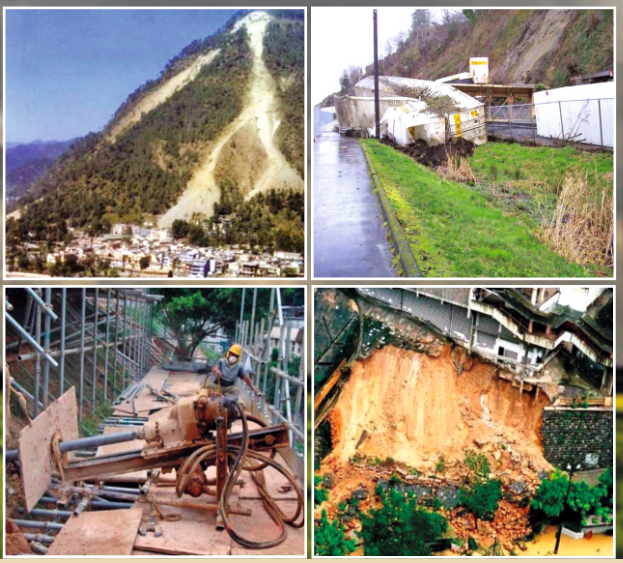
DISASTER
Response & Management



March 2019, Volume 6, Number 1
ISSN: 2347-2553

LBSNAA

CENTRE FOR DISASTER MANAGEMENT
Lal Bahadur Shastri National Academy of Administration, Mussoorie - 248179

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March 2019, Volume 6, Issue 1
ISSN: 2347-2553

Centre for Disaster Management
Lal Bahadur Shastri National Academy of Administration
Mussoorie - 248179, Uttarakhand, INDIA
EPABX: (0135) 2632236, 2632489, 2632374
Phone & Fax: (0135) 2632655, Fax: 2632350, 2632720
Email: cdm.lbsnaa@nic.in

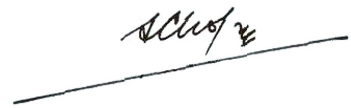
Designed & Processed by
Chandu Press, D-97, Shakarpur, Delhi-110092
Ph.: 011-22526936, 09810519841
E-mail: chandupress@gmail.com

DIRECTOR'S MESSAGE

Due to its unique geographical and geological conditions, India is vulnerable to various natural disasters. In India, the incidents of flood, drought and other natural disasters are on the rise and pose a tremendous challenge to the society in general and administration in particular. Each disaster heightens the sense of urgency to equip ourselves better in coping and managing them. In this context, the training of civil servant in Disaster Management assumes critical significance.

There is a need to move from the paradigm of responding to disasters to one of building in resilience against disasters in all aspects of decision making. A key challenge to administrators would be raise the level of awareness in the society regarding the cost of allowing disasters to affect it and to build resilience in infrastructure and in the community.

It gives me immense pleasure to note that Centre for Disaster Management, LBSNAA is bringing out the edited journal "Disaster-Response and Management" Volume 6, Issue 1 for the year 2018-19 under the project "Capacity Building on Disaster Management for IAS/Central Civil Services Officers" sponsored by National Disaster Management Authority (NDMA). This is the compilation of research articles providing insights in the recent trends in disaster management. I hope this volume will add to the knowledge base for disaster management in the country and will be useful for both the trainees and the administrators in the field.



Sanjeev Chopra, IAS
Director,
LBSNAA, Mussoorie

PREFACE

The Centre for Disaster Management (CDM), Lal Bahadur Shastri National Academy of Administration (LBSNAA), Mussoorie is a training and research centre working under the aegis of LBSNAA, Mussoorie. The centre is involved in training IAS and other Group-A civil service officers at induction as well as at in-service level in various aspects of disaster management, besides undertaking, action research projects, documentation of best practices, development of case studies, etc.

The magnitude and frequency of disasters has increased drastically in terms of human, economic and environmental losses. Under the conventions on SDGs, Paris agreement, Sendai framework for Disaster Risk Reduction, there is a need to document the research carried by individuals in the field of Disaster management to achieve the committed goals of India as a signatory. Disaster Response and Management in recent times, received increased attention, both within the country and abroad. In a caring and civilized society, it is essential to deal effectively with the devastating impact of disasters.

In continuation to the successful publication of the fifth volume of the journal Disaster-Response and Management" from Centre for Disaster Management, it is our pleasure to publish Volume 6, Issue 1 of the journal "Disaster-Response and Management" for the year 2018-2019. The journal will provide an insight to administrators about the recent trends in response, planning and scientific interventions towards Disaster Risk Reduction. I would like to place on record the contribution made by faculty and staff of CDM who have contributed in various capacities for bringing out this Journal.

Raghuraj Rajendran, IAS
Deputy Director (Sr.) & Director
CDM, LBSNAA

CONTENTS

Combating Cosmic Disasters : The Future We Want

Lt. Col. Devashish De

Appreciation of a situation under a stretched catapult diplomatic condition, when an asteroid may be guided to impact the earth in the region of developing nation state as India which may not prepared for combating such situation unless COSMIN[1] is signed.

Abstract

As per a report in the 'Monthly Science Explainer 'of Guardian[2] news published on the web on 28 November 2013 there is a mention of structured and concerted observations on the types of asteroids entering the earth. The Chelyabinsk asteroid strike on 13 February 2013 put NASA on a cosmic wake up call[3]. A blinding flash, a loud sonic boom and shattered glass were the visible effect of such a strike. A persuasion of the progress of NASA over these five years brought out it's consistent preparation by the way of organising early warning, telescopic observations, simulations in sync with FEMA and plans for a more daring actual interventions in space most of which has been covered in the paper. However, this paper looks at India which is comparatively weaker than the existing superpowers in terms of scientific advancements and capability to deflect such asteroid impacts from space. However, there seems to be a correlation of records of such impacts in the ancient Hindu texts due to which man's thoughts about the unknown took shape in the form of various scriptures as the Vedas. Based on a hypothetical assumption of an assured cosmic impact this paper brings to fore a thought on the composition of the apt Incident Command System and the way to handle this Disaster, should the same impact the Indian landmass in future. It also attaches the strings to asteroid mining due to which developed nations may resort to an arm twisting tactics to circumvent the Outer Space Treaty of October 1967. The paper concludes as a near proven conspiracy theory.

Key words: *Asteroid impact on earth, Science & Sarasvati, Cosmic Incident Command Structure, COSMIN, Asteroid Mining.*

1. Introduction to Chelyabinsk Asteroid Trail

The sites of NASA through which the details have been extracted somehow don't give a comparison of previous cosmic catastrophes. However, one of them has been explained in the later sections of this paper which relate to

the 1908 asteroid impact in Tunguska region of Siberian Forests in Russia. On 13 February 2013 a 20 meters wide asteroid, roughly the size of a house closing in at the rate of 11 miles per second blew 14 miles above earth, in air. The energy equivalence was that of 4,40,000 tons of TNT. Since Little Boy [4]was equivalent of 15000 tons of TNT so it may be assumed that 29 Little Boy Hiroshima Bombs exploded in the sky at the height mentioned. Coincidentally on the same day in Vienna UN Committee on Peaceful Uses of Outer Space Working Group (COPUOS) and Near Earth Objects(NEOs[5]) were having a meeting on how to defend Earth from possible asteroid impacts. The incidence led to formation of International Asteroid Warning Network (IAWN) and Space Missions Planning Advisory Group (SMPAG) both intended to prevent potential impact hazard of asteroid. By January 2018 the discovery of Near Earth Objects had surpassed 17500 mark, an 84% increase since January 2013. Due to the set of developments as above mentioned, in January 2016 NASA established the Planetary Defence Coordination Office (PDCO) which in the time till date has conducted tabletop exercises with Federal Emergency Management Agency (FEMA)[6]. Going beyond simulations, Year 2021, may be the period when NASA will give shape to Double Asteroid Redirection Test (DART), a space flight which when in air will nudge the asteroid from its predicted impact course.

Conclusively the summary of war effort by NASA explains the following:

1. Asteroids now stand categorised based on their weights, distance from earth, impact course, mineral retrieval potential etc.
2. While nuclear payload missiles were created for contingent conditions of Cold War
3. but their use in deflecting a cruising NEO is dubious since a secondary catastrophe is assured in case of a miss.
4. NASA and FEMA have arrived at the challenge of cosmic impacts through tabletop exercises. Scientific Impact Response Team is a consequence of the same. The settings of the table top exercise are at variance with the fine details of a cosmic disaster described in ancient Hindu texts as Skanda Purana.
5. DART space flight mission is a form of satellite observation system which will be a machine prepared to deflect a NEO but desirably not disintegrate it since it would add to the woes of such precision management of secondary asteroids created this way.
6. While the NASA space effort is on time or progressed secretly is not exactly known. However, the entire effort seems to be in contravention to the laws

of Outer Space and no noteworthy diplomatic effort has been registered to date.

7. In case of a disagreement continuing inordinately there is no way the Outer Space Laws help a nation until amidst an exceptional emergency some of the superpowers may consider to abrogate the existing world order which may trigger a chain reaction of events not suited to peace on the planet.

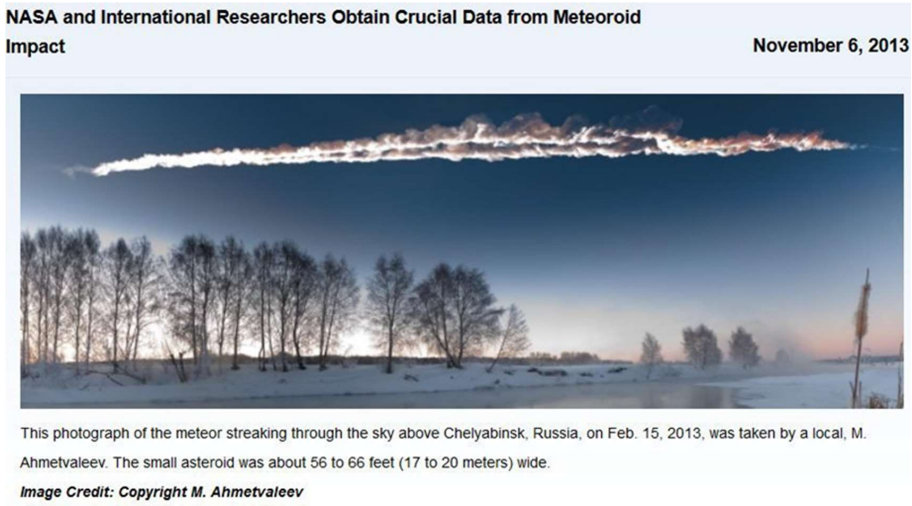


Figure1 : Source:https://www.nasa.gov/content/nasa-and-international-researchers-obtain-crucial-data-from-meteoroid-impact/)

2. Methodology

To arrive at the order in which a cosmic catastrophe may be handled, the author followed the way NASA set up the systems after the Chelyabinsk event and most of which is still evolving. The term 'sites' refer to 'websites'. Thereafter literature relating to ancient Hindu scriptures were collated and the interpretations were drawn in terms of understandable geographical phenomenon. Compared to the Chelyabinsk event where the celestial object remained in air, another detail of an actual impact in Siberian forests of Russia dating back to 1908 was placed alongside for comparison. This gave the lead in formulating a draft agreement between nations in utilizing the superior technical prowess of developed nations as United States of America, hereafter called US, which has been described as COSMIN. In the end based on a hypothetical situation a suggested composition of the Incidence Command mechanism was arrived at based on the author's military experience in combat arm of the Indian Army and with what was

being suggested by academia and NASA with respect to the composition of the scientific community.

2.1 *Analysis of Ancient Hindu Texts with references to the European Bad Star analogy*

The Hindu religion is the oldest manifestation of the balance between fear and faith. While the world today is witnessing fierce man-made disasters synchronised by fanatics, the greedy social bourgeoisie have caused a sheer resource crunch due to which the fine line of natural balance has deviated and the cyclic occurrences of earthquakes, floods and cyclones have augmented in the form of natural disasters. Many scholars have shared the thought process of ancient Hindu mind and have attempted to connect it with the modern trend of short circuiting to leading the end of civilization as a process of self-destruction. The result may be assumed to be a comparative appreciation of sorts.

The 'Bad Star' Analogy[7]comes from Europe but deliberate discussion on cosmic powers are difficult to find. For example, the term 'Disastre' is probably the original English word as per the French history of medieval times. Certain Greek term called 'Disastro' can be linked with it. Over all 'Dis-and Ástro-means the bad star. But why name Disasters as badstar since more catastrophes were known to man is required to be understood. This unforeseen but anticipated form of death like feel is a known form of fear of the unknown.

The greater thoughts have percolated to the following forms of consolidation as per the 2007edition of the Encyclopedia of Disaster Management. The natural phenomenon of Disasters is only a balancing factor of excesses with resources on earth. The excesses are manmade which contribute to this disbalance (Anthropogenic disasters) where terrible events have shaped the end to death. The strange disease which swept out the civilization of Harappa - Mohenjo Daro [8] is similar to the Ebola outbreak[9] in modern times and if this civilization gets wiped out, then it is not sure if the next stage of investigating mankind would be able to decipher the long drawn spells of anthropogenic hazards in their analysis. So these hazards can't be equated with the cosmic events described in Hindu texts. With that is the concept of hybrid disasters which are also called as complex emergencies. A handful of biological and chemical agents are powerful enough to wipe out parties in conflict. It is never always an arms ridden conflict. The BBC investigations of the swine flu pandemic actually links the sharing of profit as the reason for such acts of humans[10]. This is a translation of how subtle would be the colours of an organised economic warfare. In South Sudan the resource rich characteristics of a newborn nation has kept up the funeral pyre of masses meeting everyday with their deaths. The farmers who migrated due to

the primary reasons of conflict and secondary effects of El Nino can't be found anymore after the lapse of the geographical phenomenon[11].

Divinity and ill fate are two thought processes which seem to revolve around the uncertainties which may arise from cosmic and earth based disasters. In Kautilya's texts there is a mention of eight entities (Fire, Flood, Rats, Snakes, Beast, Demons, Famine, Epidemics) out of which the connotation of Demons and Beasts can't be interpreted until an analogy of these being celestial objects like comets and striking asteroids were arrived at in conclusion of this paper. It may be some sort of an extraterrestrial intervention. But the other six can be woven to relate to a cosmic catastrophe. For example, the 2010 floods of Yangtse River in China if would have resulted from a cosmic projectile strike on earth on a faultline, it is most likely that the impact response team would have had to cater for water entering perforations beneath earth leading to surfacing of rodents and reptiles in large numbers. Such crisis could also aggravate human conflict for survival. Nevertheless, in either flood of famine after a wildfire emergence there could be rodent led epidemic setup or plagues and leptospirosis.

In Skanda Purana as illustrated by RN Iyengar[12] the depiction of disaster is restricted to the desertified Kutch-Mount Abu region of India. From the condition of the region which is there even today it seems that in the land of fertility caused by numerous rivers and waterbodies such patches must have come from the shattered fireballs of a nova and this may be considered as corroboration of drying up of Saraswati river and submergence of Dwarka[13].

A mythological description of disasters is worth looking at before analysing the requirements today. In R N Iyengar's texts the creation of Someshwara Linga (the phallus of Shiva which is the master of moon) is probably about a unique lava outpouring that metamorphosed in that shape before putting the human beings in awe in that age. The descriptions of demons as Mandeha and Salakatankata are meteorite impacts which led to agricultural fields on fire and dried up the water resources causing famine. This impact translated to civilisations living in jungles moving to coastal areas where they started eating fish for survival. The citation of some of the sages taking up eating beef and dog's meat or even seeking alms from a Chandala are correlational facts which may be seen as corroboration. The extent of research of R N Iyengar covers the stretch from modern day Gujrat in India till Kurukshetra in Haryana after crossing Rajasthan. The explanations are apt as it describes tributary branching out from legendary rivers as Sarasvati which dried up due to the strike of a burning nova which while piercing the earth caused a well where probably the groundwater streams were led by an overflow condition and they surfaced again from outlets in proximity

as Harini, Vajrini, Nyanku, Kapila and Sarasvati. The meteorite is suspected to be the mount Abu mountain today. Till later times in history, in the writings of Arab travellers in India the mention of a river ending in such trickle is described. The identified tributaries were also probably renamed as Mati (idea), Smiriti (memory), Prajna (conscience), Medha(intellect), Buddhi (wisdom), Giridhara (tall iconic) which are all renditions of the qualities of Sarasvati who in Hindu mythology is Goddess of learning. While large scale death and destruction must have been imminent but emergence of new vegetation with medicinal qualities is well described. The summary of celestial intrusions are as under:

Meteorites come as high velocity balls of fire. The material composition of such nova's may not be known to man. While the damage may be conspicuous but it is a limited time affair with high costs. The positive outcome is the likely generation of medicinal plants or hot springs. The common outcomes are creation of a hill if the meteorite falls on earth, tsunami if it lands in the sea, earthquake if it disturbs the faultline, desertification due to raging fires settling down at the cost of remnant water available, end of river flow to generate new ones unlike tributaries and may be called 'distributaries'.

3. Discussions on Cosmic Strike[14] not deflected

A comet strike will entail localised destruction. In an urban or forest setup it may have cascading effect. So while arriving at the crater a team of scientists earmarked in advance may be a proactive policy decision. As of now in developing countries as India somethings which has gone beyond the coping capacity of the military and civil administration combined, are isolated examples of nuclear proliferation and noteworthy industrial disasters as the Bhopal Gas Tragedy[15]. The correlation thus being established on the earliest recording of mankind in ancient Indian texts in its manifestation in the modern day situation. To repeal such a circumstance, the list may include the geomorphological impact characteristics, environmental impact and biological sustainenance parameters after such strikes.

An asteroid explosion of 1908 in Siberia which led to flattening of 2000 square kilometres of forest in Tunguska region of Siberia was investigated 19 years later. As per studies a delayed explosion could have wiped St Petersburg. So with the nuclear missile interceptors in the inventory of the mighty as United States or Russia a coherent policy could be effective in wiping out these ingressing celestial projectiles or else continue the mapping process in continuation. It may be noted that a crater is created only if the dissipated energy is between 10 Megatons or 10 lakh Megaton. The extinction of Dinosaurs is also related to such phenomenon. Scientists claim that 1 km diameter crater can devastate approximately 8000 square kilometres. This

means that the state of Sikkim or an island size as Andaman & Nicobar Islands would technically vanish.

Here comes the reference of the Torino Impact Hazard Scale as seen on the NASA website[16]. Wildfires may be characteristics of a devastated forest region. The fault lines may get activated creating secondary disasters in the form of earthquakes and Tsunamis. A Scientific Impact response team (SI*RT) would have to undertake preliminary reconnaissance on rotary wing aircrafts or in armoured vehicles or on foot with protective clothing and gear. Unmanned aerial vehicle and drones may be even more useful. The incident command center will have to armed with an image interpretation team of the Defence. A tentative organisational chart may look like one as under in Figure 3&4.

The Chelyabinsk meteorite impact, which becomes the basis of this paper was followed up with some Table Top exercises with FEMA but based on the settings it may be felt that a lot could have been done to arrive at a proactive solution to all these. Based on the composition of the attendees of NASA - FEMA combined a similar exercise can be initiated in India with professionals from AERB[17], Professors from IIT[18] & TISS[19] besides competent academia, MOSPI, meteorological department (IMD) etc. and members of Armed Forces of the Union. An exercise simulator of NASA identified an impending meteorite due to impact the earth in four years' time frame. But such simulation is debatable since in case of a multitude of attack it would be a robot based firing weapon apparatus which will retain the initiative. It would be a challenge to meet the objective due to exacting shortage of time and space. Video-game simulation would constitute the element of innovation in all probability. Nevertheless, these inordinate time lapse, after the NEO has been identified will infuse fear in the sovereign setups due to which the practices in the World order may change and the mighty might start feeling the pulse of control which may crash economies and may serve avoidable miseries to humans of select nation state.

It was also seen that while mass evacuation was spoken of, but the weakening of masses due to Sonic Boom & Dazzle was not placed as a contingent condition. Also the multitude of secondary accidents was not war-gamed. There was no mention of architectural improvements in urban setup leading to escape in predesigned bunkers and underground cavities. For how many aircrafts with nuclear payloads could be scrambled was not forethought. Similarly, the role of missile and artillery units will have to be streamlined. Yet a major role in response would be of that of Army Engineers who would have to streamline firefighting, remove large boulder of debris, carry out explosions and link new lines on communication besides providing for water and sanitation. Then there would be a number of tasks that the SI*RT would provide.

