Work Organ 11(6):689–708. doi:10.1111/j.1468-0432.2004.00255.x

Toft B, Reynolds S (2005) Learning from disasters: a management approach, 3rd edn. Palgrave Macmillan, Hampshire

TrustOrg (2013) Women in disasters. Thomson Reuters Foundation. http://www.trust.org/spotlight/Women-the-poorer-half-of-the-world?tab=briefing. Accessed 17 Feb 2014
UN (2005) Hyogo framework for action 2005–2015: building the resilience of nations and communities to disasters. In: World conference on disaster reduction, Kobe, Hyogo, Japan, 18–22 Jan 2005
UN (2015) Sendai framework for disaster risk reduction 2015–2030. UNISDR, Geneva. http://www.unisdr.org/we/coordinate/sendai-framework. Accessed 24 June 2016
UNDP (2007) Human development report 2007/08. Fighting climate change: human solidarity in a divided world. Palgrave Macmillan, New York
UNISDR (2006) Developing early warning systems, a checklist. In: Third international conference on early warning. http://www.unisdr.org/we/inform/publications/608. Accessed 14 Jan 2014
UNISDR (2009a) 2009 UNISDR terminology on disaster risk reduction. UNISDR, Geneva. http://www.preventionweb.net/files/7817_UNISDRTerminologyEnglish.pdf. Accessed 2 Aug 2016
UNISDR (2009b) Making disaster risk reduction gender-sensitive: policy and practical guidelines. UNISDR, Geneva. http://www.unisdr.org/we/inform/publications/9922. Accessed 4 May 2012
UNISDR (2015a) Making development sustainable: the future of disaster risk management: Global assessment report on disaster risk reduction 2015. UNISDR, Geneva
UNISDR (2015b) Japan provides early warning example: UN world conference in disaster risk reduction 2015 Sendai Japan. In: Third UN world conference on disaster risk reduction. www.wcdrr.org. Accessed 16 Mar 2015
Varley A (1994) The exceptional and the everyday: vulnerability analysis in the international decade for natural disasters reduction. In: Varley A (ed) Disasters, development and environment. Wiley, New York, pp 1–11
Vickers G (1983) Human systems are different. J Appl Syst Anal 10(1983):3–13
Walker C, Broderick J (2006) The civil contingencies act 2004: risk, resilience and the law in the United Kingdom. Oxford University Press, Oxford
Waring A (1989) Systems methods for managers. Blackwell Scientific Publications, Oxford
Weick KE (1990) The vulnerable systems: an analysis of the Tenerife air disaster. J Manag 16 (3):571–593. doi:10.1177/014920639001600304
Weir DTH (1996) Risk and disasters: The role of communications breakdown in plane crashes and business failure. In: Hood C, Jones C (eds) Accident and design: contemporary debates in risk management. UCL Press, Oxon, pp 114–126
Wenger E (1998) Communities of practices: learning, meaning, and identity. Cambridge University Press, New York
WHO (2002) Gender and health in natural disasters. WHO: gender, equity, human rights. http://www.who.int/gender/other_health/en/genderdisasters.pdf. Accessed 9 December 2014
Winchester P (2000) Cyclone mitigation, resource allocation and post-disaster reconstruction in south India: lessons learnt from two decades of research. Disasters 24(2):18–37
Wisner B, Blaikie P, Cannon T, Davis I (2004) At risk: natural hazards, people's vulnerability and disasters, 2nd edn. Routledge, London
Zaman MQ (1999) Vulnerability, disaster, and survival in Bangladesh: Three case studies. In: Smith O, Hoffman S (eds) The angry earth: disaster in anthropological perspective. Routledge, New York, pp 192–212

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