Chapter 5
Systems Failure Revisited

Abstract This chapter summarises the previous chapters and outlines some of the limitations of systems failure. In doing so, this chapter proposes an emerging tool called 'systems alignment'. Perfect systems alignment is neither proposed nor is it possible in this real world because of people's subjective world views, different frames of reference, unique communication structures, cultures and the like. However, a weaker version of systems alignment, or some accommodation over the issue of reducing death can also lead to positive outcomes, as observed in the case of Cyclone Phailin by designing an overall goal of 'zero casualty at any cost' for the disaster management system. This chapter also outlines some organisational learnings that can take place from the findings of this research as well as some impact for policy and theory change in Odisha and beyond.

Keywords Avoidable deaths · Complex perspective · Coordination · Communication sub-systems · Decision making · Disaster management practices · Hazard · Human and organizational capacities · Justice · Policy · Political leadership · Systems alignment · Theory · Unavoidable deaths · Worldviews

It is argued that most of the deaths in disasters are avoidable. Avoidable deaths are preventable deaths due to advancements in disaster management science and weather forecasting systems; increased sophistication in human-built environments; as well as ongoing economic and policy development worldwide. When avoidable deaths continue to happen, this is event violence. Violence is commenced by the relevant actors and organisations in failing to protect or save precious lives. Deaths in disasters, in this vein, are a case for violation of justice. In the event of disasters, justice is denied to those women, men and children who would have otherwise lived a long life and an accomplished life. In order to promote justice in disasters, three arguments were made. First, human deaths must be identified as a matter of justice; as such they should receive a high priority from the disaster management system by developing a 'goal' to reduce death. Second, problems can be framed, as well as solved, within a disaster management system through support-led processes, such as effective INGO, NGO, community and government organisation

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coordination and communication. Third, it can make room for demands of duty from the actors and organisations involved in protecting lives (Sen 1999, 2009) (Chap. 1).

By engaging with the existing risk and vulnerability perspectives, Chap. 2 aimed to explain why deaths in disasters occur. Risk or the traditional perspective enabled the advantage of understanding the dynamics of geohazards and their effect on humans. The vulnerability perspective on the other hand, helped in explaining why some groups of people are more vulnerable to disasters than others due to their class, gender, age, and race identities. An additional 'complex perspective' is also suggested to explain why deaths continue to occur. 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 was presented in Chap. 2. Systems failure has three inter-connected components: coordination, communication and world views. The analytical advantage of this tool was discussed in light of the two different case studies, Super-Cyclone of 1999 and Cyclone Phailin of 2013 in Chaps. 3 and 4. Table 5.1 exhibits the differences between the two disasters, as identified in the previous chapters while using the analytical tool of systems failure.

5.1 Systems Alignment

Systems failure provided a new perspective to analyse both the cyclones in Odisha. It also identified that systems' failures can be rectified by aligning the systems, which is coined here as 'systems alignment', in order to tackle wicked or complex problems, such as avoiding deaths in disasters. See Fig. 5.1 for the determinants of system alignment. Perfect systems alignment is neither proposed nor is it possible in this real world because of people's subjective world views, different frames of reference, unique communication structures, cultures and the like. However, a weaker version of systems alignment, or some accommodation over the issue of reducing deaths can also lead to positive outcomes, as observed in the case of Cyclone Phailin by designing an overall goal of 'zero casualty at any cost' for the disaster management system. Alignments for coordination and communication were achieved by investing in science and technology related to early warning systems, developing administrative and knowledge network and policy and planning—amongst many. World views were progressed through a culture of disaster preparedness, learning and a strong commitment to reduce deaths. A synopsis of these alignments of coordination, communication and world views in the context of Odisha/India is as follows for the purpose of learning.

Table 5.1 Difference between the Super-Cyclone and Cyclone Phailin (Produced by author)

	Coordination	Communication	World views
Super-Cyclone 1999	No coordination	Only via telephone	Complacent and conservative
	Core information available 48 h ago	Early warning system was under-developed	No goal
	Odisha Relief Code was activated afterwards	The communication system to disseminate information and warnings was under-developed	Lack of leadership
	Response system was reactionary	Limited forecast technology to generate core information	A fatalistic mind-set that hindered evacuation
	No authority to monitor relief and rescue		
	Lack of plan or planning		
Cyclone Phailin 2013	"excellent coordination" (IMD, Director)	Telephone, mobile, hot line, V-Sat, ham radio, fax, e-mail, radio, TV	
	Core information was available 4 days ago (>96 h)	Mike, loud speaker, word of mouth, force	Goal: "Zero Casualty at Any Cost"
	Knowledge and administrative networks developed by the Government of India helped analysing the core information	Early warning system was well developed	Strong, strategic and decentralised leadership
	Response system was proactive	The communication system to disseminate information was well developed	A change of mind-set with a heightened awareness on gender and disaster preparedness
	Numerous authorities/organisations monitored and assisted with rescue efforts	Warnings were disseminated very well, even by text and radio	Improved institutional arrangements for disaster management
	District Disaster Management was in place as well as the Disaster Management Act 2005	Improved infrastructure (road, cyclone shelters, public buildings)	
		New space-based technology the INSAT Satellite—3D	
		High power computer systems	

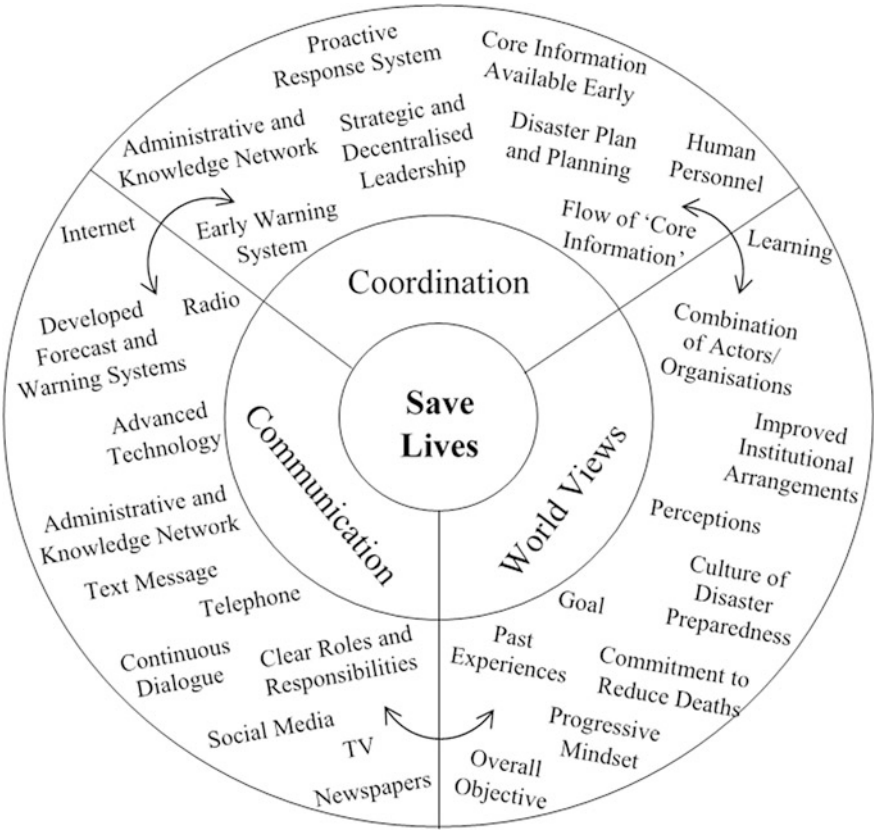

Fig. 5.1 Determinants of systems alignment to save lives (Produced by author)

