Analysis of Man-Made Risks: The Indian Context

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Abstract

Risk is the probability of any harmful consequences from the occurrence of any event that disrupts the functioning of a certain region. In India, a lot of research work and development has been made in the field of risk reduction due to natural events but not much of comprehensive work has been done for risk reduction due to man-made events. The article consists of two parts: the first part is a data compilation on life losses due to man-made reasons and shows us why research work and development in the field of risk reduction due to man-made events in India is required. The second part consists of a suggestive methodology to develop framework that can be used for assessing man-made risks in India.

Keywords: Man-Made disaster, India, Risk assessment, Death toll.

Introduction

"Disasters don't just happen. They are the result of a chain of events, locked together in moment in time." This chain of events refers to those actions which have high risk potential to disturb the functioning of a society. Risk is a function of hazard, vulnerability, exposure, deficiencies in preparedness, location and coping capacities. A man-made risk results from hazards that are of threats having an element of human intent, negligence, error or involving from a failure of a man-made system. The rate at which economic losses, human life losses and property losses are taking place in the world due to disasters, it has become essential for us as disaster managers to do analyses of the disasters, know their origin and consequences and find steps to mitigate those and take measures so that those kinds do not get repeated.

Although we cannot stop the naturally occurring events, such as earthquake, tsunami, flood, cyclones, etc., but we can certainly do analyses of the events to find out how much is the intervention of the man-kind that have resulted these naturally occurring events to turn into a disaster. The man-made events are cases which can be prevented most of the times by just following some rules and regulations and decreasing the factor of negligence. But it is found that, the losses due to man-made disaster are much more than the losses due to natural disasters. So it is required to do thorough analysis on the man-made risk and prepare preventive measures for them.

Man-made Risks in India

Report of High Powered Committee on Disaster Management-Oct. 2001, Govt. of India

The disaster management report by the High Powered Committee (HPC) was a long two-year exercise done under Department of Agriculture and Cooperation, Ministry of Agriculture, Govt. of India. The exercise was almost at its end when the 9/11 struck USA. It made the committee to rethink on the output of this

exercise and made them realize that "in today's world, we not only have to prepare ourselves for the prevention of hazards we already know of but also of those that we may have to imagine as possibilities."[5] Initially, the objective of the exercise was to make disaster management plans which gradually got enlarged into a huge national exercise involving natural events as well as man-made events. This was the first ever exercise in India that took place in such a comprehensive manner to look at all kinds of possible disasters that can occur in India.

From the study of the report, the area of concern for this article is taken into account. The report contained concerns about natural as well as non-natural disasters that occurred in India. In the report, the committee sorted out the events that affected India and the death toll due to the events, it is found that most of them had man-made interventions and the death rate due to those were very high and mostly they could have been avoided. The ministry responsible for managing a particular disaster needs the cooperation of other ministries to improve the response management. So a multi-hazard approach is required where the roles and responsibilities of each agency must be defined.

Table 1.Disasters and Their Nodal Ministry

Disaster	Nodal Ministry
Air accidents	Ministry of Civil Aviation
Civil Strife	Ministry of Home Affairs
Railway Accidents	Ministry of Railways
Chemical Disasters	Ministry of Environment & Forests
Biological Disasters	Ministry of Health
Natural Disasters	Ministry of Agriculture
Nuclear Accidents inside or outside the country which poses health or other hazard to people in India	Department of Atomic Energy

Table 2.Different Disasters/High Risk Events in India as Identified by HPC

A. Water and Climate Related Disasters	B. Geologically Related Disasters	E. Accident Related Disasters
1. Floods and Drainage Management 2. Cyclones 3. Tornadoes and Hurricanes 4. Hailstorm 5. Cloud Burst 6. Heat Wave and Cold Wave 7. Snow Avalanches 8. Droughts 9. Sea Erosions 10. Thunder and Lighting	1. Landslides and Mudflows 2. Earthquakes 3. Dam Failures/ Dam Bursts 4. Mine Fires **C. Chemical, Industrial and Nuclear related disasters** 1. Chemical and Industrial Disasters 2. Nuclear disasters **D. Biologically related disasters** 1. Biological Disasters and Epidemics 2. Pest Attacks 3. Cattle Epidemics 4. Food Poisoning	1. Forest Fires 2. Urban Fires 3. Mine Flooding 4. Oil Spill 5. Major Building Collapse 6. Serial Bomb Blasts 7. Festival related disasters 8. Electrical Disasters and Fires 9. Air, Road and Rail Accidents 10. Boat Capsizing 11. Village Fire