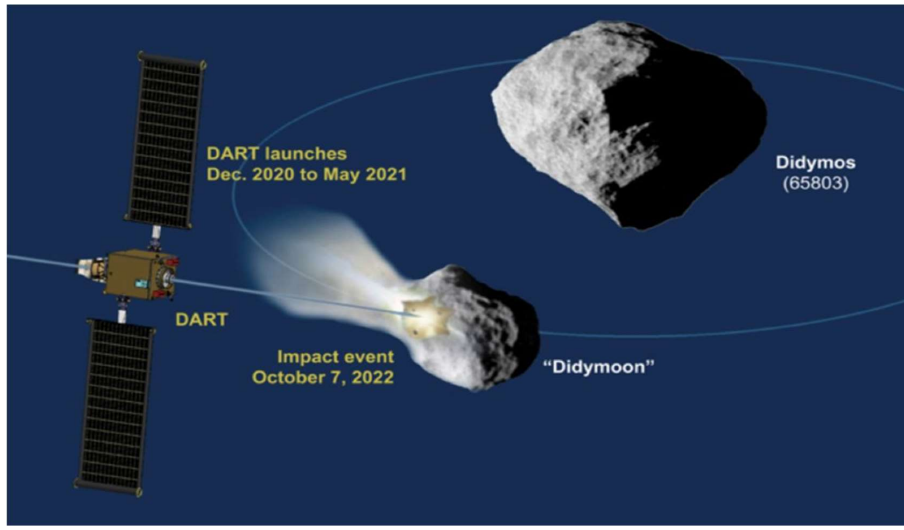


Figure 2 : A DART operation
Source: https://www.nasa.gov/sites/default/files/thumbnails/image/pd-dart-spacecraft-bus.png

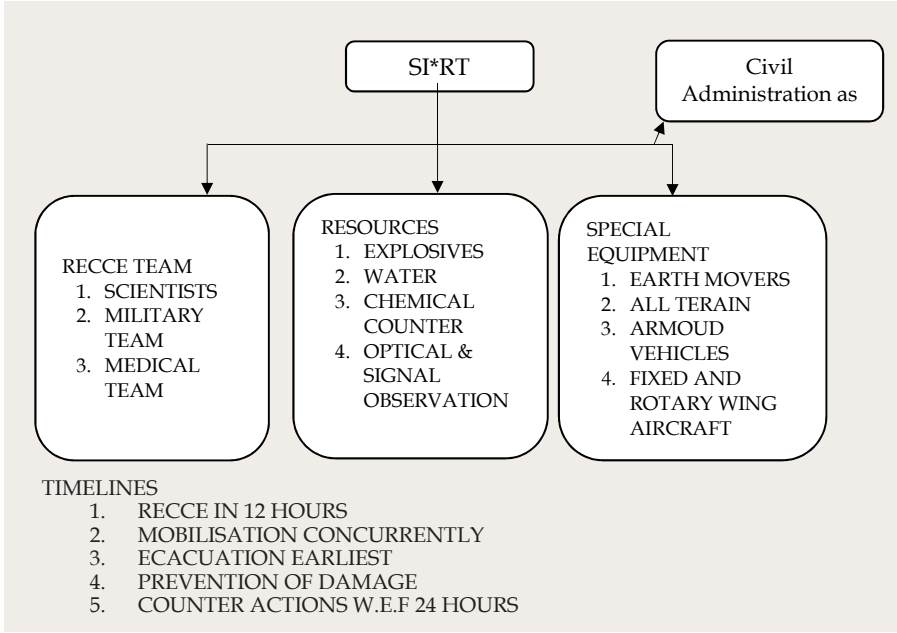


Figure 3 : Incident organisation chart

Some of the new form of actions would be as under:

Event	Feature	Actions recommended
Sonic Boom Precipitations from Orange clouddissolved in the air	High Decibel sound that would shatter glasses or would cause acute damage to human sensory organs. While very less literature seems to be available but a hot falling asteroid which may finally end in upper layers of atmosphere may trigger a rain due to low pressure creation which may lead to acid rain .	As of now more research is recommended but for an identified object entering earth's atmosphere a counter seems possible. All actions of preventing damages from an acid rain may be disseminated. There could be more objectives for the Cosmo chemist.

On Extragalactic Nebulae- notes

*Most comets and asteroids are known to impact locally and global scale damage has never been anticipated and assessed. (Charles Cockell, 2005)

*For energies between 10MT to 10^6 MTa crater will be formed (Arizona Meteor Crater[20]). Beyond that worldwide impact may be considered severe as the way Dinosaurs were wiped out. The event frequency is once per 100 million years.

*In small scale impacts public is likely to be fascinated and anguished. Poisonous fumes and radioactive asteroids are clear and present forms of danger. Commercial information for public may hide information that may cause panic[21], which otherwise people have a right to know.

*Hydrologists will be required to correlate the bathymetric studies.

*Civil Engineers would use the data provided by impact geologists to identify faulting and swamping.

*Fire Response Personnel & Police will have defined tasks

*Concept of 'Gravitational Keyholes'[22] of tangent flying asteroids as 99942 Apophis[23] will have to be consolidated.

*Comets travel faster than asteroid and deliver nine times the energy of an asteroid (Shoemaker Levy 9[24]).

*A NEO is defined as an object that passes within 1.3 Astronomical Units.

*NASA programmes dealing with Potentially hazardous objects (PHOs) are Near Earth Asteroid Rendezvous (NEAR), Deep Impact Mission which slammed into Comet Temple-1 on 04 July 2005, Dawn Mission, QuineQ & Don Quijote.

*Other tools & techniques include nuclear & non-nuclear kinetic impactors, gravity tractors[25], focussed solar & laser energy rockets to change PHO's orbital velocity, asteroid tug etc

*For PHO's larger than 1 km nuclear option can be exercised. To prevent disintegration of a PHO to be deflected a standalone nuclear explosion is recommended. Discovery of such PHOs is desired earliest. Kinetic Impacting Rockets with nuclear payload are secondary options since a miss would have catastrophic results. There are treaties which prohibit placing nuclear weapon in space .

Points not covered in published data but derived from Hindu texts & service experience

#SI*RT Rehearsals may be carried out as EX ASTERHIT 2018 once every five years. The settings will be generated by the military and the choice of station or city is recommended to be drawn from the draw of lots.

#Fire Response personnel will have to arrange for fire extinguishing arrangement through fire lanes when forest fire management situations will be invoked. For urban fires, preparations seems to exist.

#The most conspicuous result of a meteor strike would be profusion of pests, rodents and reptiles attacking the human settlements for which an assured pest control mechanism will be immediately required. There are very few notes from healthcare professionals on this.

Since personal drone aircrafts are coming in a big way it is recommended that mass evacuation may primarily be through self-owned auto piloted four seater drones and secondarily through roads and rail. Airspace clogging will be a new concept which will require an algorithmic streamlining. The NASA sites or existing literature is deficient on organised use of drones.

#Drone systemic plans for implementations will have to be catered by air force. (Refers to Drone Swarms)[26]

Use of rail spines and points of concentration for relief has to figure in Disaster Management Plans. As of now Cosmic Disaster Management doesn't form part of the National Disaster Management Plan of India[27].

While a number of identities and groups are present the clear composition of the scientific team could be as under. It is suggestive only and may be expanded for efficiency

Scientific Team				
Cosmo chemist[28]	B-612 like Foundation[29] for asteroid cataloging	Geologists	Biologists	Atomic Energy Professionals from BARC[30]
Hydrologists	Environmental Engineers	Astronomers & Cosmic Observers	Rodent & Pest Control	Vibration and sound engineers who may have to counter detrimental noise frequencies which may place mental sanity of humans & animals in a state of disarray
Military Team - based on the military arrangement of Chinese during Sichuan Earthquake				
Squadron Air Force	Missile Interceptor Units as BRAHMOS	Engineer Regiments specialists & normal	Reconnaissance & Observation Units (Helicopters)	Firefighting ordnance TFFs
One Division of troops	Naval reconnaissance frigates & other naval specialist services and equipment	Deep Sea Divers	Radiation Patrols[31] with specialist equipment as Drones for reconnaissance	Bomb Disposal and Explosive Experts
Civilian Team				
Land Use planners	Media & Communications	Medical Professionals	Disaster Management Teams	Drone Surveillance Teams[32]
Academia	NGOs	Civil Engineers & Contractors	IRDAI[33]	MOSPI[34]
Indian Railways	CGWB[35]	DGCA[36]	NCMC[37]	Fire Brigade , Police & Civil Defence

3.1 Asteroid Mining

While the 'Doomsday' story may have made an impact on the discerning reader but equally unknown may be the venture initiatives of developed nations in the field of asteroid mining. Since 2012 there are two companies namely Deep Space Industries and Planetary Resources which have come up in the United States of America and aim to harness the potential of asteroid mining. An internet search titled asteroid mining adds much more details. These companies came up since the space travel costs are coming down due to technology upgradations. Moreover, the raw materials for modern industries is likely to exhaust within 50-60 years which is the scope of existing terrestrial mining. The target

locations for new field of resources are asteroids and spent comets. Preliminary estimation aim at water for rocket fuel and platinum since scope is building up for receipt of 10-50% returns on investment. So a spacecraft weighing 300 kg with a capacity of total payload of 1500 kg can transport a ton of environmental wastes to outer space and return with a 1000 kg high value mineral extracts of gold, silver, iridium, osmium, palladium, rhodium, rhenium and tungsten. Or else a combination could be iron, cobalt, manganese, molybdenum, nickel, aluminium and titanium used in construction and manufacturing sector. Apart from this the use of water in outer space may be limited to disintegrating it so that hydrogen and oxygen can be used as fuels. The cost benefit analysis has been carried out through rockets as Atlas V & Falcon 9 rockets which translate the economics to $10000 for getting one kilogram of mass to Low Earth Orbit (LEO). This generates the appreciation on profitability (Thomas Etsy 2013).

Water is found in carbonaceous asteroids (C -Type), which form 75% of the asteroids in the Solar system. The nickel - ferrous group only constitutes 2.5-5 % & B612 foundation for asteroid cataloguing seem to be doing just that. Rare earth metals as the Platinum group metals (PGM) on cheap asteroids (M-type) is far more in the composition than that of earth. The greatest number of asteroids float between Mars and Jupiter but the distance makes the option of mining prohibitive. However, there are identified high value asteroids which have abundance of PGM and in one go an extract from a 1000-meter diameter asteroid can yield 78000 kg of Platinum. Considering the world yield at 1,92,000 kg till 2010 such could overwhelm the market and dramatically crash the price. So smaller asteroids can be cleverly targeted so that consumption rates remain slow but the market rates are also not dwarfed. PGM richness can be achieved by X-Ray spectroscopy and not really through a physical telescope. Thus the near earth asteroids (NEA) hold the scope for being mined first.

A class of easily recoverable objects (EROs) was identified by a group of researchers in 2013 and it was realised that they could be retrieved on earth if their speeds could be reduced to 500 meters per second. These could be S-type of asteroids with 10 times less metal than M -type asteroids and a 10-meter diameter S-type ERO could yield 6,50,000 kg of metal with 50 kg of rare metal as platinum and gold. The privately financed Sentinel Space Telescope which was to be made operational by 2017-18 from the day it was launched in 2013 could make the entire assessment a reality. Militarily the NASA mission OSIRIS-REx with plan to bring back 60 grammes to 2 kg of material is costing US $1 Billion. The Falcon Heavy Launch vehicle in 2018 is a promise towards economically mineable NEA.

Outer Space Treaty, 1967: The Outer Space Treaty constituting five international space treaties and five UN declarations somehow poses a

hinderance. They elementally exert on arms control, non-appropriation of space, freedom of exploration by all nations, safety and rescue of astronauts and spacecraft's, prevention of harmful interference with space activities and the environment, notification and registration of space activities and settlement of disputes. Space constitutes as common territory and belongs to no single state. Space mining is however permitted under the International Space Law but prohibits property rights over territories etc. The serious observations of Outer Space Treaty are as under and due to that a separate treaty on cosmic intervention is required.

1. Extraction of material from outer space is not a natural consequence of exploration. If it is considered embedded, then to what extent and profit cannot be the basis of it.
2. It would be appropriate to consider contesting the concept of gravity tractor since it can slow down an asteroid which may be a NEO but the fall on earth can target a city or region. The rhetoric of NASA and space communities of European nations has to be free of such intent.
3. Only astronauts have been considered as envoys of mankind but no provision exists for Scientific Impact Response Teams (SIRTs). They need to be given such status so that weaker nations permitting such intervention can be helped.
4. There are no countries adopting smaller countries who after such destruction may not be in a position to give a statement as a sovereign entity. Also which of its embassy will take precedence in action is also not known.
5. The treaty is vocal on objects launched in outer space which may land in territory of nations not initiating such launches but has no mention of unidentified or otherwise cosmic object coming in natural or artificial course.
6. What is the exact definition of the term 'Peaceful purposes' and how malafide intentions are going to be established before or after commission. For example, threat, use of force and hostile acts are prohibited for moon only but the extension of the same on earth has not been elucidated.
7. Sample collection and scientific investigation is permitted on moon only, then how the missions of OSIRIS REx are valid?
8. While consultations may ensue but some states may withdraw after they have signed, thus devaluing the binding commitment which may be most required by mankind.
9. The basis of equality cited at all stages of agreement with unequal technical reaches in exploitation of space resources certifies the void of conditionality of such equality. If developed nations go ahead with their

plan, then precious metals will be gained early by them whereas following nations will be constrained to exploit far earth objects when they would have just reached the threshold.

10. The radiation exposure is only expected from nuclear instruments fallout after use from space but in no way are they expected from unstable elements now existing in space which will lose their stability once they are in contact with atmosphere and earth's body.

Preparation Considering an Apocalypse: If humankind becomes the maker of its own demise where nanobots may engulf us, robots may enslave us, artificial intelligence may function detrimentally or genocidal virus from asteroids may take on there are proactive preparations that may be required to be taken on in the same way many nations anticipate destruction after World War III. At the face of it bank balances may vanish while machines and elevators may stop, Water may freeze and ICBMs may be launched from their silos. As a result of these anticipations a nation will have to preserve its sovereign bullion. Medicine, military and agriculture technologies will have to be preserved. A compendium of technologies may be the answer where fire and wheel may form part of its initial write-ups. Alternate set of machines in underground platforms will have to be stocked. Reserve stocks of water, seeds for new plants, nutrition supplements in the form of miniature capsules will have to be stocked. Process to reclaim the ozone layer of atmosphere and earth's magnetic field will have to be consolidated. Life under sun blackouts and corrosive rains will have to be planned. Super volcanic lava fallouts will have to be pre channeled so that life is not choked from ash, CO2 & sulphuric acid. Synthetic fuels as biofuels will hold prominence as much as under earth agriculture under lights powered from nuclear fusion.

4. Conclusion: A Hypothesis of a Conspiracy Theory:

The threat of asteroids and comets hitting the earth is real with dates, time and location known. It is real since some nations may want it to be real in all probability. In the wake of this the treaty called as the Outer Space Treaty of October 1967 (Additional Treaty: Limited Test Ban Treaty of 1963) is being called redundant by US[38, 39] and a few more but may not be so. But there are critical questions that need further corroboration. Firstly, since all the science of NEOs has been collated by NASA and similar agencies the statistics of meteors falling on earth having increased by 84% since the 2013 Chelyabinsk incidence may seem intriguing or dubious since it is also in the same time frame that the concept of asteroid mining has come up. Also this incidence happening on the day when COPUOS meeting was convened seems too good to be true , but assuredly helped the world arrive at work programs which the NASA wanted in all probability .So if asteroid deflection is so much of a concept in the set of published papers

and academic work , it should not be a ploy to propagate asteroid mining by circumventing the Outer Space Treaty by citing cosmic dangers , which in a way is protecting the interests of poor and developing nations who have a legitimate share in mining resources from open space . It could be that just like US scientific society has so many words for asteroid disintegration and deflection, there could be a more secret science to actually attract celestial matter to earth to achieve three aims (slowing the speed of asteroid has been described as one of them through gravitational keyhole). First to defer the costs of space explorations and second to convince the remaining world society of the imminent dangers of celestial objects and the last one being an instrument to intimidate weaker nations. No wonder the asteroid falling in the air space of Russia and making headlines in a way seems to renew the vibes of Cold War and keep the stagnated confrontation alive. Also since asteroids like Apophis the orbit of which will remain known to the target nation for many years and region will continue to be seen by that set of mankind who may be earmarked for crucification, it can be seen as a stretched catapult diplomacy to trade safety for some benefit the stronger nation may be looking forward to accrue .At least in India it is possible that the superstition of Demons & Beasts[40] as described in Skanda Purana will return back and masses will hallucinate[41, 42] Shumbha & Nishumbha[43], Chanda & Munda or even Tarakasura[44] and the political wave will work in favour of U.S who may be seen as holding the trishula[45] finally. That would be clever arm twisting. Already Elon Musk's[46] firm TESLA has achieved the reusable rocket prototype under its SpaceX program[47]. This also makes the possibilities of War imminent since in case of hostilities a country as US may use an MIRV[48] and send a few to probe certain asteroids and get these asteroids on earth so that the cost of War is retrieved through gains of PGM extraction by efforts of private firms as TESLA. During that time the strings attached from the treaties would be null and void.

Notwithstanding the avers made in this paper an additional agreement called COSMIN can supplement the protection parameters of all citizens of the globe which has been drafted as under.

COUNTERING COSMIC PROJECTILE INTERVENTION – COSMIN:

"Negotiated the Ballistic Missile holding nations along with nations not having these or are on the verge of achieving threshold in such missile stocking for which research and development process is in place hereby come to a consensus on utilisation of such sensitive instruments for creating an interception pattern against cosmic projectiles and bodies created or not created by mankind. These include advanced space instruments as kinectic impactor or gravity tractor.

That under the permissions assumed to be granted by this treaty a scientific military and associated experts reaction team will come into force, who will carry out prevention proactively by mapping a portion of the sky allotted under mutual consent. That the interception so planned will preferably plan a destruction trajectory to ensure fallout on the sea or on earmarked wasteland of continents combined or even space. The interception meeting in the sky will be at heights where the fireball or sonic boom will not affect the human settlements beneath. In case of a miss nations will be prepared for the loss and will initiate secondary actions to counter secondary disasters as wildfires, countering known and unknown chemical reactions, earthquakes and tsunamis. This process will be called as countering cosmic intervention. (COSMIN). A SIRT will therefore be also an envoy of mankind as the earlier designation limited to astronauts only.

The financial cost of this project will be as per purchasing power parity of economic interventions anticipated. The costs will also include actual fire practice with unintended man and resource harm and will be well announced for all to take proactive precautions against instrument malfunction. An insurance mechanism will be well built and the premium will be uniformly calculated against compensations desired. In case of lack of corpus such disbursements will never exceed 30 % of the reserves. The premiums will be shared pro rata on the basis of economic potential of signing nations.

Nations will come across a One Disaster Resurrection Plan which may be called as the ODR Plan for short in which preplanned military and civilian interventions will be discussed and implemented. Despite some nations proliferating as rogue nations the benefits will be extended.

But for once for the purpose of stabilisation, after an impact, the inflation index will be frozen for a period of five years to permit all affected to have equal opportunity of growth.Sea lanes of communication will be guarded by sovereign nations except for the powers of moderating navigation which may be done so as not to raise any complaint.

The scope for mitigating disputes is less and so will be mutually decimated. The scope for fraud and deceit remains since in imminently or in later timeframes the larger picture of economic interest may figure out. Apropos the signing countries pledge not to get into these forms of diplomatic strategies at the cost of ignorance of the weaker and others.

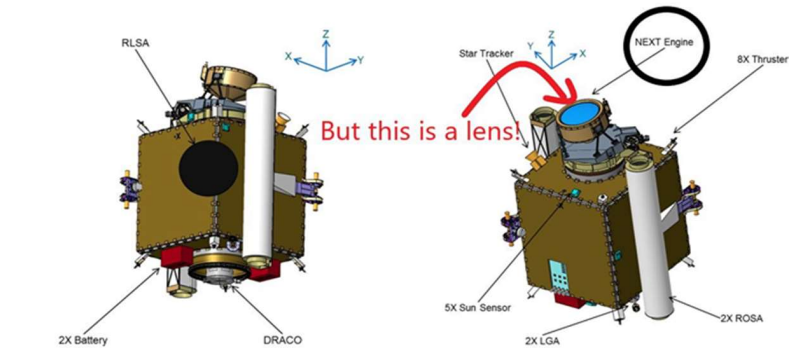
This agreement made on this ---------- day of year ------- will come in force suo moto for all nation states and entities signing it. It will be subjected to review every decade to include scientific and political advancement.

For developing nations as India: As of now the option to deflect space objects as asteroids is military only. But it is essential that the situation solution is included in the National Disaster Management Plan. A SI*RT is required and needs to be given statutory powers. Institutions as IIT need to create specialist professionals as cosmo-chemist. An elaborate exercise as ASTERHIT needs to evolve in reactive and proactive stance. It is well known that the treaty of OUTER SPACE is redundant but deliberate consultations is suggested without falling prey to the mild intimidations as it is being served through media.