5.1.1 *Enhancing Coordination and Decision Making Processes*

It was argued that when core information is unavailable, all actors are constrained in the coordination of the response. Accordingly, the availability and accessibility of this core information is crucial to rectifying the situation. In India and Odisha, the governments rectified this by investing in modern, up-to-date early warning systems. Investment in science and technology are important means of generating more core information and thereby, enhancing coordination (Alberts and Hayes 2003; UNISDR 2015b) as observed in the case of Odisha. These initiatives are consistent with the development occurring in the Asia Pacific region after the Indian Ocean Tsunami in 2004.[1]

[1]According to the international commitment through the Economic and Social Commission for Asia and the Pacific (ESCAP) Panel on Tropical Cyclones, the World Meteorological

The Government of India began the capacity building process by modernising the Indian Meteorology Department,[2] as well as India's disaster management system in the aftermath of the Super-Cyclone (Planning Commission 2013a). The decision to modernise the Indian Meteorology Department and the disaster management system was facilitated largely by two factors: economic growth and the recognition that India faces losses up to 2% of its GDP due to natural disasters. During the 10th (2003–2007) and 11th Five Year Plans (2007–2012), India's economy grew by 8% (Planning Commission[3] 2013a). In the 12th Five Year Plan (2012–2017), India is considered as the second fastest growing economy in the world. This success helped the central government to make strategic investments in science, technology, policy and planning to counteract the consequences of natural disasters. The strategies were translated into action by adopting two inter-connected components: *knowledge network* and *administrative network* (Srivastava 2009).

To develop the knowledge network, the Government of India established the Earth System Science Observation (ESSO) under the Ministry of Environmental Science in 2006. Earth System Science Observation observes earth systems to

(Footnote 1 continued)

Organization's Regional Specialized Meteorological Centre (RSMC-New Delhi) now issues information four to eight times a day to panel member countries when tropical cyclones form in the Bay of Bengal and the Arabian Sea (Pattie 2009). The panel member countries include: Thailand, Myanmar, Bangladesh, India, Pakistan, Sri Lanka, the Maldives and Oman (Pattie 2009). It is claimed that this core information made available by the World Meteorological Organization was vital to reducing human deaths during the cyclones Nargis in 2008 in Myanmar (Pattie 2009) and Mahasen in Bangladesh in 2013. The UN systems including the World Health Organization, United Nations Environment Programme, United Nations Development Programme, United Nations Food and Agricultural Organization, World Meteorological Organization, United Nations Educational, Scientific and Cultural Organization, United Nations International Strategy for Disaster Reduction, World Food Programme and The Famine Early Warning Systems Network – are now given a special charge by the aforementioned governments to foster awareness and develop the effective use of early warning systems in their institutional jurisdictions (Glantz 2009). In Sendai, the World Meteorological Organization announced more support to governments and others in developing multi-hazard early warning systems (UNISDR 2015b).

[2]Government of India modernised the Indian Meteorology Department by: '(i) commissioning 10 global positioning system stations; (ii) installing nine Doppler Weather Radars besides the existing five Doppler Weather Radars which have improved real time monitoring services; (iii) installing integrated Airport Meteorological Instruments at Mumbai, Hyderabad, Bangalore, Jaipur and Delhi airports; (iv) installing 550 Automatic Weather Stations apart from the existing 125, in addition to installation of 689 Automatic Rain Gauges; (v) commissioning of a set of four High Power Computers with a total installed capacity of 124 Teraflops for global data processing and Numerical Weather Prediction for weather forecasting services. A district-level agro-meteorological advisory service along with a five days in advance district-level weather forecast system, covering all the 555 districts, was launched for farmers in partnership with a number of Central Government ministries and organisations, state-level institutions, private agencies, non-governmental organizations, progressive farmers and the media. Over 3 million farmers have subscribed to receive this information through mobile phones' (Planning Commission 2013a: 254).

[3]The Planning Commission of India has been renamed as Nitiyog by the current Prime Minister, Mr. Narendro Modi.

understand the variability of these systems and to improve the weather forecasting system for hazards (Planning Commission 2013a). It also established India's Space Research Organisation (SRO) under which the Disaster Management Support (DMS) provides near real-time support in the form of imaging and communication satellites for efficient management of disasters in India (Planning Commission 2013a, b). The National Emergency Communication Network (NECN), a sub-communication system, has also been set up with the aim "to interconnect national, state and district Emergency Operation Centres (EOCs) as well as mobile and transportable Emergency Operation Centres which can be deployed at emergency and district situation" (Srivastava 2009: 70). These initiatives were pivotal in the reduction of human deaths during Phailin. Furthermore, the ongoing dialogue created as part of the knowledge network between the Indian Meteorology Department, Earth System Science Observation, India's Space Research Organisation, Central Water Commission, National Geography Research Institute and National Remote Sensing Organisation (Srivastava 2009) led to the generation of effective core information during Phailin, as well as its dissemination to the at-risk population (Director of Indian Meteorology Department, 21 and 22 July 2014, Bhubaneswar).

This national level development was matched with the modernisation of the Indian Meteorology Department in Odisha. The Indian Meteorology Department in Odisha was established in 1948 and was upgraded to a Cyclone-Warning Centre in 1973 after a severe cyclone in 1971 (Barik 2014). In 2002, the Government of India installed a Doppler radar in Paradeep (Indian Meteorology Department/Odisha 2014). Doppler radars monitor rain, wind and observe tropical cyclones (Kalsi 2003). The Indian Meteorology Department in Odisha also "monitors 21 observatories, 37 automatic weather stations, 177 automatic rain gauge stations, 149 rain gauge stations under different schemes, four pilot balloon observatories and 13 cyclone disaster mitigation committee stations across the state" (Barik 2014).

During the interview with the Director of Indian Meteorology Department, the Director said that the state government had agreed to install three additional Doppler radars in Gopalpur, Sambalpur and Baleswar in Odisha (21 July 2014; OSDMA 2011). This should enable them to provide weather updates every 15 min for thunderstorms, heavy rainfall and hail storms. Currently they work closely with the Indian Meteorology Departments in Kolkata, Vishakhapatnam and Patna to get weather updates every 4–5 h depending on the temporal conditions of the wind and cloud. As part of this knowledge network, the Director also mentioned that he interacts with the Indian Meteorology Department in New Delhi everyday via e-mails and telephone. This network between the different branches of Indian Meteorology Department was crucial during Phailin to generate effective core information, as well as coordinate this information across the relevant state disaster management departments in Odisha (Director of Indian Meteorology Department, 21 July 2014; Barik 2014). This knowledge network coupled with high power computing systems (Meteo France International Synergie System) enabled the Director and his Duty Officers to generate almost accurate early warnings during Phailin (Director of Indian Meteorology Department, 21 July 2014; Barik 2014).

According to the Director, their accuracy target is '85–90%' because forecasting can never be 100% accurate. Forecasting can only act as a 'reference'. However, this reference has to be infused with reflection, experience and wisdom of the practitioners. This can be explained in the words of the Director:

> Because of technology we are able to run the models in our office, we have servers, high-speed computers so it can run within 2 hours and generate forecasts of next 3–4 days. I can see this before 12 O'clock and give forecast at 12.30. So I got a reference, for which technology is crucial. Because human knowledge, human mind cannot predict more than 24 hours or 48 hours max. There is a limitation. But, we fully do not depend upon models. We do value additions. We exercise our experience, we add our observational data. But the reference helps. […] We get ideas. Then we look into cloud related weather patterns.
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> **Author: When you say of value addition and experience, I understand that you have been in this job for a long time. Do you have any other practitioners working with you who are equally valuable in generating this knowledge collectively?** Oh yes. They are the Duty Officers […]. They will get trained for minimum 5 years. Each season has different characteristics. They face different types of weather each season. So while working for 5 years, they will learn what has been last year. What could happen this year or could be done or how was that and so on […].
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> **Author: what is the academic background of this Duty Officers?** Earlier they used to have BSc in Physics or Chemistry or Maths. Or some came through promotion, but none through direct recruitment. But now the government has changed the recruitment policy. Duty Officers have to have postgraduates […] in maths, physics […] or meteorology or atmospheric science or geophysics or engineering. **Author: After 5 years, what happens to the Duty Officer?** Some will retire, some will become Sr. Duty Officers. […] We also have other groups such as Observational Groups. They are also scientific assistants […] but are much like entry cadre. They also had BScs like the Duty Officers […] but now this has been changed to postgraduates. […] They observe and whilst taking observations, they will understand what meteorology is? When they get promoted, they will be utilised in different shifts […].
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> (Interview held on 22 July 2014, Indian Meteorology Department, Bhubaneswar).