Life Losses due to Man-Made Events in India

The data are collected from the Accidental Deaths and Suicides in India (ADSI), Report by Bureau of Police Research and Development, Ministry of Home Affairs, Government of India. ADSI reports are available from the year 1967 onwards. These reports contain the overall snap shot of the deaths in a particular year and analysing the growth or decline rate w.r.t. to the previous year. The division of deaths is done on the basis of natural and non-natural cause. It also contains the clock wise division of death, meaning per day division of death w.r.t. various categories. It also has Indian maps which shows state-wise the death and rate at which deaths occurs. As the area of concern in this article is man-made disaster, so the deaths due to the man-made interventions are taken into account. The causes that are taken into account are as per as the categorization of disasters done by the HPC report by Department of Agriculture & Co-operation, Ministry of Agriculture, Govt. of India.

Table 3.Reported Life Losses due to Man-Made Events in India

YEAR	AIR CRASH	RAIL DEATHS	ROAD DEATHS	STAM-PEDE	STRUCTURE FAILURE	BOAT CAPSIZE	FACTORY DEATHS	MINES DISASTER	ELECTRICAL DISASTER	FIRE	EXPLOSION FIRE ARMS	EPIDE-MICS	POISO-NING	TOTAL
1967	342	7133	6173	X	1378	X	704	X	X	8272	774	X	5888	30664
1968	158	7960	6152	X	1256	X	821	X	X	8751	1032	X	7912	34042
1969	117	7896	7071	X	1295	X	552	X	X	9031	961	X	8308	35231
1970	279	8282	7288	X	1524	X	729	X	X	9419	985	X	9738	38244
1971	205	9652	11740	X	1552	250	529	476	X	9810	1318	X	8145	43677
1972	206	9418	12891	X	1134	334	834	381	X	10771	1077	X	8128	45174
1973	120	9027	11237	X	1299	235	506	684	X	9745	1128	X	8236	42217
1974	92	11317	14307	X	1196	295	565	485	X	10085	1276	X	8692	48310
1975	120	10393	15190	X	1402	399	643	755	X	10645	1690	X	7466	48703
1976	293	9598	15903	X	1613	758	535	712	X	11221	1653	X	8096	50382
1977	92	10207	15090	X	1256	356	451	748	X	10878	1514	X	6666	47258
1978	133	11117	17660	X	1476	399	491	798	X	11187	2047	X	6438	51746
1979	70	11126	18273	X	991	306	502	628	X	10282	1640	X	5845	49663
1980	42	11735	17481	X	1308	1401	698	677	X	12081	2199	X	5973	53595
1981	54	12408	20578	X	1465	312	641	1032	X	12945	2422	X	6239	58096
1982	102	12789	22199	X	1157	161	735	624	X	14555	2230	X	6864	61416
1983	56	13124	23375	X	1501	421	688	697	X	15372	1876	X	5736	62846
1984	52	12735	29375	X	1220	446	666	556	1160	15741	2234	X	6735	70920
1985	85	13307	29831	X	1341	285	585	579	1834	16667	2251	X	8560	75325
1986	169	13382	27990	X	1203	248	799	719	2335	18335	2048	X	8631	75859
1987	64	12985	33884	X	1097	415	1021	663	2408	18574	1961	X	8960	82032
1988	732	13099	31945	X	1825	260	703	648	2490	18943	1700	X	11005	83350
1989	66	14608	42075	X	1080	198	591	436	2542	20288	2315	X	11354	95553
1990	188	13796	43005	X	1472	675	658	690	2957	20522	3287	X	13164	100414
1991	15	16080	44930	X	2006	422	539	519	2933	22306	3775	X	13697	107222
1992	17	17834	49156	X	1903	277	549	776	3062	22010	3853	X	12773	112210
1993	46	16800	45769	X	1127	346	550	403	3488	22395	2298	X	13134	106356
1994	80	18340	51855	X	1190	371	606	506	3502	23323	2862	X	13752	116387
1995	X	X	X	X	X	X	X	X	X	X	X	X	X	0
1996	10	16452	68351	233	2881	1076	616	349	3861	22922	1631	1165	14861	134408
1997	338	14975	69800	64	2050	959	613	447	4303	22649	1963	180	14090	132431
1998	16	14270	74204	19	2126	517	669	614	4583	25166	2429	82	16646	141341
1999	13	17264	76732	19	2412	1041	642	426	5304	25898	3428	161	18167	151507
2000	36	18505	81036	20	2386	523	667	446	5671	28400	3000	174	19232	160096
2001	72	17920	80118	50	2233	785	625	467	5663	25467	3359	102	17125	153986
2002	X	X	X	X	X	X	X	X	X	X	X	X	X	0
2003	37	17899	84059	44	2216	550	674	625	5361	21004	3233	64	15764	151530
2004	51	18521	84430	83	2376	765	712	550	6336	19278	2715	78	15075	150970
2005	23	20418	91376	31	2169	562	715	456	6224	18445	2884	69	15817	159189
2006	6	20011	98254	346	2718	759	671	456	6987	19093	2897	103	13722	166023
2007	2	25927	105725	18	2399	830	869	409	7619	19222	2985	76	15489	181570
2008	11	25970	114590	75	2623	901	836	435	8076	20772	2715	47	17421	194472
2009	19	26348	118239	434	2833	979	858	371	8067	22454	2431	73	16436	199542
2010	12	25793	126896	110	2847	984	1044	423	8539	23268	2172	75	18599	210762
2011	23	27798	133938	113	2682	760	1043	355	9059	24414	2181	57	19373	221796
2012	18	28238	136834	489	3161	849	1091	385	8945	24576	1782	127	20888	227383
2013	14	29210	139091	70	2682	668	1007	359	8750	23281	1620	80	21857	228689
TOTAL	4696	701667	2E+06	2218	81061	23078	31243	22765	142059	790463	97831	2713	536697	4792587
AVG.	104.4	15592.6	52358	130.47	1801.3556	512.844	694.2889	505.8889	3156.86667	17566	2174.02222	159.6	11926.6	