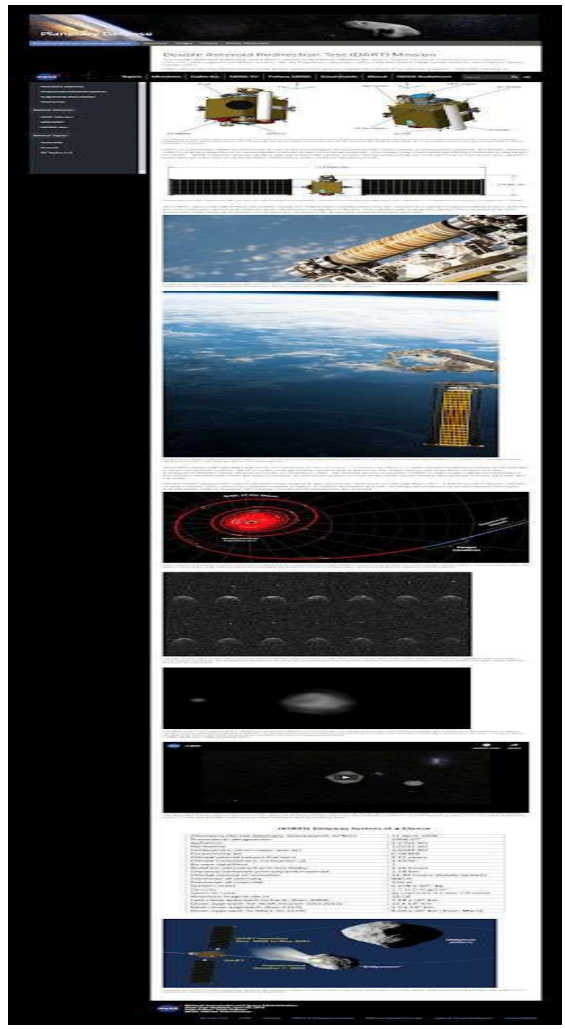
For developed nations as in Europe & US: It is a fact that the gold rush from the asteroids have begun. But it is just a matter of time when scientists from across the nation will make their sovereign entities to capitalise on it. A competition will bring in quarrel and eventually Star Wars will result in. The prophecies of Apocalypse can't be made to come true since greed would blind wisdom. Also it would be myopic to not look at the mankind's documented features on cosmic strikes from times earliest. Extinction of mankind is just a hypothesis but the genetic mutation resulting in deformations is a truth which gold rush cannot obviate.

Contributory Doubts to the Hypothesis in Animated Setup:

1. The lens could search for metals while on asteroid probe or concentrate a laser fire for deflection or delay. Which one is true?
2. A disintegration of asteroid can create an additional NEO difficult to handle or cause loss of PGM which will diminish returns on investment
3. A DART can be a deflector or hooker like harpoon-something that a WMD missile can't do. Here it is on a mosquito bite flight simulation.
4. Are these NASA images with abbreviations not a ploy to put the common man in illusion? Maybe or may not be.



NASA-DART Project - What's RLSA, DRACO,ROSA or LGA?



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Lt Col Devashish De (On Study Leave) Scholar
Jamsetji Tata School of Disaster Studies
Tata Institute of Social Sciences, Deonar, Mumbai-400088
devashishde@gmail.com

Building Capacities for Disaster Resilient Haryana

Abhay Srivastava*, Bhuwan Kumar and Anshu Tiwari

1. Introduction

Disaster risks and vulnerabilities are increasing in the world due to rising population; rapid and unplanned urbanization and indiscriminate exploitation of various natural resources for economic development. Climatic variability and global climate change are also becoming major threats and have started worsening the situation. The 3rd United Nations World Conference on Disaster Risk Reduction (DRR) was held in Sendai, Japan in March 2015, which concluded with adoption of "Sendai Framework for Disaster Risk Reduction 2015-2030" by 187 counties replacing Hyogo Framework for Action 2005-2015.

The Sendai Framework for Disaster Risk Reduction (SFDRR) focuses on disaster risks whereas the focus of Hyogo Framework for Action (HFA) was on disaster losses. The outcome as expected from HFA was substantial reduction disaster losses in lives ad in the social, economic and environmental assets the communities and countries. On the other hand, the expected outcome from the SFDRR is substantial reduction of disaster risks and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries. Thus, the focus has been shifted from minimizing the impacts of disasters to reducing the size and risks of disasters. This shift would have an overall impact on reducing disaster losses.

SFDRR advocates for building resilience and enhancing knowledge through means of better understanding of risks, improved awareness about the response actions to these risks and better preparedness. These measures will help in reducing the scale of disasters. SFDRR also calls for strengthening disaster risk governance to manage disaster risks. It promotes local platforms on DRR in addition to National Platforms and putting people at centre of planning process with assigning the roles and responsibilities for reducing risks to the communities.

Through its third priority "Investing in disaster risk reduction for resilience", SFDRR calls for coordination among regional and national financial institutions

for taking measures for minimizing the risks by investing into early warning and communication, mitigation projects, capacity enhancement and mainstreaming disaster risk reduction into development activities. SFDRR significantly increased the scope of action in recover, rehabilitation and reconstruction by incorporating fourth priority for action.

It is important that we learn lessons from the past disasters in order to build a safer and more resilient tomorrow. While understanding risks we need to address risks in the context of sustainable development and changing climate. Emphasis should be given on understanding the traditional best practices and indigenous knowledge. Better coordination amongst various stakeholders would certainly contribute in reducing the impacts of disasters. Disaster risk reduction should be seen as a policy concern that cuts across many sectors, including health and education. Implementation of integrated environmental and natural resources management approaches is also required for significantly reducing the risks of disasters.

For better implementation of SFDRR the focus should be on analysis of existing risk reduction policies. Well-established mechanism for knowledge dissemination will result into enhanced capacities of the communities. Mainstreaming DRR with consideration of DRR in all sectors and adequate financial provisions are essential for building resilient society and attaining sustainable development.

2. Government of Haryana Initiatives:

Based on the priorities of Sendai declaration, Hon'ble Prime Minister during his address at the 7th Asian Ministerial Conference on Disaster Risk Reduction held in November, 2016, outlined a 10-point agenda for renewing efforts towards Disaster Risk Reduction and to achieve the goals of Sendai declaration by 2030. The state of Haryana under the able guidance of Hon'ble Chief Minister and Hon'ble Revenue Minister of Haryana has established an institutional framework for DRR from state level to grass-root levels. State is implementing the agenda laid by Hon'ble PM and working on most of the components. These components are as following:

Agenda No. 1 : "All development sectors must imbibe the principles of disaster risk management". Seeking the inspiration from the agenda, the developmental departments in Haryana like Town & Country planning, Haryana Urban Development Authority (HUDA) and Public Works Department (Building & Roads) and other developmental sectors are ensuring the implementation of National Building Code in order to come up with Disaster Resilient Structures keeping in view the risks and hazards of the particular areas. In order to streamline the provisions of Building Rules and to facilitate citizens, the Building Rules being followed by the different Agencies/ Departments/ Authorities were then

repealed by the Government and the Haryana Building Code, 2016 was made applicable to entire State of Haryana from 30.06.2016. Thereafter, considering and examining several representations/ suggestions received on the Code, the Code has been revised as the Haryana Building Code, 2017. This building code is bringing the uniformity in the building construction in the State by giving the adequate attention to disaster risk reduction procedure. State is ensuring that all development projects - airports, roads, canals, hospitals, schools, bridges – are built to appropriate standards.

Agenda No. 2 : "Work towards risk coverage for all-starting from poor households to SMEs to multi-national corporations to Nation States" State has taken steps towards risk coverage. In this context, Pradhan Mantri Fasal Bima Yojana has been launched in the State which provides a considerable financial help in case of damage to crops due to natural calamities, pests and diseases. State is also in the way of developing an online portal for this scheme for bringing the transparency in the implementation of the scheme.

Agenda No. 3 : "Encourage the greater involvement and leadership of women in disaster risk management". Trainings are being providing to the women volunteers, Anganwadi workers, Asha workers and Self Help Groups to support special needs of women affected by disasters and making them team members of various teams of first responders in Village, School, College and other safety initiatives.

Agenda No. 4 : "Invest in risk mapping globally". Haryana is vulnerable to Floods & Earthquake. State has a comprehensive Flood Control Program in place which includes investment in flood reduction infrastructure, capacity building and flood preparedness. State Government has undertaken Hazard Vulnerability Risk Assessment (HVRA) of the State as part of preparation of State, District, City, Village and Departmental Disaster Management Plans. For mapping risks related to hazards such as earthquakes, State has widely accepted standards and parameters. State has requested Ministry of Earth Sciences, Government of India to prepare micro zonation of earthquake of the State. Simultaneously, State is also considering micro zonation of the vulnerable areas with the help of different institutes IIT's/ NIT's/ Local Engineering reputed institutions etc.

Agenda No. 5 : "Leverage technology to enhance the efficiency of our disaster risk management efforts" State has an e-platform that brings together organizations and individuals and helps them map and exchange expertise, technology and resources. GIS Resource Inventory of Critical Resources (government) covering almost all the fields like Police, Medical, and Transportation etc., to minimize the response time in case of disaster have been created. It can also be used in normal time for better response and ease of access. Private resources are now been including too in the next phase. Spotting of disaster response resource

inventories in GIS enabled environment in the State has become one of our priorities. In collaboration with NDMA, State are in process of establishing State-of-the-Art Emergency Operation Centre (EOC) at state as State as well as district level, with an integrated system which will connect all the stakeholders from a single central location.

Agenda No. 6 : "Develop a network of universities to work on disaster issues". As part of this network, different universities could specialize in multi-disciplinary research on disaster issues most relevant to them. State would like to open a centre for research in the field of Disaster Management on the issues like Hazard and vulnerability assessment, Risk analysis and further advance technologies. In this regard, State seeks financial assistance from NDMA, MHA and Ministry of Human Resources, Govt. of India. State is also constituting an Advisory Committee comprising of experts from different universities and agencies.

Agenda No. 7 : "Utilise the opportunities provided by social media and mobile technologies". Social media is transforming disaster response. It is helping response agencies in quickly organizing themselves, and enabling citizens to connect more easily with authorities. In disaster after disaster, affected people are using social media to help each other. In this context, State is formally utilizing these technologies to spread the awareness regarding Disaster Management and sharing expertise amongst the researchers, academicians and practitioners. To monitor flood situation during 2016-17 State had collaborated with different organizations and institutions through a whatsapp group of experts and to monitor rainfall and flow of water of the rivers. The group included all the stakeholders, i.e. Hon'ble Chief Minister, Revenue & Finance Minister, Agriculture Minister, Irrigation Minister, Chief Secretary, Administrative Secretaries, Divisional Commissioners, Deputy Commissioners, field level functionaries, NGO's, Central Government institutions like CWC, IMD and NDMA, disaster management officials of Armed Forces and officials of surrounding states/UTs like Delhi, Himachal Pradesh and Uttrakhand. Because of active flood management measures, administration would be able to manage cloud burst like situation when around 365 mm rainfall occurred in short span of five hours in Yamunanagar district by releasing advance warnings and evacuation in 2016. Timely airlift saved eight lives of persons stranded on Yamuna island on 27.07.2016 – this was possible due to faster communication enabled by social media apps. IMD is providing real time data on Earthquake to all the stakeholders of the State through SMS.

Agenda No. 8 : "Build on local capacity and initiative". The task of disaster risk management, particularly in rapidly growing economies, is so huge that formal institutions of the state can at best be instrumental in creating the enabling conditions. Specific actions have to be designed and implemented

locally. In this context, the State Disaster Management Plan and District Disaster Management Plan for all the districts have been prepared and implemented. State have prepared around 3710 government school safety plans, with Hazard, Risk, Vulnerability & Capacity Analysis; trainings on Disaster Management and preparation of different teams of school children and teachers as first responders. The same methodology has been adopted preparing 70 College and 650 Village Disaster Management Plans. The specific sectoral plans like Bus Stands and Railway Stations Disaster Management Plans for all the districts have been prepared. State are now preparing the Disaster Management Plans of Mini Secretariats, Judicial Complexes and Civil Hospitals consisting of HRVC, formation of Emergency Response teams (by designation) and trainings of the teams on specific subjects. State have worked with Department of Sports & Youth Affairs to train the students of schools especially sports persons, NSS/ NCC scouts and NYK volunteers at divisional level, in First-aid, Search & Rescue, Evacuation, Fire Safety and Camp Management who live around vulnerable areas such as Bus Stands, Railway Stations, Flood prone and Industrial areas etc., to make them capable enough as first responders. The Disaster Management Initiatives for Legal Services have been conducted to spread the awareness about legal aspect of Disaster Management Act and its implementation. State is in the way of establishing dedicating State Disaster Response Force.

Agenda No. 9 : "Opportunity to learn from a disaster must not be wasted". State have documented the case studies of past disaster events like Samjhauta Express Fire Tragedy, Dabwali Fire Incident and Charkhi Dadri Air Accident. The lessons learnt from these disasters are also applied in the training of officers/ officials of Govt. of Haryana. State is working for building an e-platform that brings together Centre and States, communities and individuals, scientific institutions and disaster management units and helps them map and exchange best practices, expertise, technology and resources.

Agenda No. 10 : "Bring about greater cohesion in international response to disasters". State is also in consent that the collective strength and solidarity of disaster responders from all over the world could be enhanced if they work under a common umbrella. State will provide its full cooperation to the Central Government in this initiative.

3. Brief Activities on Disaster Risk Reduction (DRR) in Haryana (till 2018):

Under the capacity Building funds of the year 2010-15 year marked by the 13th Finance Commission and 10% of the State Disaster Response Fund S of the state Government, allocated by 14th Finance Commission, the following initiatives have been conducted in the state from year 2012 to till date:

3.1 District Disaster Management Resource Inventory (DDMRI)

The DDMRI has been prepared for all districts of Haryana. This Resource Inventory provides user friendly database of equipment's, their location, quantity and capacity along with the contact person with number in district. For example, in case of an earthquake, the DDMRI gives us details of important resources like JCB/ cranes for debris removal, list of ambulance services in the district, firefighting equipment's, govt. and private hospitals along with their capacity, list of blood banks and blood donors, etc.

The following steps were taken in preparing DDMRI:

- Preparation of Resource Inventory of each government department at district level
- Taking GPS points of each equipment by going in field and taking actual location
- Superimposing the GPS points on district maps using ArcGIS software
- District Resource Inventory Maps prepared

3.2 District Disaster Management Plan (DDMP)

The DDMPs for all the districts of Haryana has been prepared and being updated every year. These DDMPs were based on national guidelines by NDMA, and are highly appreciated by NDMA, even congratulating Haryana as a State with one of the best DDMPs in the country. The following steps were taken to prepare DDMP:

- Conducted Hazard, Risk, Vulnerability, & Capacity (HRVC) Analysis
- Prepared Incident Response System (IRS) of district
- Prepared 'Preparedness Checklist' for each frontline department
- Prevention & Mitigation measures – linking them with schemes running across State
- Financial arrangements, relief & rehabilitation measures
- Updation mechanism of DDMP

3.3 Mini Secretariat Safety Initiative

This initiative was completed to make the critical infrastructures safe in the districts. Mini Secretariat Safety plan of 21 districts has been prepared. The trainings regarding the safety plan have also been conducted to aware the staff of Mini Sec. about the plan and its implementation. Mini Secretariat Safety initiative in each district included following steps:

- Safety Audits and Hazard Analysis of Mini Secretariat,

- Formed first responder teams of the Staff in Mini Secretariat (Evacuation team, Search & Rescue team, First Aid team, Fire Fighting team)
- Safety plan prepared
- Conducted trainings of first responders on evacuation, search & rescue, first aid, and fire fighting
- Conducted mock drills

3.4 Judicial Complex Safety Initiative

Judicial Complex Safety Plans has been prepared for District Courts of 21 districts. This initiative included following steps:

- Safety Audits and Hazard Analysis of Judicial Complex,
- Safety committee constitution
- Formed first responder teams of the Staff in Judicial Complex (Evacuation team, Search & Rescue team, First Aid team, Fire Fighting team)
- Safety plan prepared
- Conducted trainings of first responders on evacuation, search & rescue, first aid, and fire fighting
- Conducted mock drills

3.5 Hospital Emergency Preparedness Initiative

The safety plan of Civil Hospital of each of the 21 districts was prepared for any emergency situation through this initiative. This activity included:

- Safety Audits and Hazard Analysis of Judicial Complex,
- Safety committee constitution
- Formed first responder teams of the Staff in Judicial Complex (Evacuation team, Search & Rescue team, First Aid team, Fire Fighting team)
- Safety plan prepared
- One-day training of doctors, two-day training of paramedics and staff
- Conducted mock drills.

3.6 School Safety Initiative

The total 5100 schools have been covered till date under this initiative. This included identification of 200 schools per district in the nine districts of Haryana representing all blocks, preparing their safety plans as per their respective hazard profile and training of their staff and students for safe evacuations, through mock drills. After conducting school safety in 200 schools per district in nine districts (in 2013-14), the next project covered the next 100 schools in

previous 14 districts. The remaining 7 Districts covered 200 schools. Block-level trainings of teachers on Disaster Management were also organized in all 21 districts. 124 Trainings at Block-level in all 124 blocks of State took place under School Safety Initiative in till 2016. The details of its activities are as below:

- Block level Training of Trainers (ToT) in all Blocks of Haryana
- HRVC Analysis of schools
- Safety Committee constitution in all schools
- Quick Response Teams of Evacuation, Search & Rescue, First-Aid, and Fire Fighting
- Safety Plans prepared
- Mock Drills in 5 schools conducted

3.7 Village Disaster Management Plans (VDMPs)

600 villages per district were covered in 9 districts of the state. These 50 villages were identified on basis of their Hazard, Risk, Vulnerability, Capacity (HRVC) profile in district. Based on VDMPs, Quick Response Teams (QRTs) of villagers were trained in Evacuation, Search & Rescue skills, Fire Fighting, and First-Aid. In the current financial year, 20 villages have been assigned in all the districts of Haryana. The methodology followed under this initiative is as follows:

- Village level Training on disaster management
- HRVC Analysis of village
- Safety Committee constitution
- Quick Response Teams of Evacuation, Search & Rescue, First-Aid, and Fire Fighting
- Village DM Plans prepared

3.8 Railway Station Disaster Management Plan

The main Railway Station/ Junction in the district headquarter of 21 districts was focused towards Disaster Preparedness - on how the District Administration and Railway Administration go hand-in-hand in the district in case of an emergency related to Indian Railways. The activities conducted in this activity are given below:

- HRVC Analysis of Railway Station
- Safety Committee constitution
- Quick Response Teams of Evacuation, Search & Rescue, First-Aid, and Fire Fighting
- Railway Station DM Plan prepared

3.9 Bus Stand Disaster Management Plan:

The Disaster Management Plan of each district headquarter Bus Stand of 21 districts is prepared in the districts focusing on their respective HRVC and staff deployed at the Bus Stand and their roles & responsibilities during peace, as well as emergency times. The procedure under this initiative is as follows:

- HRVC Analysis of Bus Stand
- Safety Committee constitution
- Quick Response Teams of Evacuation, Search & Rescue, First-Aid, and Fire Fighting
- Bus Stand DM Plan prepared

3.10 College Safety Initiative including College Disaster Management Plan:

Five Government Colleges in the district have been chosen based on the HRVC of the district and their individual vulnerabilities. The Disaster Management Plan of 70 colleges is prepared. The following steps were taken under this initiative:

- Workshop on College Disaster Management conducted
- HRVC Analysis of College
- Safety Committee constitution
- Quick Response Teams of Evacuation, Search & Rescue, First-Aid, and Fire Fighting
- College DM Plans prepared

3.11 Secretariat Safety Initiative, Chandigarh

A team from CDM, HIPA was deputed to conduct Safety Initiative for New Haryana Secretariat Sector-17 & Haryana Civil Secretariat, Sector-1 Chandigarh. The following steps were taken under this initiative:

- HRVC Analysis of Secretariats
- Safety Committee Constituted
- QRTs of Evacuation, Search & Rescue, First Aid, and Fire Fighting prepared
- Training to QRTs given
- Safety Plan prepared
- Mock Drill conducted (at Sector-17 building)

3.12 Haryana State Legal Service Authority

The Disaster Management Initiatives for Legal Services have been conducted to spread the awareness about legal aspect of Disaster Management Act and its implementation. The main emphasis was laid on legal services due to unawareness of laws for compensation of Disasters Relief and makes it convenient for local people to aware about the processes and application through Public Prosecutors. In this regard, a two-day state level workshop on "District Legal Service Authority- Disaster Management Initiative" disaster of one Public Prosecutor and one Para legal volunteer with respective districts' Research Officer have been conducted with the objective of outlining their role in Post Disaster compensation and relief distribution. Later on, the trainings for the District Legal Service Authority on the same subject had been conducted in all the districts by trained PPs, Research Officer and Para legal volunteers.

3.13 Safety weeks

Five safety Weeks on Earthquake, Fire, Flood, Chemical/ Industrial and Road Safety had been conducted in all 21 districts for creating awareness and sensitization among the locals/residents of their respective districts. In this year, four safety weeks would be conducted on Earthquake, CBRN (Fire), Flood and Road Safety in all districts.