The Indian Meteorology Department provided an ideal setting to observe the interplay of technology and human wisdom and knowledge. In the inter-disaster period, technology related to forecasting has advanced, and so has the demand for recruiting specialised human experts for these jobs. This new generation of experts will enhance the human-technology interaction, but wisdom and knowledge will still have to be gathered based on reflection-in/on-action and experience[4] (Schön 1983; Weick 1988). The reflective processes that the Duty Officers and the Observational Groups undergo as part of their training are necessary to build an *Auftragssystem*[5] Although *Auftragssystem* and 'power to the edge' are quite similar

[4]Reflection-in-action is based on a rapid interpretation of the situation (Ghaye and Ghaye 1998). It indicates that it commences in the middle of action, whereas 'reflection-on-action' occurs after the event to improve future action (Ghaye and Ghaye 1998; Schön 1983).

[5]This mission systems approach was developed by Adolph Hitler's military in Germany. The essence of this approach is that: "a subordinate commander, a subaltern […] should be trained to a level where he (or very rarely, she) could achieve the tactical goals of superior officers, with or without orders. […] Such a localised system of behavioural guidance makes heavy demands on the

concepts, the latter highlights that information communication tools are important to empower the responders working on the edge. Both of these concepts are useful in supporting the flow of core information in order to develop an effective disaster response system (Reason 1997) or a decentralised localised system so that they are capable of making critical decisions (Grint 2008). However, localised systems are dependent on the quality of the training received from first line of supervisors (Reason 1997).

At the Indian Meteorology Department, it is the Director who performs the supervisory role. He is an Officer from the Indian Administrative Service (IAS).[6] IAS is part of the Indian Civil Service which was established by the British government in colonial times. Currently the Civil Service forms the backbone of Indian government machinery. In addition to IAS, the Indian Civil Service recruits two other types of Officers: Central Services and State Services.[7] These Officers constitute all the major departments which run the state and central administration (UPSC 2015). The incumbents are part of an elite bureaucracy (Benbabaali 2008) and they play a crucial role in preserving national and state unity, integrity and uniform standards of administration by adopting a non-political, non-sectarian, secular outlook (GoI 2008). In the hierarchy of the Indian Civil Service, IAS officers are considered the 'cream' of India (GoI 2008). In this light, the current Director of Indian Meteorology Department is an outstanding individual. He also has a PhD in Meteorological Science. He took up his position in Odisha in 2007. Before that he was posted in Shillong, a north-eastern state of India. Although the author was unable to interview any Duty Officers, his presence, knowledge and experience made a huge contribution during Phailin as compared to the Super-Cyclone. The State Programme Officer of United Nations Development Programme is quoted in this regard:

> IMD (Indian Meteorology Department) played a crucial role. The information provided by IMD and Dr XXX was really precise and really concrete.

(Footnote 5 continued)

personal qualities of the superiors. A prerequisite is an extensive experience of the jobs carried out in the workplace of the conditions under which they are likely to be performed. […] Effective teams capable of operating autonomously when the circumstances demand it, need high quality leaders. This is in turn requires with the organisation invest heavily in the quality, motivation and experience – its first line supervisory" (Reason 1997: 218).

[6]The IAS exam is considered to be one of the toughest exams in India and the success rate is just 0.1% (GoI 2008; UPSC 2015).

[7]Author's other respondents including the three District Emergency Officers, Deputy General Manager of Odisha State Disaster Management Authority and the Deputy Relief Commissioner were recruited through the Odisha State Civil Service exam. Besides this, the District Emergency Officers of Jagatsinghpur and Ganjam had M.Phil. from two prestigious Universities of India (Jawaharlal Nehru University and the Institute of Population Studies in Mumbai) and the Deputy General Manager of Odisha State Disaster Management Authority had a Ph.D. All the respondents were also highly educated.

Developing Policies and Planning for Coordination: To promote an administrative network, the Planning Commission (2013b) outlined several strategies in the 10th Five Year Plan (2003–2007) which included:

i. policy guidelines on preparation of developmental plans;
ii. a multi-pronged strategy for risk management; and
iii. the recognition of a need for planned expenditure on disaster management and preventive measures in addition to the National Calamity Relief Fund.

These strategies were aligned with the UN's Hyogo Framework for Action, which the Government of India ratified in 2005 in Hyogo, Japan. The Government of India also passed the first ever 'Disaster Management Act 2005'- mentioned in the previous chapters. According to this Act, all the Indian states are required to develop a State Disaster Management Policy and Disaster Management Plans in order to decentralise the disaster management system[8] (OSDMA 2012). To facilitate the administrative network further, the Government of India also set up the National Institute of Disaster Management (NIDM) under the Ministry of Home Affairs in New Delhi. National Institute of Disaster Management builds the capacity of state administrators and responders through training and support. It is also geared towards providing support to the planners and practitioners through research (Srivastava 2009). To solidify this administrative network, the Government of India dedicated the 11th Five Year Plan (2007–2012) to disaster preparedness. The 12th Five Year Plan (2012–2017) is also designed to complement the previous initiatives by:

i. setting up early warning systems in all hazard prone areas of India;
ii. building communication networks;
iii. mainstreaming DRR into development activities; and
iv. building the capacity of the at-risk communities and of disaster management organisations.

For this, Indian Rupees 52,839 Crore (approx. GBP 5,562 Million) has been earmarked for the Ministry of Home Affairs (Planning Commission 2013a).

This wider policy change in India also coincided with the state building processes that began under the leadership of Mr. Naveen Patnaik in 1999. Under his direction, the Orissa Sate Disaster Mitigation Authority (later renamed as Odisha State Disaster Management Authority) was established, which helped immensely in co-coordination with local, national and international NGOs and multinational organisations, as well as towards the implementation of disaster preparedness and mitigation measures in the post Super-Cyclone era (GoO 2002; Ray-Bennett 2009; Samal 2003). Odisha State Disaster Management Authority and United Nations Development Programme Office together played a crucial role in building the capacities of the state, district, block and panchayati responders, through training and consultation (GoO 2001; OSDMA 2011). Capacity building training is critical

[8]Until 2005 only Odisha, Gujarat and Maharashtra had state disaster management policies in India.

in developing an effective localised *Auftragssystem* (Prizza 2007; Reason 1997). State Disaster Management Authority has also initiated NGO-GO coordination in the aftermath of the Super-Cyclone. The author had the privilege of attending several of these meetings during the floods of 2003 (Ray-Bennett 2009). Currently the NGO-GO coordination comprises of 22 INGOs, NGOs and UN agencies- together they are known as Inter Agency Group (OSDMA 2011). The Inter Agency Group played a crucial role in disseminating core information during Phailin (Deputy Relief Commissioner, State Programme Officer of United Nations Development Programme, Director of Indian Meteorology Department, 21–23 July 2014, Bhubaneswar). For instance, preparedness meetings were held among various Disaster Response and Volunteer Teams by the International Federation of Red Cross to assist with evacuation and relief (Harriman 2013). Also, State Disaster Management Authority and United Nations Development Programme Office together played a crucial role in building the capacity of the Inter Agency Group, as well as women's micro-credit groups through training and consultation (OSDMA 2011).