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Table 4.Comparison of Reported Deaths due to Natural and Man-Made Events in India

YEAR	NATURAL CAUSES	MAN-MADE CAUSES
1967	36313	30664
1968	33951	34042
1969	37887	35231
1970	42153	38244
1971	3860	43677
1972	3593	45174
1973	4813	42217
1974	4249	48310
1975	4213	48703
1976	4026	50382
1977	11864	47258
1978	5345	51746
1979	3976	49663
1980	3740	53595
1981	4091	58096
1982	4437	61416
1983	4498	62846
1984	4241	70920
1985	3930	75325
1986	3310	75859
1987	3909	82032
1988	4317	83350
1989	4555	95553
1990	4561	100414
1991	4447	107222
1992	4183	112210
1993	11125	106356
1994	4439	116387
1995	X	X
1996	21600	134408
1997	18930	132431
1998	18908	141341
1999	22762	151507
2000	27506	160096
2001	17366	153986
2002	X	X
2003	16723	151530
2004	14954	150970
2005	18937	159189
2006	22415	166023
2007	21502	181570
2008	25153	194472
2009	23993	199542
2010	22256	210762
2011	25066	221796
2012	23690	227383
2013	22960	228689
TOTAL	630747	4792587
AVG.	14016.6	106501.9333

The man-made interventions that are taken into account for this article are:

- Air crashes, rail accidents and road accidents
- Stampedes (from the year 1996 was included in the record)
- Collapse of structures (till 1995 it was building collapse, but from 1996 onwards it contained collapse of houses, buildings, dams and bridges)
- Boat capsizes
- Factory accidents
- Mines disasters
- Electrical disasters (from the year 1984 was included in the record)
- Fires (due to fireworks/ crackers, short circuit, gas cylinders/ stove burst)
- Explosions and use of fire arms
- Epidemics (chicken-guniya, malaria-dengue, babunic plague, cholera, flu pandemic, swine flu)
- Poisoning (food poisoning, poisonous liquid, leakage of poisonous gases)