3.14 Case-studies:

There had been two major disasters in the history of Haryana, a detailed and thorough documentation of which is very important for the sate so as to get qualitative insights and learning for the future preparedness and overall disaster management. Thus, case studies of these disasters were prepared. These four cases were:

- Shahberi Twin Building Collapse
- Charkhi Dadri Air Collision
- Dabwali Fire
- Samjhauta Express Bomb Blast

3.15 City Disaster Management Plans

Every city has its own characteristic and more specific hazard profile as compared to district at large. Keeping in view the same, city-specific Disaster Management plans were made.

3.16 NH-8 Disaster Management Plan

As a district related activity, Research Officer, Rewari prepared the Disaster Management Plan for National Highway-8 for the region in and around Rewari district.

3.17 Brahmsarovar Disaster Management Plan

As a district specific activity, Research Officer, Kurukshetra prepared Brahmsarovar Disaster Management Plan in district Kurukshetra. This place has a religious value and attracts visitors in lacs during festivals such as Gita Jayanti, a national festival.

3.18 Updation & Training based on District Disaster Management Plan and District Disaster Management Resource Inventory (DDMRI)

The trainings on implementation and updation of DDMPs and DDMRI are being conducted in each district of Haryana in every year.

3.19 Resource Inventory using GIS

GIS Lab with Arc GIS software had been established in HIPA. The equipment-wise GIS-Based District Resource Inventory have been prepared using GIS software. The maps give out the details of equipment like type, quantity, contact address, contact person etc., by single clicking on the equipment icon. The resource inventory maps have been created to reduce the response time and to see the information about the particular equipment's in the whole district, in one vision.

3.20 Departmental Disaster Management Plan and Trainings

Five frontline departments will be targeted and the disaster management plans of the same will be made. The trainings for their officials would be conducted. The draft of the template for the same has been prepared in HIPA and would be distributed soon.

3.21 Collaborations

Apart from this, various collaborations have also been established between various State Institutions to conduct the disaster management activities.

a. Haryana Irrigation Research & Management Institute

The trainings of Superintending Engineers, Executive Engineers, Sub-Divisional Engineers and Junior Engineers of Irrigation Department are being conducted in Disaster Management at HIRMI, Kurukshetra. A unique perspective was given to Flood Management through these trainings, and techniques like, GIS & Remote Sensing were discussed in Flood Management. Also, the batch of Beldars, mates, was taken to field visit of Hathnikund Barrage in Yamunanagar.

b. Divisional Training Centres (DTCs) of HIPA

Special training programmes for Class III & IV employees of Govt. of Haryana have been arranged at district-level under their respective Divisional Training

Centres of HIPA. They are being trained as first responders for any disaster/ emergency for the administration/government, making it a Capacity Building measure to strengthen the society.

c. State Institute of Health & Family Welfare

Through this collaboration between, more than 300 Medics & Paramedics of Health Department, Haryana have been targeted to train in Disaster Management and also taught important issues like, psychological first-aid and health-issues post-disasters, etc. These training workshops are one of its kinds and are conducted with a participatory, two-way learning approach.

d. Haryana Institute of Rural Development, Nilokheri

The training of the Panches, Sarpanches, Village Secretaries of Haryana, in ground-level disaster management practices, safeguarding their villages, and sensitizing them towards village disaster management initiative involving their active participation

e. Patwar Institute, Panchkula

To train the Patwaris, Kanungos in disaster management, especially their roles and responsibilities as per their respective District Disaster Management Plans in preparedness time as well as emergency situations.

f. Department of Home Guards & Civil Defence, Haryana

To establish Quick Response Teams in the State by strengthening the department and training its personnel.

g. AIIMS Trauma Centre

Through this collaboration, the training of Medical Officers in specialized EMS skills who undergo an intensive training for five days at AIIMS. Medical Officers enhance their clinical and crisis management skills, through courses such as: Basic Life Support, Trauma Life Support, AIIMS ultrasound trauma life support, along with ED Duty at AIIMS, concluding with mock drill.

3.22 Trainings/ Workshops/ Seminars:

Centre for Disaster Management was created w.e.f. 01st July 1994 in Haryana Institute of Public Administration with an aim to build training, research capability and consultancy within the State of Haryana.

Since then CDM- HIPA is been involved in various trainings and capacity building activities of the state. It has developed various modules for natural disaster, man- made disasters, specialized activities that laid the foundation of proactive approach of disaster management planning and mitigation.

The trainings are conducted on various aspects of Disaster Management from mitigation, preparedness to response and recovery. These include various hazard specific trainings and workshops like on earthquake, fire, flood drought, industrial/ chemical disaster etc. Other themes and sectors targeted for training include Incident Response System, Emergency Medical Services, gender perspective, human rights perspective, school/College safety, Village Safety, Community Based Disaster Management, Legal Services, Panchayat, Nagarpalika, NGO, Red-Cross, NCC/NSS etc., in Disaster Managements, climate change, watershed management, Remote Sensing and GIS, etc. The centre has also conducted various ToT for NCC / NSS coordinators of schools and colleges, DRR workshop, workshop on formulation implementation and updation of DDMP and State and District Resource Inventory, etc. Needless to say that the entire capacity building activities under DRR has been conducted by CDM, HIPA.

3. Road Map Ahead

The Sendai Framework for Disaster Risk Reduction (2015) sets following four priorities and seven targets to support the assessment of progress by the member countries to achieve the goal for Disaster Risk Reduction:

3.1 Priorities

Prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience.

3.2 Goal

- Understanding disaster risk;
- Strengthening disaster risk governance to manage disaster risk;
- Investing in disaster reduction for resilience and;
- Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction.

3.3 Targets

- Substantially reduce global disaster mortality by 2030, aiming to lower average per 100,000 global mortality rate in the decade 2020-2030 compared to the period 2005-2015.
- Substantially reduce the number of affected people globally by 2030, aiming to lower average global figure per 100,000 in the decade 2020 -2030 compared to the period 2005-2015.
- Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030.

- Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030.
- Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020.
- Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this Framework by 2030.
- Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by 2030.

Haryana being a developed State within India did lots of Disaster Risk Reduction work in the area of Capacity Building of all stakeholders like Village, Schools, Colleges, Community, Farmers and all officers and officials Government Departments. However, Haryana needs focused Disaster Risk Reduction activities in terms of resource development, Integrated Disaster Risk Reduction culture into all development; Infrastructure Development like EOC, Warning System, Training & Research etc. to achieve the Sendai goal as well as Hon'ble Prime Minister 10-point agenda on DRR i.e. Delhi Declaration on Disaster Risk Reduction. In nutshell Haryana needs to develop *Road Map for Disaster Risk Reduction* based on its Hazard, Risk, Vulnerability and Capacity to cope up with crisis to become *Disaster Resilient State by 2030*.

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**Head, Centre for Disaster Management, Haryana Institute of Public Administration, Plot No. 76, Sector – 18, Gurgaon , abhays.hipa@nic.in*

Drought variability and its impact on livelihood in Bundelkhand Agroclimatic zone of Madhya Pradesh

A.K. Srivastava[*] and Panakj Kumar Singh[1]

Abstract

The numbers of drought years were increased manifold in the past decade in Bundelkhand Agroclimatic Zone of Madhya Pradesh. The micro level variability of drought was much higher than the temporal scale variability. The occurrence of drought at micro level in the recent decade was much higher. The frequent occurrence of drought in the past decade had increased the soybean and rice yield variability in this zone. This paper attempts to present impact of variability of drought on rice and soybean yield and also rural livelihood. In Datia and Chhatarpur district, the animal discomfort days were increased over the decades. The combination of drought and their cumulative impact has severely affected the livelihood of this zone.

Keywords : *Drought, micro level, ground water level, crop yield, livelihood*

1. Introduction

Madhya Pradesh spreads over 30.8 million hectares of land and has shares around 6.0 per cent of India's population. Around 71.3 per cent of the population lives in rural areas as compared to the national average of 68.8 per cent, making the state largely a rural economy. The state ranks second highest in the country in food grain production only after Uttar Pradesh. Agro-climatic diversity and topographical variations enable the state to grow a wide range of cereals, pulses, oilseeds and cash crops, besides being home to varieties of plant species. Madhya Pradesh leads in the production of Soybean, gram and cherishes the reputation for high quality wheat production. The state is well known for pulses and oilseeds production. Madhya Pradesh has a unique identity as the soya producing state of India. In the *Kharif* season, soybean and rice are widely grown.

Bundelkhand in Madhya Pradesh is considered as one of most downtrodden and poverty stricken region in the country. The region comprises of seven districts of Madhya Pradesh and all of them have their economy predominantly based on rainfed agriculture. Over six to eight decades ago, this region had good

agriculture; however, the current scene in agricultural sector in Bundelkhand is not encouraging. The infertility of land, low productivity, improper land distribution in which a few medium and large farmers have major share in land holdings, lack of irrigation facilities and unscientific cultivation in terms of non-use of modern methods in agriculture have kept the agriculture-based economy on the verge of subsistence only. Moreover, Bundelkhand is known as a drought prone region. The monsoon rains are quite crucial and for past several years, the region has faced deficit rains leading to water scarcity particularly for agriculture related activities. The severity of the distress is also reflected as many social consequences. Successive crop failures and lack of employment has led to migration of working youth and adults leaving children and elderly behind. The ample migration also results into large scale desertion of livestock, deprivation of care and education to adolescents. The most pathetic part of the drought distress is that farmers are obliged to borrow money from money lenders and banks with high interest rates. The weakened financial status of rural farmers has further affected very badly, the social life, health and their livelihood. Though the Bundelkhand Agroclimatic zone is not prone to big natural calamities such as earthquake, cyclone, flood but affected by drought, hot days, hailstorm, frost which ultimately upsetting the farming in this zone frequently.

Drought ranks first among all the natural disasters in terms of extent of effect on population, livelihoods, environment, society and economy (Hewitt, 1997). Rainfall is the primary driver of meteorological drought. Generally, the drought is defined as a deficiency of precipitation over an extended period of time (Eriyagama et al., 2009), while, the meteorological drought is defined usually on the basis of the degree of dryness (in comparison to some "normal" or average amount) and the duration of the dry period. High temperatures exacerbate the effects of drought, damage crops and their establishment, and reduce yields. In India, on the basis of rainfall deviations, meteorological drought is declared if the total season's rainfall is less than 75 per cent of long term mean, while less than -50 per cent deviations represents severe drought (www.imd.gov.in). Drought and floods are natural disasters, which have a direct impact on socio-economic aspects due to marked impact on food production (Vijayvergiya, 2004).

The challenge of drought has been further compounded by lack of water resource development and management projects, negligence of the traditional water harvesting systems, and inclination and adoption of water intensive commercial crops leading to an intense water-stressed environment in the region. Under such situations, the rational management of water resources is possible only by analyzing the temporal and spatial characteristics of drought and evaluating its potential impact on population livelihood. Droughts and famines have occurred in India for centuries and have been traditionally mentioned. Studies by Smith

and Sikka (1987), Singh and Kriplani (1985), Chowdhury et al. (1988), Singh et al. (1992), and Vernekar et al. (1993) have shown that the 30-50-day mode has strong inter-annual variability, which may in turn affect the variability of the monsoon season rainfall through active-break monsoon episodes. A few studies on key aspects of the drought in Bundelkhand region at micro scales pertaining to a specific area have also been carried out by various researchers *viz.*, Pandey et al. (2010), Jain et al. (2012), and Alam et al. (2014), Patel and Yadav (2015) and Kundu, (2018). Swaminathan and Rengalakshmi (2016) reported the impact of extreme weather events on crop yield.

The districts under Bundelkhand zone namely Tikamgarh, Chhatarpur and Datia are chronic drought prone area because of its low rainfall with high inter-annual variability. Thus, the three districts with contrasting rainfall patterns have been selected for analyzing the drought variability. In the present study, temporal and spatial variability in the drought in threes three districts of Bundelkhand region covering an area of about 16426 km^2 are reported. The Impact of of the spatiotemporal variations of meteorological drought on soybean and rice production in the selected districts has been evaluated. Additionally, the study also attempted to assess the major impacts of variability of drought on livelihood of this region.

2. Study area and methodology

Madhya Pradesh, being in the centre of the country touches boundaries of 7 states therefore reflects regional tendencies of different socio-cultural and linguistic patterns. The natural features of the state are also diverse. The state comprises with hill, valley, plateau and plain regions. It has 5 crop zones, 4 soil types and 11 agro climatic regions which add to the biodiversity in the State and acts favourable for the production of various crop types. The agro climatic regions are Chhattisgarh plains, Northern Hill Region, Kymore Plateau and Satpura Hills of Chhattisgarh, Central Narmada Valley, Vindhya Plateau, Gird Region, Bundelkhand, Satpura Plateau, Malwa Plateau, Nimar Plains and Jhabua Hills. The Bundelkhand zone includes the districts of Datia, Chhatarpur and Tikamgarh (Fig.1). The area under the Bundelkhand zone receives relatively moderate rainfall of around 700-1000 mm annually, the climate is dry sub-humid and the soil type is classified as mixed red and black. All these districts have their economy predominantly based on rainfed agriculture.

District wise weather and crop data were collected and procured from IMD, Pune and MP state agriculture economics statistics department, Bhopal. Daily temperatures (maximum and minimum) and rainfall data during the period 1971 - 2010 of these three districts were collected and their normals were calculated and screened for meteorological droughts (negative deviation in annual rainfall > 25% of normal rainfall of a particular place), and animal discomfort (when

daily maximum temperature > 39°C and RH<30%) were analyzed and compared on decadal scale to examine the climatic fluctuations. The associations between drought with soybean and rice yield were examined and analyzed.

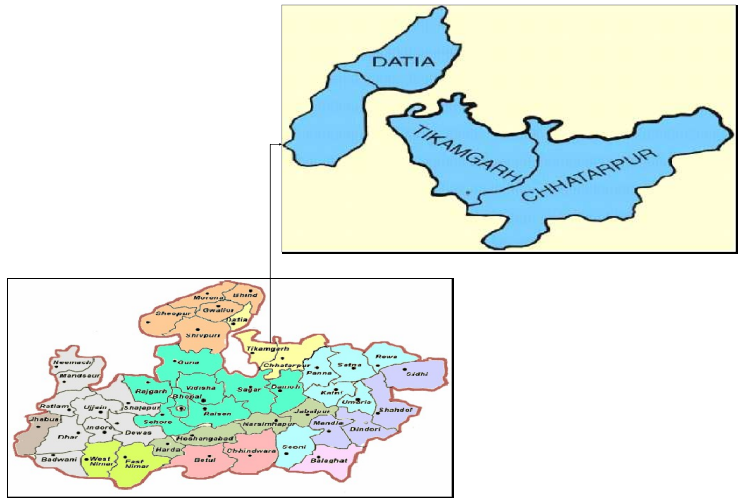

Fig.1 : Location map of Bundelkhand Agroclimatic zone of Madhya Pradesh

2.1 *Climate resource and major crops*

The average annual rainfall is 1050 mm inTikamgarh district, 1,008 mm in Chhatarpur and 794 mm in Datia. About 90% of the annual rainfall occurs during the southwest monsoon (from mid-June to early October), and most of the monsoon surface runoff is lost owing to poor water resource management system. The predominant crops grown in all three districts are soybean, paddy, wheat and chickpea. Sesame and black gram are also grown during *kharif* in Tikamgarh. Mustard in *Rabi* and Paddy in *kharif* is practiced in Datia, while pigeonpea is largely taken in Chhatarpur. Mostly rainfed agriculture is practiced in the catchment, resulting in poor agricultural yields. About 3 % of the total area is irrigated by surface water and 2 % by ground water. Perennial and summer crops are rarely grown. In a major portion of the area, single crop is practiced due to poor groundwater availability and lack of irrigation facilities.

Table 1 : Climate and crops of Bundelkhand Agroclimatic zone

District	Tikamgarh	Chhatarpur	Datia
No. of Block	07	08	04
Annual Rainfall (mm)	1000	1008	794
Major field crops	Soybean, Sesame, Wheat, Chickpea, Black gram	Wheat, Soybean, Chickpea, Pigeonpea	Wheat, Mustard, Chickpea, Paddy, Soybean

Soils are black, red, mixed and alluvial soils, with undulating surface varied from 1 to more than 10 per cent. Soils of almost every area have poor organic content. In Tikamgarh, a yellowish, light- red coloured variety of soil is prominent in Tikamgarh. The soil is sandy and has some clay content. It is well aerated and easily accepts water and is suited for cultivation of sesame. Mostly Red soil are found over granites in Chhatarpur, from which it is derived, and is seen in shades of brown, yellow or grey, depending on the iron content.

3. Results and discussion

3.1 Temporal variability of drought at district level

The chronic droughts in last few decades have hit the Bundelkhand zone of Madhya Pradesh causing near disastrous situation, particularly among the farming communities in rural belt. Reducing rains have created drinking water crisis and diminishing income and starvation-like situation in rural areas. In view of recurrence of droughts in the last decades, an adequate assessment of adverse impacts of drought is necessary to avoid its vulnerability on crop production and livelihood. The temporal variability of droughts years have been analyzed and presented in table 2. It was observed that the frequency of drought at district level increased in past decade.

Table 2 : Decadal variability of number of drought years′ in Bundelkhand Agroclimatic zone

Decade	Tikamgarh	Chhatarpur	Datia
1971-80	01	03	01
1981-90	01	01	01
1991-2000	00	01	01
2001-10	03	04	03

3.2 Spatial variability

A long term study of meteorological drought in Bundelkhand agro-climatic zone of Madhya Pradesh was carried out and presented (Table 3-5). Block wise frequency analysis of meteorological drought has shown a peculiar behavior in this zone in the recent decades.

3.3 Block wise drought in Tikamgarh district

The block wise normal rainfall in the Tikamgarh district varied from 690.3 to 952.2 mm (Table 6). At micro level, the Tikamgarh district was affected by the meteorological drought to a tune of 16 (Palera) to 23 (Jatara) per cent (Table 3). A close analysis of the meteorological drought indicates that before the year 2000, the frequency of meteorological drought at micro scale was very low and some of the blocks (Tikamgarh, Niwari and Baldevgarh) were even not affected

by the severe drought year 1987. The variability of meteorological drought at block level is high. Out of seven blocks in Tikamgarh district, the Jatara block was maximally (seven out of ten years) hit during the recent decade. The frequency at micro scale during recent decade was increased very much and the meteorological drought sometimes affected the micro level in consecutively two to three years (2005,2006,2007) due to which the crop yields were severely affected. On an average, the frequency of meteorological drought affecting the blocks of Tikamgarh districts to an extent of 40 per cent in a decadal scale. The occurrence of droughts in Palera block was the lowest in the district although, the highest number of drought in this block was occurred during the decade of 1991-2000.

Table 3 : Block wise distribution of meteorological drought in Tikamgarh district of Madhya Pradesh.

Block Name	Data-base	Normal Rainfall (mm)	Drought year	Lowest-highest Rainfall (mm)
Tikamgarh	1970-2010	952.2	1986, 1991, 2001, 2007, 2010	333.0-1701.0
Jatara	1970-2010	815.0	1975, 1986, 1987, 1998, 2000, 2001, 2002, 2005, 2006, 2007, 2010	422.0-1492.3
Niwari	1970-2010	842.0	1975, 1978, 1979, 1981, 1989, 1994, 2000, 2006, 2010	342.9-1504.4
Baldevgarh	1981-2010	690.3	2005, 2006, 2007, 2010	262.0-1338.4
Prithvipur	1982-2010	824.7	1983, 1987, 1989, 2000, 2004, 2005, 2006, 2007	338.0-1302.4
Palera	1985-2010	782.9	1986, 1987, 1988, 2006	433.0-1342.5
Orchha	1985-2010	749.8	1985, 1987, 1988, 2004, 2005, 2006, 2007	382.5-1191.0

3.4 Block wise drought in Chhatarpur district

The block wise normal rainfall in the Chhatarpur district varied from 837.3 to 1111.1 mm (Table 4). At micro level, in the Chhatarpur district, Gaurihar (17 per cent) was least affected while Bijawar (27 per cent) by the meteorological drought. A close analysis of the meteorological drought indicates that all the blocks have been getting affected since the decades of seventies or eighties. The

variability of meteorological drought at block level is high. Out of seven blocks in Chhatarpur district, the Baxwaha block was maximally hit during the recent decade. In Baxwaha, the frequency was even high during recent decade and the meteorological drought affected the micro level in 2001, 2006, 2007 and 2009) due to which the crop yields as well as livelihood were severely affected.

3.5 Block wise drought in Datia district

The block wise normal rainfall in the Datia district varied from 667.9 to 778.3 mm (Table 5). At micro level, the Indergarh block in the Datia district was maximally affected by the meteorological drought to a tune of 25 per cent. The Bhander block also faced meteorological drought to a tune of 25 per cent, however the recurrence of drought was only in recent decade. The variability of meteorological drought at block level in Datia district is high. Out of four blocks in Datia district, the three blocks namely Seondha, Bhander and Indergarh were hit thrice during the recent decade. The frequency at micro scale during recent decade was increased very much and the meteorological drought sometimes affected the micro level in consecutively two to three years (2005, 2006, 2007) causing near ruinous situation of crop production.