In light of these activities, Odisha State Disaster Management Authority is a vital thread that connects and coordinates with the primary, secondary and tertiary organisations and the at-risk communities in Odisha before, during and after disasters. Central to this coordinating process is the strategic positioning of Odisha State Disaster Management Authority. As discussed in Chap. 2, disaster management is a linear system, one in which organisations and actors are spatially separated (Perrow 1999). The Government of Odisha has managed to reduce this spatial separation by positioning Odisha State Disaster Management Authority with the other relevant government departments in one office complex. For instance, the State Disaster Management Authority's office is located a floor above the Special Relief Organisation and the Managing Directors of these organisations sit on the sixth floor of the same building. During the author's fieldwork, the roles of the Managing Director of the Odisha State Disaster Management Authority and the Special Relief Organisation were filled by the same person. This allowed the Director to align the disaster related policies and programmes of these two organisations. However, the Indian Meteorology Department was not located in the same office complex because it required space to host a number of technologies and equipment.

Nevertheless, the distance between Odisha State Disaster Management Authority and Indian Meteorology Department was less than 5 km. The close proximity of the relevant organisations means that the government actors are able to meet often, dine and discuss, talk over tea, and also arrange meetings at a very short notice. This was observed whilst dining with the members of Odisha State Disaster Management Authority, which included the Deputy General Manager. These congregations enhanced agility and communication between the departments and actors for the transmission of the core information prior to Phailin—something that was not possible in 1999. This strategic positioning of Odisha State Disaster Management Authority is then also conducive to promoting both knowledge and administrative networks with regard to disaster management.

5.1.2 Aligning Communication Sub-systems

Overcoming physical disruptions and levelling hierarchies that hinder communication is central to improving the communication sub-system (Chap. 2). Disaster management actors collectively are often spatially separated, as discussed above. They are also spatially separated from the at-risk population. Hence, maintaining the flow of this core information is vital. As mentioned earlier, information communication tools are increasingly used to communicate the core information. Yet, the breakdown of these tools is often inevitable, depending on the magnitude of the hazard (Comfort et al. 2004; Romo-Murphy et al. 2011). Accordingly, primary and secondary organisations must prioritise the securing of communication systems. A number of initiatives are already under-way with the help of space-based technology in this regard.

Space-based technology is considered as a major enabler for disaster management in Europe and the United States.[9] In India too, space-based technology, such as satellite phones and deployable VSAT terminals are now a major enabler for disaster management (Srivastava 2009). More recently, social media tools, such as Facebook, Twitter, Instagram, YouTube and blogs have demonstrated significant value during emergencies for the responders, at-risk population and for bystanders. These digital tools have been proven to give affected "communities a flexible information platform to share local knowledge, transparently document efforts, crowd-verification or eliminate false rumours, and engage in two-way communication with formal emergency response agencies" (Moore and Verity 2014: 3). For example, during the super typhoon Haiyan in the Philippines, Twitter enabled the first responders to engage with the public in real time and this interaction had proven to be very effective for emergency response planning.[10] To facilitate the increasing popularity of social media, the UN's Office for the Coordination of Humanitarian Affairs (OCHA) have standardised three hashtags for emergencies in 2014[11] (see Moore and Verity 2014; MacLean 2015). In Odisha, the role of social media was not emphasised by the responders. Mobile phones, hotlines, e-mails,

[9]Europe's Meteosat Generation Satellite (MSG) and the American National Oceanic and Atmospheric Administration (NOAA) are both responsible for weather forecasting (DLR 2013). As part of the International Charter, 'Space and Major Disasters' DLR's Centre for Satellite-Assisted Crisis Information (ZKI) in Germany played a crucial role in supplying up-to-date satellite images (with the help of TerraSAR-Z and RapidEye) to the Japanese government in the aftermath of the Japan Tsunami in 2011. The satellite images led to the development of maps in order to supply relief forces with useful information immediately (DLR 2013).

[10]"Within the first 48 hours after Super Typhoon Haiyan's landfall, nearly 230,000 tweets were published internationally containing a situationally relevant hashtag. From those tweets, over 600 written messages and 180 images were identified containing actionable information for emergency response planning" (Moore and Verity 2014: 3).

[11]Three hashtags for emergencies are: Early standardisation of the disaster name (e.g., #Fay), how to report non-emergency needs (e.g., #PublicRep) and requesting emergency assistance (e.g., #911US)" (Moore and Verity 2014: 2).

landlines, HAM radios, V-Sat, fax, radio, TV, word of mouth, community level announcement via the village task force—played an important role to maintain inter-organisational coordination, as well as coordination with at-risk community in disseminating the core information.

Disaster management in India (and elsewhere) is largely a government business and government offices and departments are hierarchical and bureaucratic in nature. Rigid hierarchical structures are detrimental to the flow of core information. These structures also promote a rigid mind-set. However, in this information age, these organisations are also under constant public gaze due to the burgeoning media industry and the pressure from NGOs and the UN (Director of the Indian Meteorology Department, 21 July 2014, Bhubaneswar). As a result, the standard operating procedures for a bureaucracy are in flux, and even more so during the dynamic phase of a disaster. In such a context, it was observed that the Government of Odisha leveraged the principles of 'command and control[12]' (C2), 'command, control and communication' (C3), and *Auftragssystem* or a localised disaster management system in order to maintain the flow of core information. Once the core information is generated by the Meteorology Department, Odisha State Disaster Management Authority, The Special Relief Organisation and the District Emergency Officers take ownership of this information and design their responses accordingly for the at-risk population. However, the ability of the actors to generate, disseminate and own the core information as well as develop the requisite response is embedded in the context of *Auftragssystem*. The 'Disaster Management Act 2005' has facilitated this *Auftragssystem* through the devolution of the disaster management system by creating a three-tier administrative structure (national, state and district) as well as Disaster Management Plans for the district, block and village levels.

United Nations Development Programme and Odisha State Disaster Management Authority together played key roles in developing these Plans in 30 districts. These Plans include specific instructions from Odisha State Disaster Management Authority, Special Relief Organisation and District Level Natural Calamity Committee. These Plans are living documents and are updated annually by the District Collectors in association with the Superintendent of Police, Assistant District Magistrates, Emergency Officers and the Line Department Officers. They are updated according to the requirements set by Odisha State Disaster Management Authority and United Nations Development Programme on issues relating to resources, human resources, technology and coordination (GoO 2012, 2014a).

[12]Command and control (C2) is different from the 'chain of command' approach (Alberts and Hayes 2003). The chain of command (C) is a traditional approach where the commander (traditional leader—see Senge 1990) is in charge of decision making. Command usually subsumed control in this approach. In C2, on the other hand, the command and control responsibilities are shared. There is no longer one commander in charge rather a collection of individuals (primary and secondary responders) who are assigned to accomplish a mission. Actions, inactions, active errors, cultures and mental models are of equal importance in the operation of C2 (Alberts and Hayes 2003: 14–15).

The District Disaster Management Plans have also led to a shift from a relief centric disaster management system to a pro-active disaster management system in the districts by prompting: (i) disaster risk assessment and vulnerability analysis; (ii) the identification of disaster prone areas; (iii) the identification of response structures; (iv) developing inventories of resources; and (v) developing standard operating procedures and incident command systems specific to each district (GoO 2013; OSDMA 2011).