If we look at the statistics, the numbers are quite alarming. The major causes of deaths due to man-made events being rail accidents, road accidents, collapse of structures, factory accidents, fire and poisoning. The ratio of deaths due to natural events to that of man-made events is 1:7.6 (approx.). But the man-made factors are such events which can be easily mitigated by following some simple rules and regulations, decreasing the degree of negligence and sometimes by proper thinking and presence of mind.

Conclusion

If we see the graph of deaths due to natural causes and the man-made causes (Fig. 1), it does really show how well we are developing our strategies and formulating rules to save lives from the natural events; but the deaths due to man-made events are very high and these can only be minimized, if we do comprehensive work in formulating rules and developing strategies in the field of disaster due to man-made events. If we are able to reduce the death toll due to the major man-made factors (rail accidents, road accidents, collapse of structures, factory accidents, fire and poisoning) even by 50% then we will find a drastic change in the death ratio (Fig. 2). Figure 1 clearly indicates us to why transformation is required in the work process in the field of risk reduction due to man-made events in India and more comprehensive research works and developments in this field has to be made. Figure 2 just shows us the positive result that we can achieve if we give efforts in this field of disaster.

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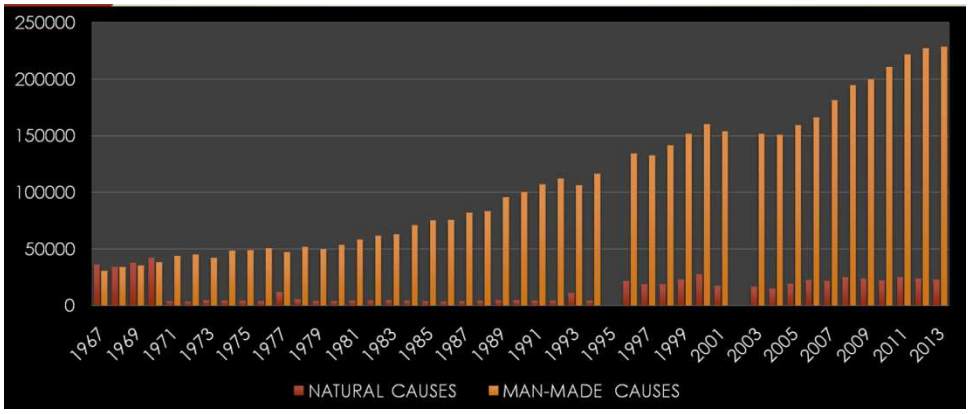

Figure 1.The Graph Indicating the Death Toll due to Natural and Man-Made Causes

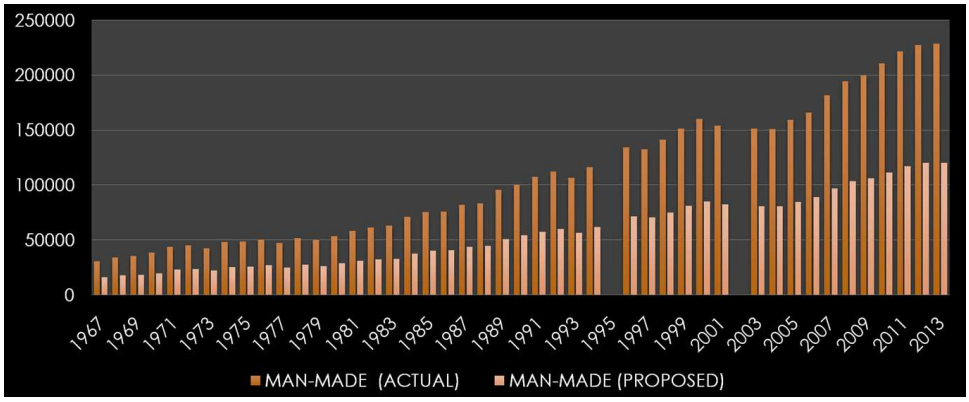

Figure 2.The Graph Indicating the Decrease in Death Toll if the Major Man-Made Factors are Minimized to Half