Table 4 : Block wise distribution of meteorological drought in Chhatarpur district of Madhya Pradesh.

Block Name	Data-base	Normal Rainfall (mm)	Drought year	Lowest-highest Rainfall (mm)
Chhatarpur	1970-2010	931.7	1973, 1974, 1988, 1995, 1998, 2000, 2007	40.0-1543.6
Badamalhara (Loudi)	1976-2010	949.3	1979, 1986, 1997, 1998, 2006, 2007	65.7-2003.6
Bijawar	1976-2010	1111.1	1979, 1986, 1989, 1990, 1992, 1996, 2001, 2007, 2008	63.0-1747.0
Nowgoan	1976-2010	966.7	1976, 1981, 1986, 1989, 1993, 2005, 2007, 2010	126.0-1763.0
Baxwaha	1982-2010	1061.0	1989, 1991, 1995, 2000, 2001, 2006, 2007, 2009	443.0-1513.0
Rajnagar	1986-2010	916.6	1986, 1989, 1995, 1998, 2006, 2007	491.9-1413.1
Gaurihar	1986-2010	837.3	1986, 2001, 2006, 2010	422.2-1256.4

Table 5 : Block wise distribution of meteorological drought in Datia district of Madhya Pradesh.

Block Name	Data-base	Normal Rainfall (mm)	Drought year	Lowest-highest Rainfall (mm)
Datia	1970-2010	748.7	1972, 1979, 2005, 2006	338.0-1295.0
Seondha	1986-2010	711.0	1987, 1989, 2002, 2005, 2006	390.0-1003.7
Bhander	1998-2010	778.3	2005, 2006, 2007	391.0-1002.0
Indergarh	1986-2010	667.9	1986, 1987, 1990, 2005, 2006, 2007	47.8-1170.1

Numerous studies have been conducted across the globe to analyze the spatial characteristics of drought. Almost in all the studies, droughts were quantified at different locations using several hydrologic data from the study area. Clausen and Pearson (1995) performed the regional drought frequency analysis to have better results for a specific area with very limited or inadequate data available. Under the study, the interrelationship was also analyzed between duration and severity of the largest annual droughts at a range of locations through linear regression analysis. Besides, a lot of studies have been conducted for evaluating the characteristics of drought for different periods and sites. Studies by Estrela et al. (2001), Yoo and Kim, (2004), Gocic and Trajkovic (2014) involved analysis of droughts in terms of the temporal evolution and the frequency of drought for the identified regions. Several scientists in India carried out decadal (Kulshreshtra and Sikka, 1989) and regional studies (Narain et.al.,2000,2001,2006) on drought. The epochal behavior of drought has been discussed by Joseph (1978), Sikka (1980), and Mooley and Parthasarathy (1984). AppaRao (1991) classified the drought-prone areas and chronically drought-affected areas. Sen and Sinha Ray (1997) have shown a decreasing trend in the area affected by drought in India. Gore and Sinha Ray (1999) made a detailed study of the variability of drought incidence over districts of Maharashtra. Sinha and Shewale (2000) have determined the probability of occurrence of drought on the basis of summer monsoon rainfall data for the period 1875-1999. Parthasarathy et al, 1987 studied the abnormalities in the performance of the Indian summer monsoon (June to September) rainfall during the period 1871 to 1984 over different meteorological subdivisions of India and found high probabilities of occurrence of droughts in Haryana, Punjab, west Rajasthan, Gujarat and Saurashtra and Kutch subdivisions.

3.6 Impact of drought on district level crop yield

Weather risks and climate fears have direct pressure on cropping systems and crop yield. The cumulative buildup of meteorological droughts rippled into hydrological as well as agricultural drought with a complex set of highly

differentiated adverse impacts and tradeoffs. Advent of drought episodes during the growing periods or at critical development stages of the crop may hinder growth processes leading reduction in harvestable yield. However, a clear perceptive of the vulnerability of food crops as well as the agronomic impacts of drought is very necessary to take on adaptive approach for mitigating its negative effects. Drought and its impact on crop production had been reported earlier (Parthasarathy et.al.,1988, 1987, Ramana Rao.et. al.,1981, Ramakrishna et.al.1984, Sastri and Patel, 1984, Sastri ,1985, Chaudhary et.al,1989) in our country. The drought occurrence is associated with many negative impacts on food, fodder and ground water recharge as well as water resources. The primary necessity of food for human and fodder for animals largely depends on precipitation in rainfed area. The semi-arid region of Bundelkhand is affected by recurring droughts and thus limits the overall food grain production. A district level analysis of drought and its impact on rice and soybean crop was performed and presented in figure 2 to 5.

3.6.1 Tikamgarh

The decadal rice yield in Tikamgarh district varied from 250 to 1120 kg per hectare. The rice yield variability in the district was increased in the recent decade when the occurrence of drought was very high. It was observed from the analysis that the drought decreased the rice yield by 46 per cent at Tikamgarh. The drought and rice yield relationship is explained by other researchers too (Kumari et al., 2004; Srivastava et al., 2000) and they reported that the rice yield was decreased by drought in Chhatisgarh and Bihar also.

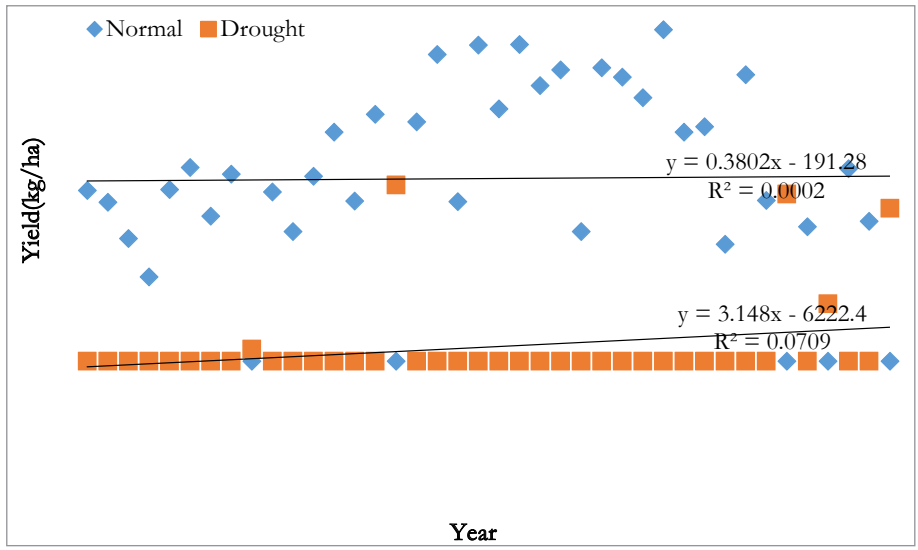

Fig 2 : Rice yield in normal and drought years at Tikamgarh

The decadal yield of soybean in Tikamgarh district varied from 390 to 1500 kg per hectare. In the last decade, the soybean yield variability was increased in the district when the occurrence of drought was also very high. It is very clear from the analysis that the drought decreased the soybean yield by 35 per cent at Tikamgarh (Fig.2) The infrequent rainfall and consistent drought cause stresses throughout flower induction and pod elongation in the crop that may have the greatest effects on final soybean yields. The effect of drought on soybean yield was also studied by Srivastava et al., (1996) confirming that the soybean productivity was decreased by drought in central India.

3.6.2 Chhatarpur

Figure 4 depicts the long term yield data of rice in normal and drought years at Chhatarpur. The decadal rice yield in Chhatarpur district varied from 425 to 1100 kg per hectare. In the last decade when the occurrence of drought was very high, the rice yield variability in the district was also increased. It was observed from the analysis that the drought decreased the rice yield by 44 per cent at Chhatarpur.

The decadal yield of soybean in Chhatarpur district varied from 320 to 850 kg per hectare. It is clear from the figure 11 that, with increase in the occurrence of drought, the soybean yield variability was increased in the district. It is also observed that drought has decreased the soybean yield by 22 % at Chhatarpur.

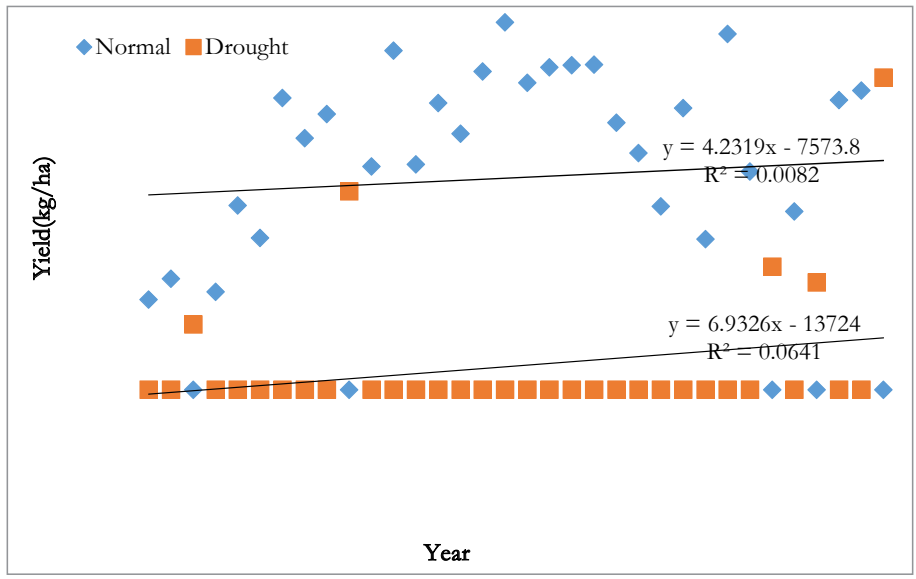

Fig 3 : Soybean yield in normal and drought years at Tikamgarh

3.6.3 *Datia*

The decadal rice yield in Datia district varied from 200 to 1800 kg per hectare. The reducing numbers of heavy rainy days incur heavy costs to the district communities in the form of reduced rice yield. It was observed from the analysis (Fig.6) that owing to the drought, rice showed a 24 per cent yield reduction at Datia.

The decadal yield of soybean in Datia district varied from 390 to 1100 kg per hectare. The soybean yield variability was increased in the last decade with the occurrence of more frequent drought in Datia district. It is very clear from the analysis (Fig. 7) that the drought decreased the soybean yield by 35 per cent at Datia.

3.7 *Drought Risk and livelihood:*

The Bundelkhand zone has been experiencing real and visible impacts of weather risks in last few decades. During the past five to six decades, there has been a steady increase in temperature, adversely affecting almost all sectors of the economy. Several droughts have been recurrent while water levels in entire Bundelkhand zone have dropped significantly. Risk of acute water shortage and the exposure of the communities to the problems arising thereafter make the zone highly drought vulnerable. Although the impacts of these weather risks are global, the most vulnerable are the poor and marginalized people who depend most directly on their ecosystems for survival. These people have the least capacity to bear climatic risks.

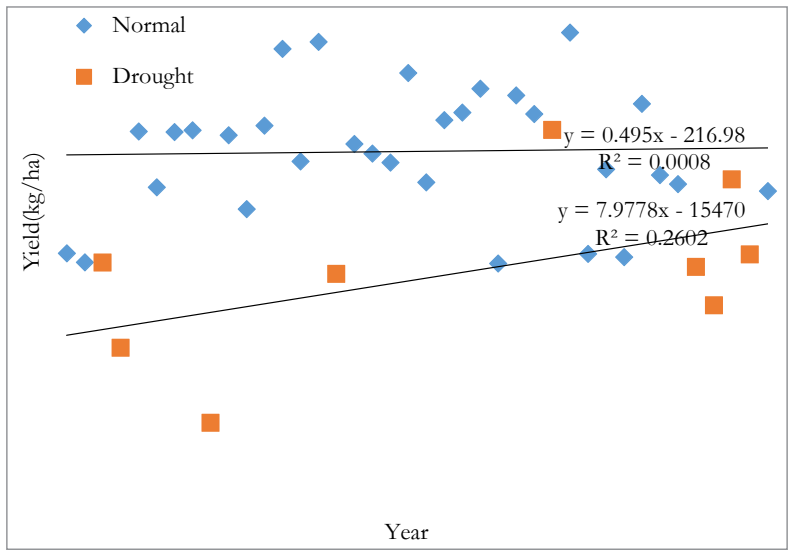

Fig 4 : Rice yield in normal and drought years at Chhatarpur

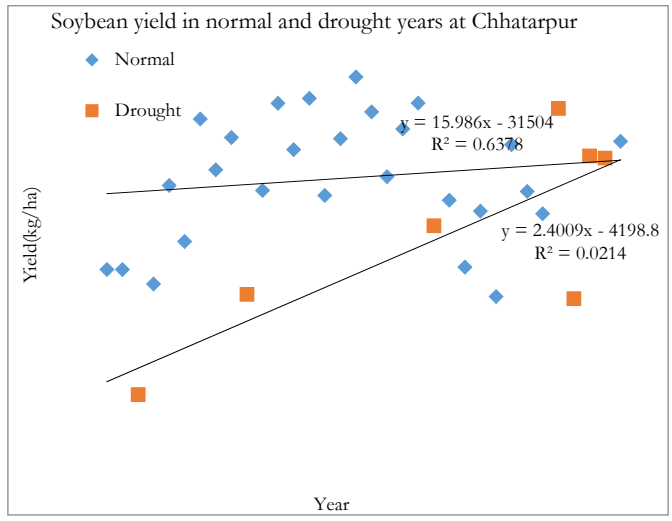

Fig 5 : Soybean yield in normal and drought years at Chhatarpur

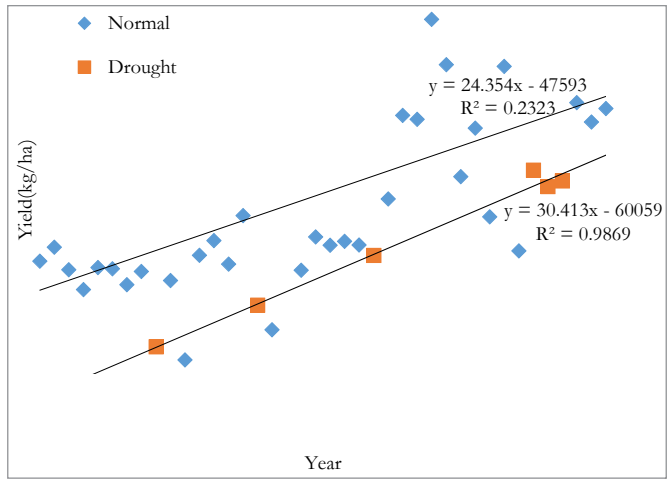

Fig 6 : Rice yield in normal and drought years at Datia

The pre and post monsoon ground water level and animal discomfort are analyzed and presented in figures 8 and 9respectively. It is quite evident from figures that the ground water level before and after monsoon and animal discomfort are decreasing and increasing over the time. The major livelihood of the rural people depends on agriculture and the continued drought years and decreasing water level lagging the impact on other major components of agriculture too. These entire situations are becoming more and more critical for the livelihood of the rural population as the basic income from the crop yield is at stalk. Krishnamurthy (2012) reported that increased likelihood of

climate-related disasters is likely to increase the vulnerability of exposed populations. He also reported the relationships between extreme weather events and migration and suggested for adequately planning and effective adaptation strategy.

3.8 Ground water level scenario:

Rainfall has a direct impact on water resources, particularly in Central India where monsoon-rainfall is the only possible mean for ground water recharge. A continuous spell of poor rainfall in successive weeks/months in combination with high temperature affects ground water recharge and imparts stress on ground water resources leading to severe drought in many parts of the region.

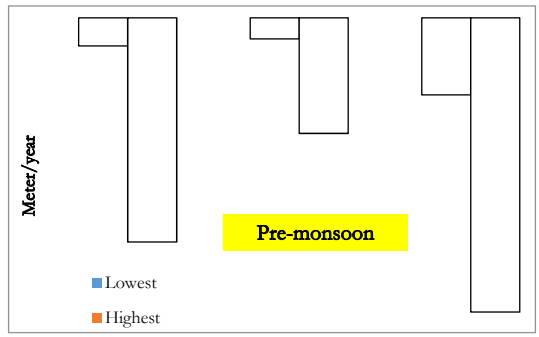

Fig 8 : Trend of ground water level during last decade in Bundelkhand Agroclimatic
Source: *Central Ground Water Board annual report 2014-15*

Ground water is main source of irrigation and constitutes to more than 80% of the total agricultural water use in all the three districts. In Tikamgarh district, wells being the main source of water for irrigation records maximum number (76215) of dug wells leaving Chhatarpur in numbers but significantly not far behind. Unlike Tikamgarh and Chhatarpur district, less than one third and half of the total numbers of dug wells, tube wells and tanks available in Datia indicating lesser trend of irrigation is groundwater dependent (*ie.* wells and tube wells). In all these districts, several water harvesting structures have been created in the recent past to ease the water situation. These water harvesting structures encompass the Bundela tanks, step wells, village ponds, haweli bundhies etc. however, many of these structure are currently in a state of public ignorance and are no longer able to harvest water for use during summer periods. In the last decades, a number of dams and reservoirs have been constructed over the local rivers namely Betwa and Jamni and their tributaries. Canals have been taken out from most of these reservoirs for water supply to Tikamgarh and Chhatarpur towns and for irrigation purposes.

3.9 Animal discomfort

The high temperatures in combination with humidity affect the milking potential of cattle. Episodes of drought, extreme heat or cold events are often responsible for the major impacts on animals' health. In Bundelkhand zone, livestock form an integral part of rural livelihood in addition to crop production. To study the impact of high temperature in combination with low humidity were analyzed to see their temporal changes. A long term data of Animal discomfort days in three districts of Bundelkhand Agroclimatic zone is presented in table 6. It is fairly noticeable that in Chhatarpur and Datia districts, the animal discomfort days have radically increased. In Tikamgarh district also, the number of animal discomfort days increased in the last decade by twenty. This sharp increase in discomfort days at Chhatarpur and datia district impacted the rural economy substantially. Several studies have also reported change in animal physiological behavior during exposure to environmental stress with the variations in the body temperature, respiratory rate, sweating rate and heart rate (Das et al., 2016; Da Silva et al., 2000,). Sandip et al., (2018) studied the thermal humidity index on buffalo milk production in Tikamgarh district and reported that long period of high ambient air temperature affects the ability of lactating buffalos.

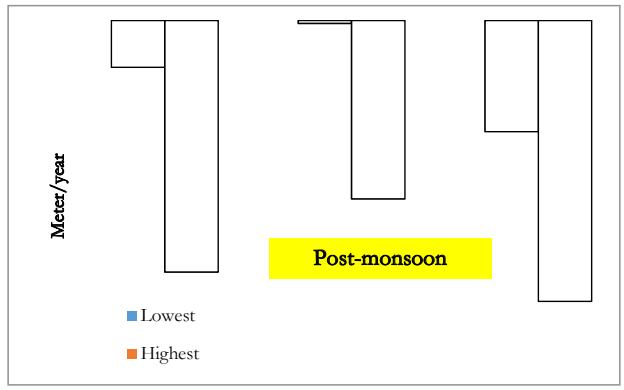

Fig. 9 : Trend of ground water level during last decade in Bundelkhand Agroclimatic zone
Source : *Central Ground Water Board annual report 2014-15*

Table. 6 : Animal discomfort days in Bundelkhand Agroclimatic zone

Decade	Tikamgarh	Chhatarpur	Datia
1971-80	613	615	-
1981-90	688	698	676
1991-2000	656	761	714
2001-10	676	767	757

3.10 Managing Weather Risk in Agriculture

3.10.1 Risk transfer options

To transfer the climate risks losses, multiple peril farm insurance like Pradhan Mantri Fasal Beema Yojna or parametric insurance may be utilized. Crop/ weather insurance should be promoted to reduce the impact of drought towards achieving stability in farm income. The traditional way to manage price variability used to be the pre harvest agreements between growers and purchasers through entering into a pre-determined specific price for future delivery while the forward contracts and contract farming could be brought in practice in Bundelkhand to manage the market price fluctuations. A few risk management strategies are furnished in table 7.

Table 7 : Risk Management Strategies in Agriculture

Informal Mechanisms		**Formal Mechanisms**	
		Market based	**Publicly provided**
On-farm	Avoiding exposure to risk Crop diversification and Intercropping. Diversification of income source Buffer stock accumulation of crops or liquid assets Adoption of advanced cropping techniques (fertilization, irrigation, resistant varieties)		Agricultural extension Integrated Pest management systems Irrigation systems)
Sharing risk with others	Crop sharing Informal risk pool	Contract marketing and futures contracts Insurance coverage net	
Coping with shocks	Sale of assets Reallocation of labor Mutual aid	Credit	Social assistance Social funds Cash transfer

Source : *Adamenko 2004, World Bank 2001.*

3.10.2 Crop management strategies

The conservation agriculture based crop management technologies including zero tillage with residue recycling, direct seeding of rice, raised bed planting and integrated approach for water, nutrient, pest-disease and weed management technologies may have potential to combat the drought and its variability impact in future. Diversification in cropping system and cultivation of more efficient C_4 crops like maize, sorghum and bajra in Bundelkhand zone may be

adopted to minimize the ill effects of drought. A brief of the crop management actions is given in table 8.