The purpose of these District Disaster Management Plans is to help the district administrations (primary responders) and their associated line departments to focus quickly on the essentials of coordinating not just the core information but also decision making, preparedness and response (GoO 2013). These Plans have also led to the development of District Disaster Management Committees (DDMC) which are planning bodies with regard to preparedness and mitigation. District Disaster Management Committees help the District Collector in a disaster climate by: (i) reviewing the threat of disasters; (ii) assessing vulnerability; (iii) evaluating preparedness measures; and (iv) eliciting suggestions for the improvement of District Disaster Management Plans (GoO 2013: 19).

District Control Rooms/District Emergency Operation Centres (DEOC) are set up to align with the State Emergency Operation Centre (SEOP) and the Control Room at the Special Relief Commissioner's Office in the Special Relief Organisation in Bhubaneswar. The State Emergency Operation Centre is equipped with a state-of-art communication network (GoO 2015) in order to remain connected with the National Emergency Communication Network (NECN). Satellite phones and deployable VSAT terminals are major enablers for this (Srivastava 2009). Toll free numbers, 1070 and 1077 have also been installed in State and District Emergency Operation Centres (OSDMA 2011).

The operation of District Emergency Operation Centres is guided by command, control and communication (C3) approach (GoO 2013). As a hub of C3, the District Collector (commander): (i) reviews, monitors and analyses the potency of a hazard along with the District Disaster Management Committee (DDMC); (ii) co-ordinates the relevant line departments; (iii) deploys senior officers to vulnerable locations for rescue and evacuation and establishing a community kitchen; (iv) shares information continuously with the Control Rooms at the Revenue Department, Special Relief Organisation and Odisha State Disaster Management Authority in Bhubaneswar; and (v) implements appropriate actions and activities as part of the disaster management system (GoO 2013: 20). In a disaster climate, this hub becomes an important means of providing direction to the block and village level officials, NGOs and volunteers (GoO 2013). It is also noted that in a disaster climate C3 is an appropriate management style, whereas in 'normal' times it might not be. This command system ensured that the response to Cyclone Phailin was effective. It guided the primary responders' actions and facilitated their sense making processes in an uncertain situation. The outcome of this was an evacuation process that was unprecedented and a dramatic reduction in human loss.

Lastly, the early warning systems that generate core information must be seen as a vital component of disaster management through the lens of a systems approach

(Glantz 2009; Herrmann 2009). When there is a disconnect between the two, responses will be inadequate. This was observed during the drought in the Horn of Africa in 2011 (Aalst et al. 2013; Global Emergency Group, undated). Although the Famine Early Warning Systems Network (FEWS Net) forecast drought in the Horn of Africa about seven months prior to the disaster, the disaster management systems in the at-risk countries took no actions to prepare. Continuous coordination and communication between early warning systems and disaster management systems should enable a systematic response.

Frames of Reference: It is now known that the disaster management system is a conglomeration of different professional groupings and actors. It is also a system that is highly reliant on technology, as we have observed above. Also, it is observed that actors within this socio-technical system adopt different frames of reference. In this light, weak forms of organisation of the actors could potentially lead to systems failure (Chap. 2). Therefore, it is pivotal that the interconnections between organisations and actors are fully acknowledged. One way to do this is to synchronise early warning systems. Government, non-government and popular media use different forecasting terminology when warning the public and private businesses (GIZ 2012, 2015; Herrmann 2009). The wide range of warning schemes is confusing for the general public, and also makes it "difficult to disseminate the warning and initiate an effective evacuation and adequate response" (GIZ 2015: 1). To minimise this, it is important that the early warnings are 'people centred' by 'incorporating local practices' (UN 2005, 2015).

Despite this there are some success stories that have been documented, such as the Radio Djati initiative in Banda Aceh after the Tsunami in 2004 (Romo-Murphy et al. 2011). Radio Djati, a local initiative in Indonesia, caters to disabled and vulnerable groups. It has developed some essential equipment and procedures needed to operate as a rapid-response radio unit in future disasters. Radio Djati has also developed a consistent disaster information system regarding early warnings in collaboration with the state radio network of Indonesia, Radio Republic Indonesia and other stakeholders in the province of Aceh (Romo-Murphy et al. 2011).

In 2008, the International Federation of Red Cross pioneered a people centred early warning system in Mozambique called Early Warning Early Action (EWEA) (Braman et al. 2008). EWEA anticipates by making use of seasonal climate information at different time scales. The communication network is central to EWEA in order to develop linkages between early warnings and actions at the community level. This approach helped to save thousands of people's lives when the Barge Dam in Ghana spilled (see Braman et al. 2008).

In the lead up to the UN's Third World Conference on Disaster Risk Reduction in Japan in March 2015, GIZ (2015) proposed 'harmonisation of early warning alert levels'. This could prove beneficial much like the standardisation of the emergency hashtags for Twitter generated by the Office for the Coordination of Humanitarian Affairs (OCHA). GIZ suggested the harmonisation of the early warnings by adopting consistent colour codes (e.g. green, yellow, orange, red, for 'increasing dangers', followed by blue for an 'all clear status') and pictograms (GIZ 2015: 1). 'Alert levels in a standardised system' can be quickly recognised by the public

much like the traffic light system. It is suggested that this harmonisation process has the potential to reduce confusion and align the communication sub-system.

In Odisha, the Special Relief Organisation issue a weather alert and the Indian Meteorology Department issue a weather warning. This division of labour helped the responders to facilitate their coordination and communication process in order to develop an effective response system.

5.1.3 World Views

In the previous chapters, the subjective world views of disaster risk reduction, gender, early warning and disaster management practitioners were examined. Harmonisation of the world views of these actors (science/scientists, social science/scientists, practice/practitioners, and lay science/lay people) is difficult to achieve due to the differing epistemological and ontological positions of these disciplines (Irwin 1995; Irwin and Wynne 1996; The Royal Society 1992). Nevertheless, it is suggested that *accommodation* of the world views could be a way forward. The process of accommodation will provide a space to host different world views or different points of view, as well as accommodate new ideas. This space is vital to resolving differences and seeking accommodation rather than just solutions (Checkland 1985). However, in some occasions accommodation might be difficult to achieve because human systems are highly complex and political systems (Vickers 1983). Some 'powerful' actors who passionately believe in a particular world view could go to extreme lengths and use all power resources to defend and advocate their views.[13] Thus, accommodation will not be easy; rather the dominant world view that of the powerful will prevail.

[13]In a visit to the Royal Society in London in February 2014, the Special Representative of the Secretary-General for disaster risk reduction, Ms. Margareta Wahlström announced 'that the second phase of the Hyogo Framework' (now the Sendai Framework) will be geared towards making Disaster Risk Reduction 'trans-boundary' by taking 'systems view'. The focus will also be on building organisational resilience, in addition to building the resilience of at-risk communities (Kemp 2014). The author was extremely excited by this announcement. On 24 June 2015, Margareta Wahlström revisited the Royal Society of London again as part of the Policy Lab Meeting on 'From Agreement to Action: What Next for the New Global Framework on Disasters?' The author attended this meeting. Margareta Wahlström provided an excellent synopsis of the Sendai Framework, one in which she recurrently emphasised the role of science in order to improve the disaster risk reduction practice.

After the meeting, the author spoke to Margareta Wahlström and reminded her of her earlier allusion to a systems view in February 2014. This is the summary of her response: 'There were not enough systems thinkers to negotiate the consultation phase of the Sendai Framework in Geneva. Rather the emphasis of DRR moved to science. They were strong. Every word of the Sendai Framework is owned by someone or somebody in this world. I think, systems thinking is now implicit in the Sendai Framework rather than explicit. However, this should not stop anyone pursuing research on this topic'.