A Suggestive Framework for Assessing Man-Made Risks in India

Near Real-Time Forensic Disaster Analysis (FDA)

It is a methodology to uncover the root causes and estimate potential losses due to any hazardous event using modern communication and information tools and analyze them in real time. One critical condition in this is the availability of data which can be referred in case of any risk. So it is necessary to document case histories in a more systematic way and have enough data collected that can be referred when it is required. Time does play an important role while doing FDA as many pieces of information emerge within the first few days; interaction is more intensive and open during these days; emergency services, tourism industry, insurance companies, relief agencies are at the peak of their work.

In India, we do not have a strong database that can be used for near real-time FDA. So we can start by documenting the past cases with respect to:

1) Time, magnitude and location of the event
2) Population of the location and its surrounding areas
3) Properties of the location (like human development index)
4) Casualties and the reasons for life losses
5) Economic losses due to the event
6) Relief/response management processes of the event and the duration

With the help of these past cases, we can prepare a knowledge database which is a combination of existing and event-specific databases. The database can help us in developing a man-made risk map, which will be of high value when we assess a man-made risk in future. We can use the database for case-based reasoning which will help us to draw conclusions about a new one.

When a new hazardous event takes place at a particular location, information about the event can be collected from social media, sources working on such events, sending teams to analyze the event and can be cross referenced for coming to a conclusion about the event. A mobile application can also be developed by which the nearby people of the affected region can give an input of data which will help in developing the new cases more firmly. Then after that we can retrieve similar cases from the past and use the analyzed or suggested solutions for a quick relief management in the affected area.

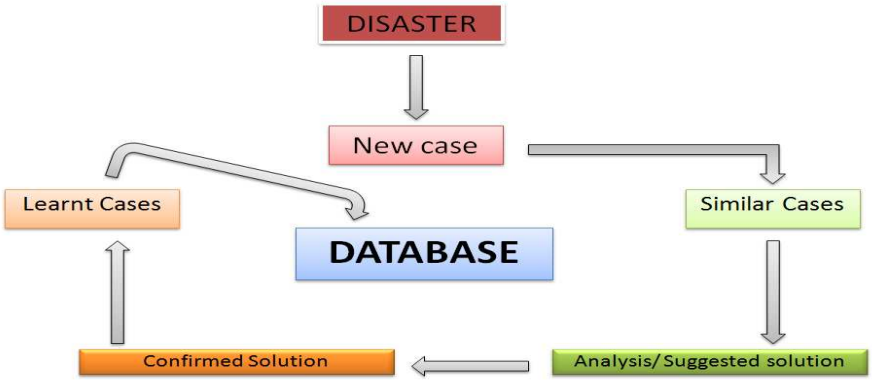

Figure 3.A Typical Flow Chart for Creating and Expanding the Knowledge Database for Man-Made Risks

- Suggestive Methodology for Man-made Risks
- The various factors that have been listed under man-made risks can be the output of either of the two types of hazards:
- Accidental man-made hazards, which cause risks when the event happens accidentally.
- Malicious man-made hazards, which cause risks when the event is done intentionally.
- The methodology that can be adopted for assessing a man-made risk event consist of the following:
- Statistical analysis using the knowledge database, near real-time FDA and man-made risk map
- Evaluation of the similar historical cases and threat analysis
- Detailed estimation of losses, damaging parameters and vulnerability indicators
- Development of an inventory
- Inventory created using the knowledge database
- Merging of old and new data into the inventory
- Visualization using GIS (in the man-made risk map)
- Spatial analysis using GIS
- Integrated risk assessment by overlaying information on critical infrastructure (damaged or destroyed), affected people (dead, injured or homeless) and economic losses.

Conclusion

The above suggested framework is on a very broad spectrum and for success in the field of risk reduction due to man-made events in India, more detailed risk assessment on man-made hazards is required, like:

- Proper characterization of the hazards are to be done
- The degree of exposure, vulnerability and damage in the domain of man-made risk is to be characterized
- Skillful processing and visualization of information
- Proper implementation of the risk assessment

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