Table 8 : Crop management and early warning strategies for climate risk management

Sections	Drought	Extreme high temperature	Heavy rainfall	Higher temperature difference
Crops	Drought tolerant cultivars	Heat tolerant cultivars and bright farming	Ridge and furrow system Drainage	Move sowing window
Weather forecasting/ Early warning	Fortnightly forecasting of dry days	Excessive hot day and cold day forecasting	Forecasting of very heavy to heavy rainfall forecasting	May be forecasted
Cattle and Sheep	Buffer feeding over the summer.	Increasing water storage and creating in-field shelters.	Provision of additional feeding. Increased feed and bedding stocks.	Shading
Poultry	upgrading the water delivery system.	Improving insulation and ventilation, providing mud wallows and	Improving building design. – Increased feed and bedding stocks.	Shading and heating

4. Summary

Recurring drought and high frequency of hot days were observed in Bundelkhand Agroclimatic zone. The meteorological drought variability was found to be high at block levels in the past decades. The decreasing ground water level during pre and post monsoon season aggravated the impact of the drought on rice and soybean yield in Datia and Chhatarpur district, the animal discomfort days were increased over the decades. Dependency of more than 70 per cent population on agriculture is directly affected by the occurrence of the variability of the drought in this zone. Increase in hot days had negative impact the animal health and milk production at Chhatarpur and Datia districts. Drought has impacted more the rice yield and Tikamgarh and Chhatarpur districts. The recurrent drought in the zone is very apparently reflected in successive crop failures and lack of employment, which has led to migration of working youth in mass. The weakened financial status of rural farmers has further affected very badly, the social life, health and their livelihood.

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**College of Agriculture, JNKVV, Tikamgarh (M.P.)-472001*
Email-ajay_weather@yahoo.com
[1]Centre for Disaster Management,
Lal Bahadur Shastri National Academy of Administration, Mussoorie-247982
pksingh66@gmail.com

Assessment of livelihood vulnerability to climate change and disasters: The case of marine fishing communities in Visakhapatnam, A.P

P. Eswara Rao* and M. R. G Naidu[1]

Abstract:

we developed Livelihood Vulnerability Index (LVI) and Livelihood Effect index (LEI) to assess the livelihood vulnerability of natural resource dependent marine fishing communities in Visakhapatnam Costal area to the impacts of climate change and disasters along with various socio economic factors. Primary Data collected from 335 respondents through household survey complemented with secondary data. A composite index was calculated and differential vulnerabilities were compared. The results of the analysis suggest that livelihoods of rural fishing communities were found to be more vulnerable than the sub-urban and urban fishing communities particularly in relation to housing, social networks, knowledge and skills, infrastructure, finance and social resource; where as sub-urban communities are slightly more vulnerable to climate change, natural disasters, and natural resources components when compared to rural and urban fishing communities. Overall, this approach used in this article may be used to monitor vulnerability, planning resources for assistance and these three vulnerability assessment indices could usefully establish the basis for a nationally applicable index to identify and prioritize adaptation and mitigation needs.

Keywords: *Livelihood, Fishing, Vulnerability, Index, Disaster.*

1. Introduction

Climate change is a global problem, its impacts differ across regions, countries, sectors, and communities (Adger *et al*., 2004). Marine fishing communities of the developing countries are most affected by the climate change because of their low adaptive capacity and limited access to alternative livelihoods (Kurukulasuriya and Rosenthal, 2003; IPCC, 2007; Skoufias *et al*., 2011). The degraded coastal and marine ecosystems and their common pool resources are highly sensitive to slight changes in natural climatic conditions (Lee and Dan

2005; Duc *et al*., 2012). The urban and sub-urban coastal areas of Visakhapatnam region has experienced a much higher economic growth, but the rural coastal areas are underdeveloped and the poverty rate is the highest (DAHDF/CMFRI, 2012). However, there is little information on how vulnerable are the marine fisheries based livelihoods to climate change and how vulnerability differs across different marine fishing communities situated in different regions along the same coastal region of Visakhapatnam district. Therefore, this study aims to develop and explain livelihood vulnerability of marine fishing communities to climate change from sampling locations in three clusters i.e. rural, urban, and sub-urban by applying three different aggregate indices (LVI, LVI-IPCC, and LEI) for assessing livelihood vulnerability.

Assessing the factors contributing to livelihood vulnerability is the first step in developing appropriate adaptation strategies (Ford and Smit, 2004), informing applicable policies and programs to reduce risks associated to climate change (Fussel and Klein, 2006; Huong *et al*., 2017; Huong *et al*., 2018). Previously, vulnerability studies tended to have a "single stress or single outcome" approach focusing on the physical impact of a disaster and its negative effects (Eakin and Luers, 2006). Subsequently, scholars argue that vulnerability assessment must integrate and test interactions between humans and their physical and social surroundings, economic and political environments (UNISDR, 2004; IPCC, 2014). Moreover, the activities of people in sight of their varying age, gender, and ethnicity characteristics are equally significant (Juntunen, 2005; Fahad *et al*., 2018; Fahad and Jing, 2018). Finally, approach method is more appropriate in examining climate change driven disaster impact and is a comprehensive view of vulnerability taking into account exposure, susceptibility, socioeconomic conditions, and resilience measures of households (HHs) (Birkmann and Wisner, 2006). There is no consensus on vulnerability assessment method, but most of the evaluation indicates one or more exposures to risk, susceptibility, and resilience (Cutter *et al*., 2003; Eakin and Luers, 2006). However, adaptation and resilience measures of livelihood may not be effective in coping with disaster without assessing and identifying vulnerability to the existing socioeconomic reality (UNISDR, 2004) and cannot take into account the impact of disaster in the time and space frame. A reasonable approach to vulnerability assessment involves, studying how vulnerable are the livelihoods of a community is compared to others and which component pushes up the level of vulnerability within the community. The framework based on the IPCC definition (IPCC, 2001) is considered as a powerful analytical tool for livelihood vulnerability assessment. Within this broader framework, Hahn *et al*. (2009) developed an indicator-based vulnerability assessment that has been used by many scholars in different contexts (Can *et al*., 2013; Shah *et al*., 2013; Madhuri *et al*., 2014; Panthi *et al*., 2016; Tjoe., 2016). Here, three types of indices are developed and compared based on different indicators. The livelihood vulnerability index (LVI)

is a composite index of all major parameters, the IPCC vulnerability approach frames the major parameters into three contributing factors to vulnerability: exposure, sensitivity, and adaptive capacity (IPCC, 2007; Hahn *et al*., 2009), and the livelihood effect index (LEI) indicates different types of capital assets that affect an HH more severely (Chambers and Cornway, 1992; DFID, 1999; Khajuria and Ravindranath, 2012; Tripathi and Vasan, 2014). LVI and LVI-IPCC indices are designed to provide development organizations and local policy-makers with a practical tool to understand demographic, economic, social, environmental, developmental and other related factors that contribute to climate change vulnerability at the community or district levels, while the LEI also provides an HH-based composite index (Urothody and Larsen, 2010).

2. Methodology

2.1 Description of the study area

Marine fisheries are the most traditional livelihood source for the households these communities. Their economy mainly depends on fisheries with low to high economic efficiency based on their assets status. This area has the more number of poor HHs. Moreover, local livelihood resources are limited by the ecosystem degradation due to overcapacity, developmental pressures. Infrastructure is poor, and there is lack of opportunities for income generation. Therefore, the government has continuously supported social economic development projects in the district through policy reforms and various rural action programs.

2.2 Sampling and data collection

C-I: Rural (Cluster-I), CII: urban (Cluster-II), and CIII: sub-urban (Cluster-III) are the three major clusters of marine fishing communities purposely selected from the district of the Visakhapatnam. For HHs survey, respondents from sample HHs were selected randomly, and approximately 120 HHs in each cluster were surveyed. The final sample size was 335 with completed questionnaires.

The HH survey was conducted in June, 2014 to August 2014. The respondents were HHs- heads or their spouses, producers (marine fishers-fishing crew and boat owners of non-motorised, motorised and mechanised crafts), processors (post-harvest workers involved in sorting, grading, peeling, curing, drying, loading and carrying of fish and shrimp), traders (petty/small & large scale fish traders including cycle traders, women traders, commission & company agents, money lenders, resellers, auctioneers, fish carriers/ head loaders) and other ancillary workers (making and repairing of nets, boat builders, painters, electricians, mechanics, suppliers of inputs like salt and ice, materials, nets, labour) were mainly attached with marine fisheries sub-sector for their livelihoods for at least 10 years. A fully structured questionnaire was used to gather information on socio-economic, demographics, livelihoods, social networks, health, food

and water security, natural disasters, and climate change, environment and developmental aspects. The survey was conducted in local language.

Interviews were conducted with due support from field staff and local partners. Survey question was based on the subcomponents or indicators as presented in Table 1. I also conducted two focus group discussions (FGDs) in each sampling location located in three clusters with each group including 7–10 HH heads from different groups, communes, leaders, village leaders to selecting realistic and compatible indicators to the socio-economic and environmental uniqueness of the studied community. Meteorological data were collected from India Meteorological Department (IMD).

2.3 Data analysis methods (qualitative and quantitative)

Three sets of analysis were undertaken:

(1) calculation of a balanced weighted average LVI,
(2) calculation of an LVI based on the IPCC framework (IPCC 2007), and
(3) calculation of an LEI.

Additionally, t-tests were used to compare the mean scores of rural, urban, and sub-urban cluster main components and subcomponents.

2.3.1 Constructing livelihood vulnerability index (LVI)

This study applied the methodology developed by Hahn *et al.* (2009) and Shah *et al.* (2013) to calculate level of vulnerability to climate change. Nevertheless, and as the authors suggest, modifications have been made to adapt it to this study. I also added five major components, besides the seven that contained the LVI developed by Hahn et al. (2009). Housing and ownership of productive assets component was separated into two distinct components to better understand the sensitivity of HHs to each of these factors. Knowledge and skills was added to the LVI as a means of capturing the human vulnerability of HHs to climate change.

The following sections provide an overview of the LVI, 13 components, and 54 indicators of livelihood vulnerability used in this study, which are presented in Table 1. In this approach, each of the 13 main components is a combination of several subcomponent indicators. Each indicator or main components are viewed as having an equal contribution in the overall sum (Sullivan *et al.*, 2002).

2.3.2 Calculating the livelihood vulnerability index (LVI)

LVI indicators are calculated through four steps (Hahn *et al.*, 2009). After raw data are transformed into appropriate measurement units, each subcomponent was standardized by the following equation:

$$index_s = (observed - minimum) / (maximum - minimum) \quad \ldots (1)$$

After each was standardized, the subcomponents were averaged using Eq. (2) for calculating the standardized scores of each main component:

$$M = \frac{\sum_{i=1}^{n} index_{si}}{n} \quad \ldots (2)$$

where '*M* 'is one of the 13 major components; $index_{si}$ represents the subcomponents; indexed by '*i*,' that make up each major component; and 'n' is the number of subcomponents in each major component. Finally, LVI score was generated by combining the weighted averages of all the major components (Eq. 3). To ensure that all main components contribute equally to the overall LVI, the weights of each main component are determined by the number of subcomponents of which it is comprised (Sullivan *et al.* 2002).

$$\text{LVI} = \frac{\sum_{i=1}^{12} w_{Mi} M_i}{\sum_{i=1}^{12} w_{Mi}} \quad \ldots (2)$$

where LVI is the vulnerability index for one of the communities, equals the weighted average of the 13 major components; w*Mi* the weights of each major component, which are determined by the number of subcomponents that make up each major component. The range of LVI lies between from 0 (least vulnerable) to 0.5 (most vulnerable).

Table 1 : Major components and subcomponents and information sources

Livelihood capitals	Major components	Sub-components (indicator)	Units	Data source
Human	Health	1. Percentage of HHs where a family member is infected by epidemics	Percent	Survey
		2. Percentage of HHs where a family member had to miss work or school due to illness in past 1 month	Percent	Survey
		3. Average time to nearest health centre	Minutes	Survey
	Knowledge and skills	4. Percentage of HHs head uneducated	Percent	Survey
		5. Percentage of HHs head just passed primary school	Percent	Survey

Livelihood capitals	Major components	Sub-components (indicator)	Units	Data source
		6. Percentage of HHs head who did not receive any training to cope with climate change	Percent	Survey
		7. Percentage of HHs where a family member has not taken any kind of vocational training	Percent	Survey
	Food	8. Percentage of households dependent on fisheries for food	Percent	Survey
		9. Percentage of households who do not save food grains	Percent	Survey
		10. Average food insufficient months	Percent	Survey
		11. Average meal per day	Percent	Survey
	Livelihood strategy	12. Percentage of HHs without members working outside fisheries sector	Percent	Survey
		13. Average no. of fishing related livelihoods pursued 14. [1/ (no. of fishing 15. activities + 1)]	1/# livelihoods	
		16. Percentage of HHs dependent on fishing as major source of income	Percent	Survey
		17. Percentage of HHs reported no non-fishing activities are affected by climate change	Percent	Survey
		18. Percentage of HHs with no jobs during disaster events	Percent	Survey
		19. Percentage of HHs migrate (seasonal/long-term) to choose non-fishing livelihoods	Percent	Survey
Natural	Natural resources	20. Percentage of HHs that depend on (exploit) natural resources	Percent	Survey
		21. Percentage of HHs using coastal space for drying fish and mending nets	Percent	Survey

Livelihood capitals	Major components	Sub-components (indicator)	Units	Data source
		22. Percentage of HHs reporting that ecosystem is degraded due to urbanisation and industrialisation/coastal development related activities coupled with climate related extremes	Percent	Survey
		23. Percentage of HHs reporting 24. that fisheries are no longer a sustainable livelihood	Percent	Survey
		25. Percentage of HHs reporting that fish resources are being scarce and no. of fish varieties were dropped now, when in comparison to 20 years back	Percent	Survey
		26. Percentage of HHs reporting that conflicts over different groups of fishers increasing due to mechanisation and over capacity	Percent	Survey
	Land and productive assets	27. Percentage of landless HHs	Percent	Survey
		28. Percentage of HHs with at least one fishing craft/gear equipment type	Percent	Survey
		29. Percentage of HHs reporting ecosystem, land, coastal vegetation degraded by climate related extremes during past 20 years	Percent	Survey
	Water	30. Percentage of HHs reporting they have heard any conflict over water in the community	Percent	Survey
		31. Percentage of HHs that do not have daily water supply	Percent	Survey
	Natural disasters and climate change	32. Average number of cyclone, storm-surge, flood, heatwave events in the past 6 years	Count	
		33. Average number of coastal erosion, drought, epidemic events in the past 6 years	Count	Survey
		34. Percentage of HHs reporting that temperature is increasing and monsoon rainfall is unpredictable	Percent	Survey

Livelihood capitals	Major components	Sub-components (indicator)	Units	Data source
		35. Percentage of HHs reporting death of a family member due to recent natural disaster	Percent	Survey
		36. Percentage of HHs reporting injury of a family member due to recent natural disaster	Percent	Survey
		37. Percentage of HHs did not receive a warning about natural disasters	Percent	Survey
		38. Mean standard deviation (MSD) of daily mean average maximum and minimum temperature by month (years: 2013–2018)	Celsius	
		39. MSD of daily mean average precipitation by month (years: 2013–2018)	Millimeters	
		40. Percentage of HHs reporting that their productive assets are lost like boats, nets, houses	Percent	Survey
Social	Social and demographic	41. Dependency ratio	Ratio	Survey
		42. Percentage of female-headed HHs	Percent	Survey
		43. Average family member in a HHs	Percent	Survey
		44. Percentage of poor HHs	Percent	Survey
	Social networks	45. Avg. receive: give ratio	Percent	Survey
		46. Percentage of HHs that have not gone to local government for any kind of assistance in past 12 month	Percent	Survey
		47. Percentage of HHs that have not been members of any cooperative/ social organizations	Percent	Survey
		48. Percentage of HHs not having TV at home	Percent	Survey
		49. Percentage of HHs not having Mobile at home	Percent	Survey

Livelihood capitals	Major components	Sub-components (indicator)	Units	Data source
Financial	Finance and income	50. Percentage of HHs who have debt to pay back to individual lender	Percent	Survey
		51. Percentage of HHs with net HHs income lower ₹50000	Percent	Survey
		52. Percentage of HHs that do not have access to financial services to any financial institution	Percent	Survey
Physical	Infrastructure	53. Average time to reach nearest vehicle station	Minutes	Survey
		54. Average time to reach nearest communication	Minutes	Survey
		55. Percentage of HHs that report no access to production means	Percent	Survey
	Housing	56. Percentage of HHs that with kutcha/ non concrete house/	Percent	Survey
		57. Percentage of HHs that with housing affected by climate related disaster	Percent	Survey

2.3.3 *Calculating the LVI-IPCC: IPCC framework approach*

This article has explored the analytical utility of using the livelihood and vulnerability index (LVI) developed by Hahn *et al.* (2009) and Shah *et al.* (2013) to understand livelihood vulnerability to climate change and disasters. Exposure of the study population is measured by the number of natural disasters that have occurred in the past 6 years, while climate variability is measured by the average standard deviation of the maximum and minimum monthly temperatures and monthly precipitation over a 6-year period. Adaptive capacity is quantified by the demographic profile of a district, the types of livelihood strategies employed, and the strength of social networks. Last, sensitivity is measured by assessing the current state of a commune's food and water security, health status, economic background, housing, infrastructure. Eqs. (1) - (3) were used to calculate the LVI–IPCC. The major components are combined into the LVI–IPCC factors and calculated by following equation:

$$\mathrm{CF}_d = \frac{\sum_{i=1}^{n} w_{Mi} M_{di}}{\sum_{i=1}^{n} w_{Mi}} \quad \ldots(4)$$

where CF_d is an IPCC defined contributing factor (exposure, sensitivity, or adaptive capacity) for community '*d*', *Mdi* are major components for community '*d*' indexed by '*i*,' w*Mi* is the weight of each major component, and '*n*' is the number of major components in each contributing factor. One exposure, sensitivity, and adaptive capacity were calculated, the three contributing factors were combined using the formula developed by Hahn *et al.* (2009).

$$\text{LVI} - \text{IPCC}_d = (\text{exposure index} - \text{adapative capacity index}) \times \text{sensitivity index} \quad \ldots(5)$$

where LVI–$IPCC_d$ is the LVI for community '*d*' expressed using the IPCC vulnerability framework. LVI–$IPCC_d$ was scaled from -1 (denoting least vulnerable) to 1 (denoting most vulnerable).

2.3.4 Calculating the LEI

Using the same data, the LEI is calculated based on five group livelihood assets vulnerability.

This entails grouping the 13 major components into each of five livelihood assets [H (Human capital), N (Natural capital), S (Social capital), P (Physical capital), and F (Financial capital)] (see Table 1). After all of the major components were calculated following formula (1) - (3), major components that make up each livelihood assets were averaged using formula (5) to obtain vulnerability value for each livelihood assets or capitals.

$$\text{LEI} = \frac{\sum_{i=1}^{5} w_{Mi} M_i}{\sum_{i=1}^{5} w_{Mi}} \quad \ldots(5)$$

where LEI is the vulnerability index for one of the five livelihood assets, equals the weighted average of major components that form that livelihood asset; WMi the weights of each major component, are determined by the number of subcomponents that make up each major components/or each capital. The range of LVI lies from 0 (least vulnerable) to 1 (high vulnerable).

3. Results and Discussion

The results of LVI values of all 13 major components calculated from 54 subcomponents of rural, urban, and sub-urban fishing communities are presented collectively in a spider diagram in Figure 2 and Table 2. With scale in 0.1 unit increments, from 0 (less vulnerable) at the center of the web to 0.9 (most vulnerable) at the outside edge. Overall, C-I: rural (0.509) and C-III: sub-urban (0.382) had a higher LVI than C- II: urban (0.373). The diagram reflects well that rural communities in C-I and C-III are more vulnerable in most components, in particular housing, social networks, knowledge and skills, infrastructure,

finance and social resource; whereas sub-urban communities in C-II are slightly more vulnerable in climate change, natural disasters, and natural resources components.

Indexed subcomponents, major components, and overall livelihood vulnerability index IPCC (LVI–IPCC) for three communes are presented in Tables 3 and 4. The LVI–IPCC estimation for C-I, C-II, and C-III are, -0.056, -0.021, and 0.040 respectively. When the main components were reviewed by subcomponents (i.e. indicators), C-I was most vulnerable in terms of dependent on fishing as major sources of income (0.957), productive assets are loss (0.899), ecosystem is degraded due to urbanisation and industrialisation (0.831), high diversity of poor fishermen (0.809), epidemics (0.730), conflicts over different groups of fishers 0.728, percent uneducated (0.652), lack of vocational training (0.870), lack of training to cope with climate change (0.826) and. C-II on the other hand was most vulnerable in terms of cyclone, storm-surge, flood, heatwave events (0.872), fisheries are no longer a sustainable livelihood (0.733), coastal space (0.870), and C-III was highest vulnerable to coastal vegetation loss (0.861) and in terms of standard deviation of daily mean average minimum temperature by month (0.756) and lost their productive assets like boats, nets, house (0.727).