Should we concede that an accommodation between actors is possible, then this has to begin by *acknowledging* the fact that human deaths in disasters are *avoidable deaths*. Second, intrinsically related to this, is the *recognition* by all actors that avoidable deaths are a case of 'event violence'. Third, to reduce such violence against women, men and children it is suggested that all actors and organisations working at the seams of disaster management systems should adopt an 'overall objective' or a goal (Jenkins 1969) which is to prevent deaths. Fourth, the translation of this objective has to be realised based on 'rational decision making model' (Pfeffer 1981). However, this process is not linear and will be fraught with power and politics. During the Cyclone Phailin, the Government of Odisha adopted the goal of 'zero human casualty' or the goal of unavoidable deaths (Chap. 4). If such a goal is ever achieved it is an ideal that illustrates the successful alignment of the human or socio-technical systems.

The Government of India, United Nations Development Programme Office and the Government of Odisha together played key roles in ushering a culture of disaster preparedness in Odisha. The Disaster Risk Management Programme, in particular helped: (i) by strengthening the state disaster management and district disaster management authorities; (ii) sharing knowledge and information to strengthen disaster management practises; (iii) mainstreaming disaster risk reduction into policies, plans and programmes; (iv) helping to prepare a disaster vulnerability atlas and Disaster Management Plans; (v) strengthening partnerships with various knowledge institutions for building the capacity of various stakeholders in DRR; (vi) building the capacity of vulnerable communities with regard to preparedness and response; and (vii) strengthening the governance arrangements for disaster response and preparedness through training (OSDMA 2012).

The culture of disaster preparedness also involved building the infrastructure required for disaster management, including good road conditions, bridges, concrete houses, multi-purpose cyclone shelters, schools and the like. Odisha State Disaster Management Authority in particular, has supervised the construction of 180 multipurpose cyclone shelters as well as community-based Shelter Management and Maintenance Committees (OSDMA 2011, 2012). It has also promoted disaster education in schools which are located within 15 km of the coast. About 96 schools have added disaster management to their curriculum (OSDMA 2011). The creation of the Odisha Rapid Action Force (ORAF) to support the district disaster response system, and plethora of community based disaster preparedness programmes by the NGOs and INGOs all contributed to build a culture of disaster preparedness.

Leadership is central to promoting a culture of disaster preparedness. Mr. Naveen Patnaik, the Chief Minister of Odisha provided much needed leadership in the aftermath of the Super-Cyclone. Since coming to power in 1999, he has declared 29 October as a 'Disaster Preparedness Day' for the state of Odisha in order to commemorate the Super-Cyclone. Since the year 2000, this is now an annual event celebrated throughout the state. Mr. Naveen Patnaik presides over this Day in Bhubaneswar and the event is attended by representatives of UN bodies, DFID, NGOs, students, volunteers and district and block level authorities. This

event is often used as a venue to launch new initiatives (such as the 'Women in Disaster Preparedness and Mitigation' or 'volunteers in disaster management'), a platform to share successes and a medium to reflect collectively for future eventualities—amongst many (OSDMA 2002a, b).

5.2 Limitations

Having discussed some of the analytical advantages of systems failure through systems alignment, this section presents some of its limitations.

First limitation: This research focussed on disaster management organisations and did not engage with the at-risk communities in Odisha. This is partly because the ability to include subjects from social systems is rather limited in systems analysis (Mingers 1980). A systems thinker takes a 'privileged position' (Latour 2005) to design systems, systems problems and systems solutions (Dekker 2006; Dekker et al. 2011). This is because systems are ideas and the imagination of human minds. In this process of framing, many questions related to social systems prevail in this research: How do the actors of social systems report deaths? Or how don't they? What motivates death reporting? What hinders death reporting? Who reports death and how? Why deaths happen despite early warnings? In this light, systems failure and systems alignment will continue to maintain and reinforce 'the political status quo' of social systems (Jackson 1991; Mingers 1980). If one believes "that problems within society are not merely contingent but systematically created by the very structure of society then small scale problem-solving, 'piece-meal engineering', cannot help but maintain that which is the very problem—society itself" (Mingers 1980: 11). However, it was posited changing the 'very problem—society itself' is an impossible task. In this imperfect society, we would still require some solutions to reduce violence and demand for justice (Sen 2003).

Sen's idea of justice is succinct to argue for event specific violence or event violence in the context of this research. Some injustices are so gross, severe and intolerable, such as deaths in disasters that the actors and sympathisers from the human activity systems cannot wait for the entire society to change, rather take rapid actions to save lives. Event violence denies structural violence or a continuum of violence that exists in vulnerable groups of people's everyday lives (Cockburn 2004; Farmer 2004; Galtung 1969), which is consistent with Mingers argument mentioned earlier. Nevertheless, this prism of event violence also offers a vantage point from which a disaster response system can operate by developing goals and targets to save precious lives. Such an approach has the potential to give agency to the poor, vulnerable and the marginalised who may lack the ability to evacuate on their own or move to higher grounds prior to a disaster climate. The recognition of event violence must promote not only a meaningful disaster response system in many of the resource constrained developing countries but also promote accountability of the responders for the at-risk communities. It should also usher a culture of rights-based disaster management, one in which the at-risk communities can

legitimately assert their rights to be rescued and evacuated to safe places prior to a disaster event. However, the recognition of event violence and the demand for structural change—two tenets of justice—are not contradictory. In the context of disaster management, they are complementary. Structural change can continue to take place in the mitigation phase, whereas the stopping of event violence can occur in a disaster climate. Both are mutually inclusive.

Second limitation: World views are important components of systems analysis. However, according to Mingers (1980), stressing the differences between world views leads to a surface level explanation rather than seeking explanation at the structures of society. This argument of Mingers stems from the idea of societal change or structural change as mentioned earlier. As a result, systems analysis lacks an explanation as to "why these particular Ws [world views] have developed and thereby how they might be changed. It lacks critical social theory" (Mingers 1980: 11). Furthermore, according to Mingers, outlining a possible world view is not enough because people can resist change. In this light, this approach lacks a theory in recognising the "difficulties of changing peoples' ways of thinking" (Mingers 1980: 11) or mental models. A snippet of this was visible in the cases of event violence in Odisha, such as the woman who came out to pick flowers on the day of Cyclone Phailin despite repeated weather warnings and alerts.

World views also generate several perspectives with regard to 'the problem'. Identifying a specific problem, as well as resolving this might be problematic in this approach (Checkland 1985). This is a paradox. In one hand, the solutions of wicked problems are inter-dependent, inter-disciplinary, inter-departmental, and multi-sectoral at the interface with technology. On the other hand, how can these be translated into actions. This is a mammoth task and could potentially be chaotic, confusing and also contribute to an ineffective disaster management system. At this point, many questions come to mind. Who will decide to seek wicked solutions? Who will coordinate such efforts? How will such efforts be coordinated? What motivates inter-departmental collaboration? How should such collaboration be facilitated? Who will facilitate and so on?

In the case of Odisha, it was the Chief Minister, who led such an effort. His efforts were facilitated by a plethora of policies, planning, programmes, funding, knowledge and administrative networks developed by the Government of India, UN, INGOs, NGOs, willingness of the at-risk community and the like. The case of Odisha illustrates the increasing role and involvement of political leadership before, during and after a disaster climate. When there is proactive political leadership, a disaster response system can be aligned with the goal of saving lives. Political leadership can promote a culture of disaster preparedness, too. In the case of Phailin, the Chief Minister set as a goal "zero casualty at any cost". Accordingly, all actors and responders organised themselves to achieve this target. The United Nations and other international funding organisations could do a great deal by encouraging political leadership to implement 'priorities for action' for effective disaster management (UN 2015; Ray-Bennett 2016).