Table 2 : Summary of the LVI results for 13 components for three communes.

Major components	Sub components	Major component values			Contributing factor values		
		C-I	C-II	C-III	C-I	C-II	C-III
Health	3	0.475	0.246	0.343			
Knowledge and skills	4	0.620	0.464	0.414			
Food	4	0.434	0.266	0.335			
Livelihood strategy	6	0.609	0.428	0.496	0.407	0.545	0.361
Natural resources	6	0.656	0.615	0.495			
Land and productive assets	3	0.548	0.500	0.258			
Water	2	0.147	0.317	0.321			
Climate change and natural disasters	9	0.632	0.418	0.506	0.597	0.484	0.460

Major components	Sub components	Major component values			Contributing factor values		
		C-I	C-II	C-III	C-I	C-II	C-III
Socio-demographic	4	0.553	0.314	0.454			
Social networks	5	0.571	0.181	0.295	0.240	0.554	0.365
Finance and income	3	0.438	0.248	0.252	0.248	0.438	0.252
Infrastructure	3	0.355	0.240	0.210			
Housing	2	0.800	0.323	0.414	0.273	0.533	0.291
Overall livelihood vulnerability index					0.509	0.373	0.382

So, the livelihood vulnerability index (LVI) of

Rural marine fishing communities (C- I) is 0.509;
Urban marine fishing communities (C- II) is 0.373;
Sub-urban marine fishing communities (C- I) is 0.382.

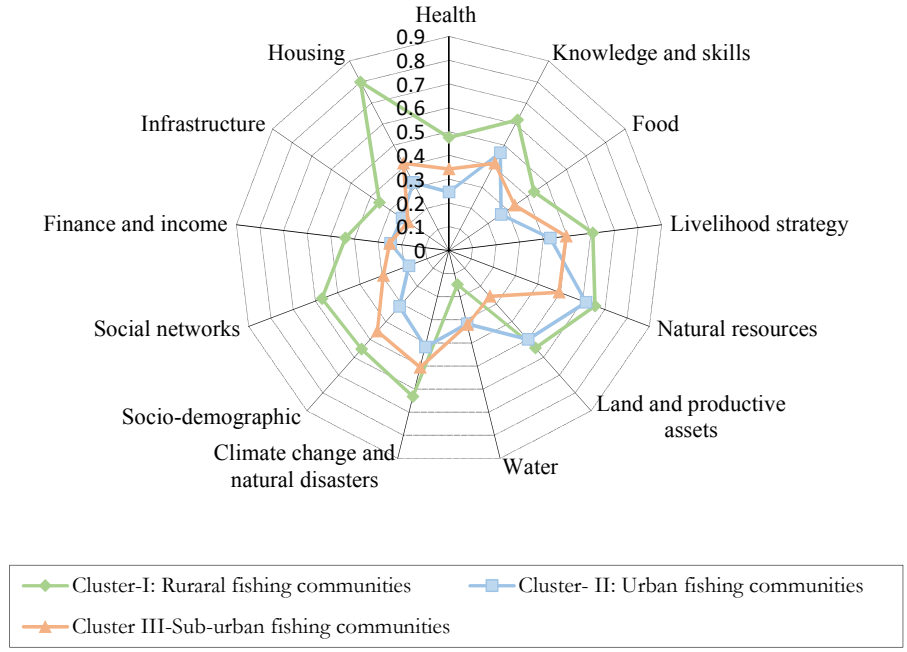

Figure 2 : Vulnerability spider diagram of the 13 major components of the Livelihood Vulnerability Index (LVI) for three clusters of Visakhapatnam.

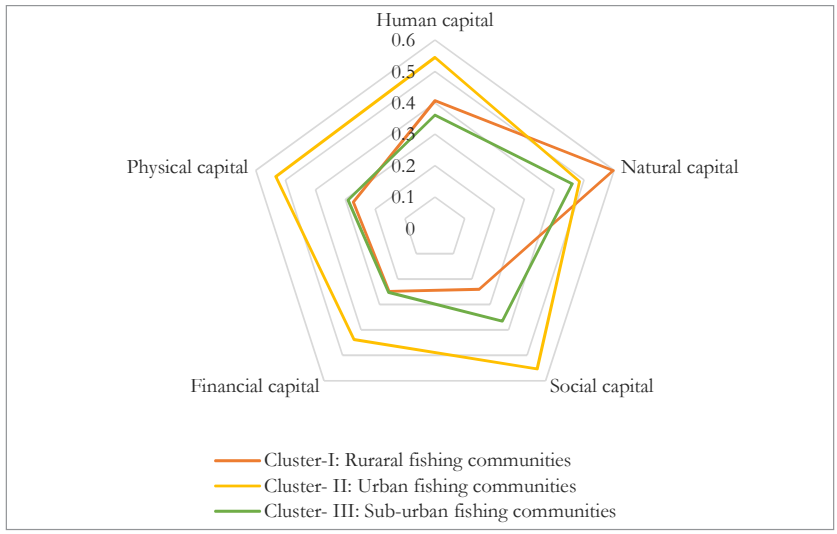

Figure 3 : Vulnerability diagram of five capitals of rural, urban, sub-urban marine fishing communities in the Visakhapatnam district

Comparison of means ($p < 0.05$ level) for C-I, C-II and C-III found statistically significant differences for 49 of the 54 subcomponents in the LVI. Vulnerability was statistically indifferent between three clusters with respect to following: percentage of HHs with landless (17.39%; 9.09%, and 13.64%); percentage of HHs reporting they have heard any conflict over water in the community (76.96%; 10.91%, and 17.27%); dependency ratio (1.41, 1.25, and 1.37); average receive: give ratio (1.27, 1.42, and 1.40); and average time to reach nearest vehicle station (54.08, 15.26, and 37.93).

The results of five capitals vulnerability are presented collectively in a spider diagram (Figures 3 and 4). With the same trend, higher livelihood vulnerability to climate change in rural marine fishing communities were observed based on the results, on other hand urban marine fishing communities, in natural capital is most vulnerable to climate change.

Table 4 : LVI–IPCC contributing factors calculation for three clusters in Visakhapatnam

IPCC contributing factors to vulnerability	Cluster-I	Cluster-II	Cluster-III
Exposure	0.396	0.478	0.336
Adaptive capacity	0.508	0.327	0.399
Sensitivity	0.500	0.396	0.508
LVI-IPCC	-0.056	0.040	-0.021

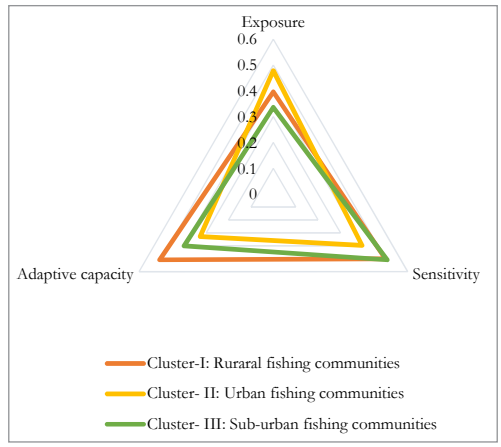

Figure 4 : Vulnerability triangle diagram of the contributing factors of the Livelihood Vulnerability Index –IPCC (LVI–IPCC) for three clusters of Visakhapatnam.

4. Conclusion

This study provides a range of indicators that can be used and replicated in empirical field settings of Visakhapatnam. These indices could be used as a practical tool for the governments, policy-makers, and developmental organizations to identify vulnerable communities, understand the factors contributing to vulnerability at district or community level, and also to prioritize the potential areas of intervention. By applying following three indices: LVI, LVI-IPCC, and LEI, the comparison of three communities, highlights the merits and challenges of comparing livelihood vulnerability of incorporating new factors, such as the impact of clean water program in rural areas. However, this case study only used the LVI that is based on the current conditions of our study sites. Therefore, selecting suitable indicators is a challenge in this approach.

Here, the experience in this study suggests that the designing of indicators required extensive review of the literature, consultation of subject experts, and engagement of stakeholders. It has unequal vulnerability within a community as there are different HHs. So, these indicators typically vary and can be used to compare the level of vulnerability within a study, but cannot be readily compared with other studies as indicators and context differ.

Table 3 : Indexed subcomponents and LVI-IPCC contributing major components to vulnerability for three clusters (C-I: Rural; C-II: Urban; C-III: Sub-urban) of Visakhapatnam.

Sub-component	C-I: Rural	C-II Urban	C-III Sub-urban	Major component	C-I: Rural	C-II Urban	C-III Sub-urban
Percent of HHs where a family member is infected by epidemics	0.730	0.455	0.555				
Average time to nearest health centre	0.282	0.111	0.210				
Percent of HHs where a family member had to miss work or school due to illness in past 1 month	0.504	0.227	0.291	Health	0.475	0.246	0.343
Percentage of HHs head uneducated	0.630	0.435	0.575				
Percentage of HHs head just passed primary school	0.484	0.123	0.377				
Percentage of HHs head who did not receive any training to cope with climate change	0.826	0.231	0.382				
Percentage of HHs where a family member has not taken any kind of vocational training	0.870	0.222	0.264	Knowledge and skills	0.415	0.152	0.371
Percentage of households dependent on fisheries for food	0.957	0.473	0.573				
Percentage of households who do not save food grains	0.035	0.127	0.182				
Average food insufficient months	0.382	0.199	0.251				
Average meal per day	0.670	0.182	0.51	Food	0.493	0.245	0.381
Percentage of HHs without members working outside fisheries sector	0.191	0.373	0.282				
Average no. of fishing related livelihoods pursued [1/ (no. of fishing activities + 1)	0.418	0.313	0.237				
Percentage of HHs dependent on fishing as major source of income	0.957	0.727	0.655				

Sub-component	C-I: Rural	C-II Urban	C-III Sub-urban	Major component	C-I: Rural	C-II Urban	C-III Sub-urban
Percentage of HHs reported no non-fishing activities are affected by climate change	0.174	0.364	0.464				
Percentage of HHs with no jobs during disaster events	0.383	0.191	0.318				
Percentage of HHs migrate (seasonal/long-term) to choose non-fishing livelihoods	0.730	0.455	0.555	Livelihood strategy	0.435	0.444	0.484
Percentage of HHs that depend on (exploit) natural resources	0.175	0.470	0.189				
Percentage of HHs using coastal space for drying fish and mending nets	0.612	0.870	0.524				
Percentage of HHs reporting that ecosystem is degraded due to urbanisation and industrialisation/coastal development related activities coupled with climate related extremes	0.831	0.621	0.743				
Percentage of HHs reporting that fisheries are no longer a sustainable livelihood	0.614	0.733	0.560				
Percentage of HHs reporting that fish resources are being scarce and no. of fish varieties were dropped now, when in comparison to 20 years back	0.523	0.289	0.513				
Percentage of HHs reporting that conflicts over different groups of fishers increasing due to mechanisation and over capacity	0.728	0.458	0.455	Natural resources	0.456	0.571	0.427
Percentage of landless HHs	0.174	0.091	0.064				
Percentage of HHs with at least one fishing craft/ gear equipment type	0.520	0.723	0.652				
Percentage of HHs reporting ecosystem, land, coastal vegetation degraded by climate related extremes during past 20 years	0.520	0.637	0.861	Land and productive assets	0.526	0.689	0.832

Sub-component	C-I: Rural	C-II Urban	C-III Sub-urban	Major component	C-I: Rural	C-II Urban	C-III Sub-urban
Percentage of HHs that do not have daily water supply	0.252	0.136	0.282				
Percentage of HHs reporting they have heard any conflict over water in the community	0.157	0.109	0.173	Water	0.417	0.317	0.344
Average number of cyclone, storm-surge, flood, heatwave events in the past 6 years	0.539	0.872	0.221				
Average number of coastal erosion, drought, epidemic events in the past 6 years	0.513	0.324	0.531				
Percentage of HHs reporting death of a family member due to recent natural disaster	0.130	0.182	0.055				
Percentage of HHs reporting injury of a family member due to recent natural disaster	0.217	0.291	0.155				
Percentage of HHs did not receive a warning about natural disasters	0.391	0.509	0.164				
Percentage of HHs reporting that temperature is increasing and monsoon rainfall is unpredictable	0.259	0.115	0.195				
Percentage of HHs reporting that their productive assets are lost like boats, nets, houses	0.899	0.792	0.727				
MSD of daily mean average maximum and minimum temperature by month (years: 2013–2018)	0.573	0.688	0.756				
Percentage of HHs reporting that their productive assets are lost like boats, nets, houses							
MSD of daily mean average precipitation by month (years: 2013–2018)	0.377	0.477	0.477	Climate change and natural disasters	0.396	0.478	0.336
Dependency ratio	0.402	0.358	0.391				
Percentage of female-headed HHs	0.278	0.055	0.218				

Sub-component	C-I: Rural	C-II Urban	C-III Sub-urban	Major component	C-I: Rural	C-II Urban	C-III Sub-urban
Average family member in a HHs	0.642	0.660	0.660				
Percentage of poor HHs	0.809	0.182	0.545	Social and demographic	0.533	0.314	0.454
Avg. receive: give ratio	0.228	0.260	0.255				
Percent of HHs that have debt to pay back to individual lender	0.174	0.264	0.373				
Percentage of HHs that have not gone to local government for any kind of assistance in past 12 month	0.304	0.109	0.064				
Percentage of HHs that have not been members of any cooperative/ social organizations	0.126	0.178	0.221				
Percentage of HHs not having TV at home	0.612	0.623	0.642				
Percentage of HHs not having Mobile at home	0.839	0.183	0.445	Social networks	0.348	0.251	0.225
Percentage of HHs who have debt to pay back to individual lender	0.578	0.264	0.452				
Percentage of HHs with net HHs income lower ₹50000	0.302	0.117	0.054				
Percentage of HHs that do not have access to financial services to any financial institution	0.687	0.373	0.209	Finance and income			
Average time to reach nearest vehicle station	0.247	0.025	0.054				
Average time to reach nearest communication	0.122	0.030	0.640				
Percentage of HHs that report no access to production means	0.303	0.120	0.525	Infrastructure			
Percentage of HHs that with kutcha/ non concrete house	0.835	0.427	0.436				
Percentage of HHs that with housing affected by climate related disaster	0.765	0.218	0.391	Housing	0.591	0.245	0.297

In addition, this indicator is fundamentally driven by prevailing climate change vulnerability theory and efforts have been made to include indicators for which data can be collected in the future, the index cannot provide medium- or long-term predictions as would more complex simulation models. Also, these indices, though a straightforward method to assess vulnerability, have limitations that could account for inaccuracies and inability to be standardized for benchmarking.

Therefore, we stress that users must be cautious about applying the approach and interpreting the results and its need for further research. To sum up, using weighted averages attributing equal weight to all subcomponents/indicators does not reflect a value to the importance of these; also, this can mask subtle but important data. Further discussion on how to weigh different indicators is needed.

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** CDM, LABSNAA, Mussoorie*
[1]Department of Environmental Sciences, Andhra University, Visakhapatnam- 530 003, Andhra Pradesh, India.

Best Practices in Heat Wave Management & Toward a Roadmap Development

K. R. Sastry

1. Introduction

India is vulnerable to extreme climatic variations as it's located in the tropical region. Heat Waves henceforth (henceforth, HWs) typically occur between March and June in India, and in some rare cases extend even till July. Thus, India experiences severe summer HW seasons, when the vertical Sun Rays reaches the Tropic of Cancer. During this period, spells of hot winds blow over certain parts of the country; and, these are called the Heat Waves. In line with the global warming, and as a result of El-Nino Southern Oscillation (ENSO) effect, the temperatures across the country indicate a severe hot period. The El-Nino leads to warming of the sea surface temperatures, which in turn, affects wind patterns and trigger both floods and droughts in different parts of the Globe. Such events are usually characterized by extreme weather events in many parts of the World. So, any increase in the global temperatures, even if by one degree, could lead to the episodes of extreme weather events like HWs during the summers; and, the two Telugu speaking States, AP and TS, are no exception to this observation.

El-Nino & La Nina: As for El-Nino, it's an oceanic atmospheric phenomenon, wherein the equatorial Pacific Ocean warms up abnormally due to weakening of trade winds. During El-Nino years, the Pacific warm pool expands to cover the tropical regions. El-Nino occurs, when the threshold value of 5˚C Oceanic Nino Index (ONI) is met or crossed for a minimum of 5 consecutive overlapping seasons of three months each. The exact opposite occurs during the La Nina, wherein the easterly trade winds strengthen and the cold upwelling (flow) of alongside the equator and the West Coast of South America intensifies. The sea surface temperatures along the equator could then fall by-13.88˚C below the normal levels.

2. Global View of Heat Waves

- In IFRCS's World Disasters Report-2016, John Twigg noted, three Heat Waves in France, India & Pakistan in 2014-15, caused 3,275, 2,248 and 1,229 deaths.

- "No greater challenge for this generation and the next one, than to prevent and prepare for the brutal force of Climate Vulnerability and Change (CC), which causes Heat Wave Disasters worldwide."
- "It's also a question of Justice: "The poor, who did nothing to produce Climate Change (CC) are the first and hardest hit. We, the rich and robust, who caused Climate Change are last & least hit"

3. Heat Wave (HW) Disaster in India

The decade of 2000-2010 was declared as the warmest for India, in particular and worldwide in general. According to the latest Indian Meteorological Department (IMD)'s data, the year 2016 has had an average annual mean land surface air temperature like 0.91˚C; and, therefore was depicted as the hottest year since 1901. India had also experienced the significant increase in the normal mean temperatures during the typical hot weather season (i.e., March-to-May) of 2016 with a deviation of +1.36˚C, the second warmest since 1901, in the annals of hottest summers. The HWs develop slowly and adversely distress the life of human beings and animals. They have registered 25,716 deaths, as reported during the period of 1992-2016 across various States. According to the IMD data, 3,000 people in 1998, in excess of 2,000 in 2002, over 2,400 in 2015; and what's more, 1,111 people perished during 2016 across the country.

In recent times, AP and TS with varied climatic zones--deltaic, arid, and coastal (AP only), experiencing severe HWs, and, witnessing heavy casualties in both urban and rural areas. Perhaps, the geographical location and the phenomenon of Climate Change (CC) could be adding to worsening the effects, referenced above, as over 2,400 perished in AP and TS in 2015 alone. Meanwhile, the residual State of AP (following division of erstwhile AP) had the Heat Wave Management Plan prepared in 2016 (which is germane to TS as well); and, it's appropriate to examine the efficacy of the Plan, in order to identify the reasons for occurrence of HWs, the best practices elsewhere to minimize its impact, also for sensitizing the stakeholders concerning the preparedness and mitigation measures from the HWs, likely to occur during the summer months annually.

4. Elucidation of Heat Waves Concept

What is a Heat wave? There is no single accepted definition for a Heat Wave, because similar temperatures can have different impacts on communities at different times. Generally speaking, a Heat Wave is a prolonged period of excessively hot weather which may be accompanied by high humidity, especially in countries, sited in the oceanic climatic zones. The extreme temperatures and resultant atmospheric conditions adversely affect people living in these regions as they cause physiological stress, sometimes resulting in death (Source: AP State Heat Wave Action Plan-2016).

Globally, 2015 was the hottest year on record, dumping the evidence set in 2014 by making it for the fourth time this (21st) Century that a new high temperature record was established. Locally, the situation in India is also deteriorated. Over 2,300 people died in 2015, making it the fifth highest in World's history in terms of mortality due to HW disaster. Most of the deaths were in Punjab, Odisha, AP, TS, and Bihar States, as the months of April and May in 2016 saw the highest recorded average global temperature ever. Moreover, Climate Change is leading to an increase in average temperatures and enlarges the possibilities of severe HWs. Extreme heat can lead to dangerous, deadly, health consequences, including heat stress and heatstroke. According to the Inter-Governmental Panel on Climate Change (IPCC), Climate Change plays a vital role in intensifying and triggering extreme heat events, which is likely to increase in the future.

The HWs have serious health impacts, aggravated further by increase in humidity. People like the elderly, children, and young (adolescents) with pre-existing health problems, housing concerns, and the economically challenged, are the most vulnerable and their susceptibility depends on the degree of exposure. Heat impacts are more in urban areas due to Urban Heat Island (UHI) effect. Factors like pollution growth, Climate Change, lifestyles of people and town characteristics and geometry increase the UHI intensity. Thus, the impact of heat is on the increase alarmingly. Aside from vulnerable groups in cities and villages, workers in outdoors like traffic police, street vendors, hawkers and those working in closed environment (e.g., in mines, industries, etc.) face considerable occupational hazards to heat stress, during the extreme heat days. So, there is an urgent requirement, not merely to mitigate extreme heat impacts, but also to adapt to changing norms of temperature in such a manner, so that it gets fixed eventually into all the planning and monitoring systems.