Third Limitation: Theory testing and theory building are two crucial elements of a case study method (Eisenhart 1989; Yin 2009, 2012). According to Flyvbjerg

(2006), this process should happen in a real-world context in order to develop context-dependent knowledge or theory, as compared to context-independent knowledge. The latter approach is popular amongst neo-positivists with the aim to generalise research theories and outcomes. Context-dependent knowledge is relevant to this research because it identified the real life issues in disaster management systems with the aim of generating learning and, perhaps, a more relevant theory that can directly relate to the practices of disaster management authorities. One downside is that context-dependent knowledge can generate a very complex theory (Eisenhart 1989). This complexity comes from the voluminous amount of data that a case study inquirer encounters in the real world. Perhaps systems failure and its emergent component, systems alignment developed in this research, are no exception. At the outset readers might feel that the tenets of systems failure (co-ordination, communication and world views) are lengthy and complex. Said that, it is also important to note that complexity is at the heart of human deaths in disasters and so excessive simplification is likely to be counter-productive.

Fourth limitation: the focus has primarily been on developing an effective response system for cyclone/flooding. The availability of core information is vital to develop a response system for these hazards. In this context, systems failure presented is hazard specific. For some hazards such as an earthquake or tsunami, the generation and dissemination of core information might be problematic because the early warning systems are still evolving. Nevertheless, the components of systems failure have transferable value for disaster management in general.

5.3 Potential Impact

Despite its limitations, systems failure can lead to several organisational specific learnings, of which three are outlined here. First, organisations can improve disaster management practices and philosophy; second, they can develop human and organisational capacities in order to deal with contemporary disaster risks; third, it can inform policy making and theory development. They are all inter-connected in reality. Practitioners and researchers are also encouraged to improvise on the components of systems failure in order to suit the context of their own organisations and the hazards that they are exposed to.

Improve Disaster Management Practices: Managing disaster risks from the perspective of systems failure can benefit disaster management significantly (White 1995), as observed in the case of Odisha. A systems thinking promotes interdependencies and collaborations between actors and organisations in order to deal with risks of modern days. But interdependencies and collaborations cannot be achieved through science and technology alone (UN 2005, 2015). They have to be complemented by management knowledge, strategies, skills and reflection - amongst many. It is suggested that the components of systems failure can contribute significantly towards this.

Coordination and communication, in particular, are identifiable. They can help organisations to manage labour, knowledge and gaps in disaster management activities. They can also promote sense making amongst the organisations by questioning:

- What is 'it' that needs coordinating?
- How can coordination of 'it' be supported, advanced and facilitated by administrative structures, processes and technology?
- What communication techniques are required to enhance coordination between human to human, human to technology and technology to human interfaces?
- What is the goal of this coordination and communication?
- Who decides this goal?
- How can this goal affect the at-risk communities?

The best outcome of a goal will be achieved if the decision making process is based on the rational model, as compared to bureaucratic and political models.[14] Successful outcomes will also be facilitated if the alignment processes of actors and organisations have begun in the mitigation phase rather than in a disaster climate. Alignment of actors and organisations is a pre-requisite in a disaster climate. The successful achievement of a goal will also be influenced if the leadership of a response system is context-specific, organisational-specific and hazard specific. However, an overall goal to reduce deaths or to achieve zero casualties will have a far-reaching effect if this goal is set by the head of a state or by the head of a nation as compared to a bureaucratic head from a disaster management organisation in the event of a large-scale disaster.

Develop Human and Organisational Capacities: Building human and organisational capacity is pivotal to maintain the momentum of the responders. It is also important for continual maintenance of the disaster management institutions designed to serve a specific purpose for the human systems. However, the assumption that actors and organisations are well equipped to deal with the contemporary disasters risks, particularly in developing countries, is widespread. This assumption was promoted by the Hyogo Framework. The question remains: how can we best build the capacity of those organisations that apply the principles of disaster risk reduction? The Hyogo Framework placed much emphasis on the capacity building of the at-risk community compared to the organisations and professionals who are involved in the day-to-day messy businesses of averting disaster risks (Ray-Bennett et al. 2014a, b). As a result, the building of organisational capacity in national and local authorities, NGOs and environmental agencies has received far less attention by the disaster risk reduction community (DFID 2012, 2013). However, capacity building of the responding organisations is now

[14]The bureaucratic model, "rely more heavily on rules, precedent, and standard operating procedures. Less time and resources will be spent on decision making, and fewer alternatives will be considered before actions are taken" (Pfeffer 1981: 24). The political decision making model, presumes "that parochial interests and preferences control choice" (for details see Pfeffer 1981: 22).

one of the 'priority for actions'[15] for the Sendai Framework, which says: "empower local authorities as appropriate, through regulatory and financial means to work and coordinate with civil society […] in disaster risk management at local level" (UN 2015: 13). It is suggested that the model of socio-technical disaster management, as well as the tool of disaster climate can help building the capacity of not just local authorities but also of the associated organisations, including the secondary and tertiary.

Disaster climate is conceived in the context of systems failure. Disaster climate encapsulates uncertainties, dynamism, imagination, critical decision making processes, readiness, incident management and communication. It is suggested that the preparation for a disaster climate can lead to scenario planning[16] amongst the responders and in doing so, build the capacity of responders to detect blind spots, human errors and new possibilities (Senge 1990; Taleb 2007). Preparation for a disaster climate can also allow responders to expand their imagination and heighten awareness of a crisis (Perrow 1999; Senge 1990; Weick 1988). Heightened awareness should enable responders to see the 'bigger picture' in order to be prepared for a developing crisis. Training, consultation, debriefs and knowledge exchange can all contribute to the capacity building of responders and organisations. Other methods that can also heighten the awareness of the responders are Causal Loop Diagrams[17] (CLD), Outcome Mapping[18] (OM), and Assumption Based Planning[19] (ABP).

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[15]'Strengthening disaster risk governance to manage disaster risk' (Priority for Action 2).

[16]Scenario planning (Masys 2012) is essentially a story, describing potential future conditions and their emergence to facilitate sense making and to inform decision making. The thought process involved in scenario planning supports 'thinking the unthinkable' exploring uncertainty and challenging mental models and assumptions in order to recognise alternate futures in a space of possibilities (VCLL 2013). There are numerous approaches to scenario planning in the literature such as Schwartz's 8-Step Scenario Building Model (see Schwartz 1996); Schoemaker's 10-Step Scenario Building Model (see Schoemaker 1993); Avin's 12-Step Scenario Building Model (see Avin 2007), and JISC's (2007) 6-Step process for the development of scenarios. By revealing the uncertainty one opens up the notion that more than one future is potentially open (VCLL 2013).

[17]Casual Loop Diagrams are important tool that can provide a language for articulating our understanding of dynamic, interconnected situations. Through the 'visual grammar' of Casual Loop Diagram, it prepares the participants to challenge the linear cause and effect relationships and decipher various interconnected feedback loops (VCLL 2013). Sterman (2000) and Senge (1990) and Senge et al. (1994) provide an excellent resource for learning about Casual Loop Diagrams (VCLL 2013).

[18]Outcome Mapping was developed by the International Development Research Centre (IDRC) in Canada in support of development efforts around the world (IDRC 2001). The application of this methodology to the disaster management domain is particularly relevant to the notion of building/enabling resilience. Two of the key features or principles of Outcome Mapping that resonate with systems thinking are its recognition of the importance of embracing different world views and perspectives as well as the acceptance of non-linear (complex) causality. The 12 steps associated with the Outcome Mapping methodology are available at IDRC (see 2001).

[19]Assumption Based Planning (ABP) is an essential element in disaster management domain according to Dewar et al. (1993). It is a powerful tool to show how plans often fail because inadequate attention was paid to the underlying assumptions. This tool aims to capture the

The current disaster management model is conceived as socio-technical. In this model, human and technology work at interface. A snippet of this model is visible in the seventh Global Target of the Sendai Framework: "substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by 2030" (UN 2015: 7). Planning disaster management from the perspective of socio-technical systems will allow governments and international organisations to locate gaps and strengths in technologies (related to early warning systems and information and communication tools), as well as in human knowledge and expertise. This will usher a new type of disaster management practice which was observed in Odisha. This approach will also lead to the development of new research, new knowledge and novel ways of understanding the human technology interface to improve disaster response systems. Learning based on this new model must also extend to gender and disaster studies in order to develop gender sensitive theories, which mirror practice and the hyper connected global world in which vulnerable subjects are located.

Policy Impact: This research can also inform policy making. There is an urgent necessity to maintain gender disaggregated death records locally, nationally and globally for future research and development. There is, however, a move towards disaggregation due to the recommendation of the Hyogo Framework in 2005. Mortality data in disasters is something that neither the international organisations, such as Centre on the Epidemiology of Disaster (CRED), nor the national governments maintain (Eklund and Tellier 2012; Sanchez et al. 2009). In Odisha the problem is systemic.

It was noticed that disaggregated mortality data by caste is filtered out at the block office level, whereas class and gender data is filtered at the district office level.[20] Due to this practise, the Odisha State Disaster Management Authority and the Special Relief Organisation in Bhubaneswar, receive caste, class and gender neutral mortality data. Caste data is lost at the block office because the pro forma designed for the local government doctor to issue a death certificate due to disasters (primary death) does not require caste to be specified. Class and gender data is lost at the district office when it is sent by the block office for further verification. Death verifications are a serious matter because according to the Orissa Relief Code

(Footnote 19 continued)

assumptions underlying plans that if invalid, could derail the plans and operations stemming from it. It is a systemic tool because it explores the interrelationships, perspectives and boundaries of an established plan to ensure the viability of that plan. Through this process, it recognises how 'load bearing vulnerable assumptions' require explicit analysis (see Dewar et al. 1993).

[20]"Indian states comprise a three-tier administrative structure. Several *gram sansad* (villages) or wards (hamlets) constitute a *gram panchayat* (GP), several GPs constitute a *panchayat samiti* (PS) or block, and several panchayat samiti constitute a *zilla parishad* or a district" (Ray-Bennett 2009a: 12).

(GoO 1996), regardless of the deceased's caste, class or gender their next of kin is entitled to an ex gratia payment or a compensation. This compensation is hazard specific[21] and is approved by the District Collector (GoO 1996, 2014a, b). Consequently, the district and block offices are not required to collect disaggregated data.

The death reporting and recording system merits review in Odisha in light of the Sendai Framework. Recently, the Sendai's Policy Brief (Fakhruddin et al. 2017) developed by the International Council for Science and Integrated Research on Disaster Risk (IRDR), suggested "[e]stablishing basic data infrastructure for disaster loss data in developing countries and supporting regional and global cooperation for disaster loss reporting". In light of this, some concerted efforts are required to develop such infrastructure at regional, national, state and district levels in India and the SAARC region. It is also important to make the disaster loss data management consistent with the Guidelines identified by Integrated Research on Disaster Risk (2015) on 'measuring losses from disasters'. For this, the Government of Odisha should aim to document not only primary deaths, but also secondary deaths and those who are missing (Dilley and Grasso 2016; IRDR 2015).

Although it was beyond the scope of this research to capture people's perspectives on Odisha's death reporting system, it is likely that deaths could go un-reported—not by the beneficiaries but rather due to the verification process carried out by the government doctor at local government hospitals. This verification process merits further investigation. It is also important to address the death reporting practices in India in order to standardize this system, (Dilley and Grasso 2016; Fakhruddin et al. 2017) and introduce good practices in order to improve the accuracy of disaster death data. To be consistent with the Sendai Framework it is also recommended that the Government of Odisha record disaggregated data. This is not currently expected according to the Relief Code. In order to promote gender disaggregated mortality data, the UN's International Strategy for Disaster Risk Reduction and Integrated Research on Disaster Reduction can take a lead role, in association with the national governments and the United Nations Development Programme Office. In India, the National Institute of Disaster Management in New Delhi and the Odisha State Disaster Management Authority in Odisha, along with United Nations Development Programme Office in Bhubaneswar can undertake this venture. Longitudinal death records at local, national and global levels will be extremely important to indicate past and future death patterns in disasters. They will also promote necessary policy, planning and response by guiding how and where the finite resources of disaster risk reduction could be better placed to reduce human deaths or change human behaviors.

Theory Impact: Our knowledge on deaths or avoidable deaths in the context of disaster risk reduction is limited. Deaths in disasters are a developmental

[21]Indian Rupees 100,000.00 (approximately Great British Pound 1,025.00) for a death due to cyclone, Indian Rupees 150,000.00 (approximately GBP 1,500.00) due to lightening, Indian Rupees 10,000 (approximately Great British Pound 100.00) due to heat wave and Indian Rupees 100,000 due to a snakebite during floods (GoO 2014a).

issue. They result in both a humanitarian loss and a loss of human capital (Lass et al. 2011). Rural developmental studies have clearly noted the impact that a woman's death can have on livelihoods as well as on social, natural and political capital (Agarwal 1990; DFID 1999; Ray-Bennett 2009). Without reducing women and men's deaths, the WHO (2002) and UNDP (2007) have firmly asserted that it is unlikely that a country can ever achieve sustainable human development. This is increasingly evident in those countries which are repeatedly affected by disasters and consistently lagging in the achievement of the sustainable goals (UNDP 2007). Avoidable deaths, therefore, aims to provide an essential background material to support methods and theories that can better discern vulnerability and steps towards establishing solutions to reduce deaths.

Indicators for avoidable deaths were suggested in Chap. 1. Indicators both at global and national levels are important milestones or benchmarks. They act as targets to be achieved by the international, national and state disaster management authorities (UN 2015; Wahlström 2015). Some ideas as how to conceive these indicators through the instance of avoidable deaths and unavoidable deaths are suggested here. Anything less than ten deaths is considered unavoidable deaths. Avoidable deaths, on the other hand, are deaths beyond the number ten and are potentially avoidable from the impact of environmental disasters in the present time, given available knowledge on the nature of these hazards and due to advancements in information technology, human interaction and effective policy interventions. These indicators have both quantitative and qualitative elements. Depending on the economy of a country (developed, developing, least developed, middle income), indicators will vary, much like the Sustainable Development Goals.

Recently, the Sendai Framework has opened up an opportunity to initiate a global debate in this regard by setting a global target of reducing 'global disaster mortality by 2030'. UNISDR is in a unique place to lead this global debate to discuss the issues related to resources, processes and technology that will be required to build the capacity of the UN Member States to achieve this target. More research is therefore required to understand the contextual processes to reduce global disaster mortality. There is also a necessity to develop appropriate methodology for avoidable death indicators that can stand up to capturing the nuances of national and global contexts. In this regard, the disaster risk reduction community can benefit significantly from the methodological practices prevalent in the health and poverty reduction sectors. It is posited that the indicators for avoidable deaths in disasters will lead to the convergence of the Sendai Framework with the Sustainable Development Goals for a sustainable human development. This convergence is pivotal since disaster risk reduction is a development issue and likewise development is disaster risk reduction (UN 2015).

Last but not the least, conceiving 'deaths in disasters' through the lens of complex perspective should promote an accountable disaster management which is still in its nascent stage in Odisha. It should also help to identify gaps (such as no measures for lightning), incapabilities and inactions that often exist at the seams of human-built disaster management system. This is because the complex perspective

allows us to redirect our attention to the actors' and organisations' actions and inactions to prevent deaths, rather than focussing solely on the severity of a risk and the vulnerabilities that exist amongst the at-risk community. When we are able to better comprehend the vulnerabilities of the disaster management system, it is more likely that we will be able to come up with concrete solutions and develop the skills, knowledge and expertise that will be required for the actors and organizations to reduce deaths of men, women and children.

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