There are many national and international examples to learn from and adapt. Nearer home, the Ahmedabad Heat Action Plan, unveiled in 2013 by Gujarat Govt., has brought down Heat Wave-linked deaths by up to 25%. Such plans have commonly emphasized, inter alia, the need for strong institutional role to drive planning, collaboration (across all actors at several different levels) and implementation, real-time surveillance, early warning systems (EWS) and mass education on preventive and the adaptive behavior. Generally, these measures can be further divided into the pre-, during-, and post-, HW phases, with each period having short and medium-term strategies to mitigate impacts and long-term strategies to disaster reduction across all States in India.

5. Heat Wave Management Plan

- In India, the first systematic attempt at Heat Wave (HW) Management Plan was taken up in Gujarat, with Ahmedabad Heat Action Plan (AHAP), mounted successfully in 2013

- With support from Climate & Development Knowledge Network (CDKN), the AHAP, was developed by the Ahmedabad Municipal Corporation (AMC), together with national and international experts

5.1 How Ahmedabad beat the heat?

- In May 2010, Ahmedabad, 5.5 million, saw HWs with record-breaking temperatures; accounted for 4,462 lives
- This was 1,344 deaths more than the toll in May 2009
- The High mortality shocked AMC, as public health experts, civil society, stakeholders joined hands to prepare an inclusive Heat Action Plan (HAP)-2013
- A first in South Asia, the HAP's primary goal was to create public awareness about extreme climates and the necessary steps to tackle and save lives.
- *Thus, the city's Heat Action Plan, unveiled in 2013, brought down Heat Wave-linked deaths by about 25%*

5.2 AHAP focused on 4 Important Strategies

(1) Building public awareness on risk of HWs thru mass outreach program using local language;

(2) Implementing response system to prevent heat-related deaths and illness at the onset;

(3) Initiating EWS and Inter-Agency Collaboration structure to alert citizens, on predicted extreme temperatures; and

(4) Capacity building among Officials, Healthcare experts to recognize & respond to heat-related illnesses (Explained in the following slides)

5.3 The 2017 Heat Action Plan Strategy-1

(a) Building Public Awareness and Community Outreach to communicate risks of HWs & execute practices to prevent heat-related deaths and illnesses

(b) Propagating messages on how to protect people against extreme heat through media outlets and information materials (in Gujarati language) like pamphlets, advertisements on heat stress prevention

(c) Efforts include: Social Media, SMS, email, radio and mobile applications such as WhatsApp

(d) Special efforts are made to reach out vulnerable people thru inter-personal communication, etc.

5.4 The 2017 Heat Action Plan Strategy-2

1. Utilizing EWS and Inter-Agency Coordination to alert residents of predicted high and extreme temperatures

2. The IMD shares a daily five-day forecast with the Nodal Officer, HAP, during the heat season
3. The AMC has created formal communication channels to alert Govt. Agencies, Met Centre, Health Officials and Hospitals, Emergency Responders, local community groups, and media outlets about forecasted extreme temperatures

5.5 The 2017 Heat Action Plan strategy-3

Capacity Building:

1. Among Healthcare Professionals to recognize and respond to heat-related illnesses, particularly, during extreme heat events
2. Such trainings focus on primary medical officers and para-medical staff, community health staff, so that they can effectively prevent and manage heat-related cases, so as to facilitate lessen mortality & morbidity

5.6 The 2017 Heat Action Plan Strategy-4

(a) Reducing Heat Exposure & Promoting Adaptive Measures by taking up new efforts including mapping of high-risk areas of the city;

(b) Increasing the outreach to communicate on prevention methods;

(c) Access to potable drinking water & cooling spaces in the city on extreme heat days

(d) Collaboration with NGOs is also identified as a means to expand outreach and communication with the city's most at-risk communities

5.7 A Collaborative Project-1

1. The AMC has tied up with Georgia Institute of Technology, Rollins School of Public Health, Emory University, IIPH, the U.S. Based Non-profit Advocacy Group & Natural Resources Defense Council; and the U.K. based Climate & Dev. Knowledge Network (CDKN) for this innovative project
2. The AMC has involved community outreach initiatives, putting EWS in place that provides a 7-day advance forecast on high temperatures and impending HWs, plus Capacity-Building of Healthcare professionals, to treat people with heat-related complications
3. A Nodal Officer coordinates with Agencies & Stakeholder Groups, to execute HAP, when temperatures touch 48°C

5.8 A Collaborative Project-2

- Once the HAP is activated, the AMC issues color-coded alerts or heat warnings based on weather forecasts;

- For e.g., an" Yellow Alert" is issued when temperature is expected to range from 41.1°C to 43°C; while an Orange Alert indicates a range of 43.1°C-44.9°C. The Red Alert signifies extreme heat upwards of 45°C; and
- Other actions in HAP include: stocking hospitals & health centers with ice packs; extra water supplies in the slums & vulnerable areas; opening drinking water centers in the city; Running Fountains, Water Sprinklers at crossroads and Gardens; and, shifting School & College timings to ensure children don't venture out during peak heat hours

5.9 Success and Emulation:

- According to Director, IIPH: Mortality came down to 20-25% with the implementation of the HAP
- In May 2016, when the temperature crossed 48°C in the city, the death toll was around 250.
- Impressed with AMC model, civic bodies in Nagpur and Bhubaneswar launched similar initiatives
- "Now even Karachi (Pakistan) is thinking of emulating HAP," as noted by Mihir Bhatt of AIDMI, which is also involved in executing HAP in the 3 Indian cities
- HAP has a positive impact on the street vendors, casual laborers, traffic police, construction workers, School Children & AMC Staff

5.10 Results of Heat Action Plans

1. Ahmedbad had a major HW in May 2010, when the temperature reached 46.8°C (i.e., over 116°F)
2. Preliminary evaluation of 2013 to 2016 HAPs shows positive results in reducing mortality during the hottest months of the year
3. During India's historic HW in 2015, responsible for over 2,300 deaths across the country, Ahmedabad reported fewer than 20 heat-related deaths
4. At 48°C, Ahmedabad shattered its century old record on 19 May 2016. The temperature was 6 degrees above normal, making HW conditions unbearable. Due to preparedness, deaths were not reported

5.11 Sharing Lessons from AMC

- The AMC has developed a set of resources, including a City Resilience Toolkit, How-to-do-Manual & an Advisory Titled: "Rising Temperatures & Deadly Threat issue briefs"
- Resources outline key strategies & policy interventions that form the basis of HAP, focusing on most vulnerable groups;

- The project is about saving lives & helping people to create healthier communities, more secure from dangers of extreme heat, even as CC affects cities like Ahmedabad, Gujarat state & all around the world
- It's hoped HAP will guide cities & rural areas in India & other developing nations to adapt & develop their own HAPs;
- Thru preventative action like the HAP, countless lives can be saved as the weather becomes increasingly hot & extreme
- These resources are available online at: https://www.nrdc.org/resources/rising-temperatures-deadly-threat-preparing-communitiesindia-extreme-heat-events.

5.12 Need for a National HAP Roadmap

- In Gujarat's context, need for a National Heat Action Plan (NHAP) Roadmap came up
- The Roadmap isn't only about extending help to the affected Cities & States, but also to mount a National Agenda for Adaptation Planning on rising temperature in State Plans
- It's hoped Roadmap would help design for Space, Utilities, Infrastructure, and Industries Sectors apropos HWs Management

5.13 Heat Wave Roadmap be taken up in 3 Stages"

I. In the next 3 to 6 months (First Phase)

(a) An Anchor Agency may be identified and tasked with initiating stakeholder engagement on heat wave management using the existing materials;

(b) Consultations and brainstorming with stakeholders will add to the analysis & issues identified, within this report, to support engagement in Developing National Heat Action Plan (NHAP)

(c) Additionally, 5-10 vulnerable States and Cities may be encouraged to undertake HW Management. Planning

II. In the next 6 to 12 months (Second & Third Phases)

- The Anchor Agency, after securing the necessary mandate and resources, could take forward and complete the NHAP development process

III. In the next 12 to 18 months

- The Anchor Agency could focus on extending support for Heat Wave Mgt. planning to priority states and cities
- This could be by monitoring the process and its effectiveness by making informed changes in approach as it works towards the NHAP's stated goals and objectives

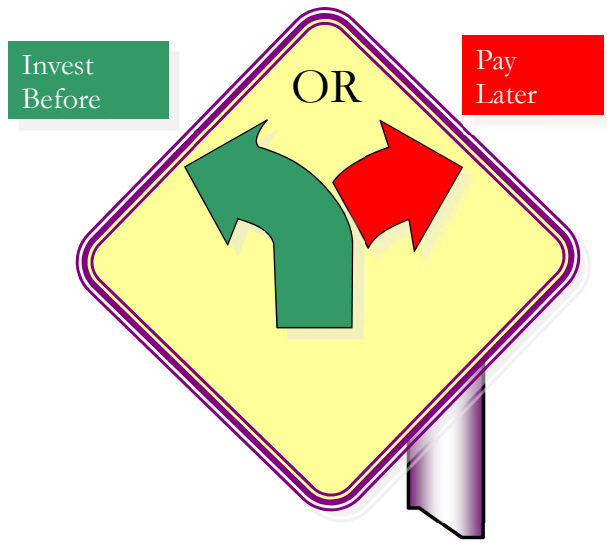
5.14 Roadmap Development Process

1. The process of Roadmap Development is consultative in nature
2. An expert group is formed to review process
3. A review of national and international initiatives has been carried out
4. Besides, several consultations were carried out with Sector Leaders: Climate, Disaster, Environment, Health, Urban Management and Public Policy

5.15 Understanding Climate Health Association of India (CHAI)'s \ Initiatives to Roadmap Development:

- Inputs were classified from various Discussions and workshops held to gain insights: Comprehending Advisory Meetings of Climate & Health Associations in India (CHAI) & World Meteorology Organization Meeting held in Colombo:
- Field visits to Gujarat & Bihar were conducted;
- All those recommendations & insights emerged have been synthesized in the proposed Roadmap;
- It identifies intent, objectives, interventions about priority areas for reflection during planning stage
- It's to be adopted & executed by India–again a first in South Asia--to Make Heat Management, the National Plan & Climate Agenda achievable

5.16 The Only (Correct) Option



6. Heat Wave Action Plan of AP State (2016) in a Capsular form

6.1 Necessity of HW Action Plan

There is a strong and global scientific consensus that the climate is changing and this alteration will cause an increase in average global temperatures, plus the number and intensity of heat-waves. According to the IFRC's World Disasters Report-2016, by John Twigg, University College of London, three (3) Heat Waves in France, India & Pakistan during 2014-15, caused 3,275, 2,248 and 1,229 deaths, respectively. It follows, HWs are a significant cause of death and morbidity across the world, and the impacts of heat events are likely to increase due to unstable frequency, severity, and intensity of heat-waves caused by climate change.

Geographically, AP comprises 13 districts spreading over 664 Mandals, of which, Chittoor District has the most number of Mandals (66); whereas, Vizianagaram District, has the least number of Mandals (34): and, a majority of the Mandals are susceptible to Heat Wave disaster during summers every year. Furthermore, India has been feeling the impact of climate change in terms of increased instances of HWs that are more intense in nature with each passing year, and have a devastating impact on human health, thereby increasing the number of HW casualties. Heat waves have contributed to more deaths than any other natural disaster in Andhra Pradesh and represent a significant risk to public health.

Global Thermal Heat Indices, a combination of maximum temperature and relative humidity are used to assess the impact of 'Heat Wave ' conditions. For Indian conditions, the hand book of Energy Conscious Buildings by Ministry of New and Renewable Energy, GOI, indicates the zones of human comfort based on ambient temperature and humidity, mean radiant temperature, wind speed, solar radiation and evaporative cooling. (Source: IMD criteria for Heat Waves).

There is a need of a coordinated multi-agency approach to AP's management of HWs. At present, the problem of HWs is being managed at an operational level but it needs to be managed at a strategic level. There is the need for clear roles and responsibilities in the management of HWs, sufficient strategic monitoring, and greater clarity around triggers for activation and data sharing across multiple systems and mapping or analysis of the extreme heat impacts across the community. Earlier efforts of the GoAP to reduce mortality and mitigate the suffering of general public due to HWs, even after implementing some of the recommendations of the State Level Committee headed by the Director General, TERI, New Delhi, (Early Warning System, Public Awareness Campaigning, etc.) have not proved adequate. This may be seen from the fact that 448 deaths were reported due to HW/Sun Stroke during summer-2014, which increased to 1,369 in 2015. Taking cognizance of the serious situation arising out of the intense HWs on general public leading to high fatalities, the GoAP issued Orders constituting

a Committee with eleven (11) Principal Secretaries/Director rank officers as members under the Chairmanship of the Principal Secretary, Revenue (Land & DM) to prepare a Comprehensive HW Action Plan for AP State, vide G.O. Ms. No.14, Revenue (DM. II) Department, dt.03.12.2015.

6.2 Objective of the Plan:

The primary objective of the Plan is to reduce heat-related morbidity and deaths through issuing heat-health warnings, with particular emphasis on the most vulnerable groups, provide timely advice and announcements of upcoming HWs, raise awareness amongst the public and health workers to take appropriate precautions and coordinate and mobilize all available resources, in a timely manner to prevent and reduce the negative health consequences of HWs. It aims to achieve this objective by providing a framework for implementation, coordination of an integrated response and continuous evaluation of extreme heat response activities.

6.2.1 Key Components of the Plan

- To monitor climate conditions and Initiating an Early Warning System and Inter-Agency Coordination to alert stakeholders of predicted high and extreme temperatures;
- Building Public Awareness & increasing Community Outreach to communicate the risks of HWs and implement practices to prevent heat-related deaths & illnesses;
- Special efforts will be made to reach vulnerable populations through inter-personal communication and other outreach methods including posters, brochures and information sheets, etc;
- Identifying vulnerable populations & health risks specific to each group;
- Developing effective strategies, agency coordination and response planning that addresses heat-health risks;
- Heat Health Information Surveillance System—to monitor and assess the impact of HWs on human health;
- Capacity Building among Health Care Professionals to recognize and respond to heat related illnesses, particularly during extreme heat events;
- Reducing Heat Exposure and Promoting Adaptive Measures by launching new efforts including mapping of high-risk areas, access to potable drinking water and cooling spaces during extreme heat days;
- Collaboration with non-governmental organizations as a means to expand outreach and communication with the most vulnerable communities; and
- Evaluating and updating the Heat Action Plan regularly.

6.2.2 Heat Alert Warning Systems (HAWS)

1. Accurate and timely alert systems are essential. Collaboration with India IMD is needed to develop heat warning systems (HWS), trigger a warning,

determine the threshold for action and communicate the risks. It is important that a HHWS is targeted to the local needs and is accurate and timely.

2. India IMD is forecasting Heat Waves, as defined by forecasts of day and night temperatures and their duration well in advance and communicating the details of forecasts, besides posting them on their web site (www.imdhyderabad.gov.in).
3. Also, the GoAP have installed Automated Weather Stations (AWS) across the state. These weather stations report temperature and Relative Humidity on hourly basis. The data from these stations are uploaded on real-time on www.apsdps.gov.in web portal. The real time data from AWS shall be used to monitor heat wave conditions in respective areas.
4. In addition Possible 'Heat Wave' impact maps generated by India Meteorological Department (IMD) / Andhra Pradesh State Development Planning Society (APSDPS), based on the simulations made shall be used as guidance maps for taking precautionary measures by various departments.
5. Three target groups were suggested to receive different, but coherent messages: (a) People at risk (general population); (b)Voluntary caretakers of the people at risk; and (c) Professional care and health system.
6. Public information services are necessary for disseminating information to the population in a timely and adequate manner. Communication with the media needs to be ongoing and aimed at providing enough coverage in informative programs for topics related to protection from heat-waves.
7. During heat-waves, daily announcements will be contain information on the daily temperatures, the consequences for the population's health of the same, the activities undertaken, recommendations for the public, etc.

6.2.3 Roles &Responsibilities of Departments /Agencies to counter Heat Wave:

1. There needs to be greater clarity apropos the roles and responsibilities in the management of Heat wave. Preparation and response to Heat wave is to be managed in an integrated manner for which clear leadership to anchor the process is necessary. A control agency leads the response to a particular type of emergency. Support agencies provide resources, such as personnel, essential services and materials, to support or assist a control agency or affected person.
2. Disaster Management Dept. is the control agency for the response to heat wave, and that other agencies, including the Dept. of Health, have a support role.

3. Commissioner/Director, Disaster Management, as the Incident Controller and Nodal Officer for Heat Waves, is responsible for strategic management of the incident at the State Level. The District Collectors are the Incident Controllers and Nodal Officers at the District Level.

6.2.4 General Responsibilities of Incident Controller & Nodal Officer are:

(a) Managing all response activities;
(b) Notifying support agencies;
(c) Establishing incident and emergency management teams;
(d) Collecting, analyzing and disseminating information regarding the emergency;
(e) Leading multi-agency response planning;
(f) Issuing timely information and warnings to the community; and
(g) Developing incident action plans.

6.2.5 Implementation of AP Heat Action Plan

1. Successful implementation of a Heat Action Plan requires coordinated action between many diverse stakeholders, including Government Departments/ Agencies, healthcare professionals including emergency medical personnel, health center staff, and hospital staff; and community groups.
2. Following the forecasting of a heat event, immediate notification of the public and all those participating in the response is critical to ensure the plan is activated.
3. The Heat Wave Action Plan shall be implemented in three (3) Phases annually.

Phase-I: Pre-Heat Season (January to February)

- Pre-Heat Season is devoted to develop early warning systems, communication plan of alerts to the general public, healthcare professionals and voluntary groups (care givers) with emphasis on training and capacity building of these groups.

Phase-II: During the Heat Season (March to July)

- High alert, continuous monitoring of the situation, coordination with all the departments/agencies concerned on one hand and general public & media on the other hand is the focus of this phase.

Phase-III: – Post -Heat Season (August to December)

- The concentration is on evaluation and updating the plan. It is important at the end of the summer to evaluate whether the heat health action plan

has worked. Continuous plan updating is a necessity. Global climate change is projected to further increase the frequency, intensity and duration of heat-waves and attributable to deaths. Public health prevention measures need to take into consideration the additional threat from climate change and be adjusted over a period of time. Measures that are effective now, might not be effective in future. Development of appropriate Heat Index suitable for Andhra Pradesh by analyzing temperature and mortality data by involving IMD, APSDPS and Medical & Health Department is necessary to evaluate and to update the plan.

6.2.6 Phase-wise Responsibilities of Various Departments & Agencies

I. Pre-Heat season (January to February)

- Incident Controller/Nodal Officer (Commissioner, DM) at State and (Collector) at District Level in all the Three Phases of Heat Wave Mitigation Efforts.
- Preparation of a list of High risk areas in the State/District, vulnerable to HWs for more focused in planning to mitigate adverse affects of Heat wave;
- Identification of vulnerable groups of population;
- Convene meetings with concerned Departments/Agencies/NGOs involved in response mechanism to HWs & review the action plan periodically;
- Designation of a single officer as point of contact for each department;
- Organize Training for health workers, link workers, school children, and the local community in preventive measures and treatment protocol involving the Medical & Health Department;
- Distribute pamphlets and posters with tips to prevent heat stress in local language, to hospitals, schools, and professional associations; and
- Set up Heat Action Web Page on Disaster Management/District Web site.

In all, the 3 (I, II and III) Phases, the following Departments play a key Role:

- Incident Controller (Commissioner, DM) & Collector at the District level;
- I & PR Dept.;
- Medical & Health Dept- Medical Professionals;
- Making available 108 & 104 Services;
- MA & UD & PR Dept; in Phases Ii & III, the GPs will also be involved;
- Labour & Employment Dept.,
- Animal Husbandry Dept.,
- Rural Development Dept.,
- Transport Dept., & APSRTC;

- Information & Technology (IT) Dept.,
- Education & Fire Departments; and
- Community, Self-Help Groups (SHGs), Ward level Committees, NGOs.

6.2.7 Health Impact of Heat Waves

- Heat-related illness occurs when the body is unable to adequately cool itself. The setting for Heat illness involves hot environment; +/- exertion; +/- insulating clothing or swaddling.
- Extreme heat events can also exacerbate / aggravate pre-existing conditions, with the risk of heat-related mortality (death) and morbidity (disease, illness) increasing for people with illnesses—including cardiovascular disease, diabetes and cancer.
- Heat-waves characterized by long duration and high intensity have the highest impact on: mortality.
- The impact of heat waves characterized by longer duration (more than four days) was 1.5 to 5 times higher than for short heat-waves.
- The health impacts of hot weather and heat-waves depend upon the level of exposure (frequency, intensity and duration) to heat; and the size of the exposed population; the characteristics of the population (susceptibility) and the prevention measures in place.
- The adverse health effects of heat-waves are largely preventable.

6.2.8 Vulnerable Groups of Population

- Young children; Pregnant Women; and, Nursing mothers;
- People above 60, infirm, isolated, and destitute with pre-existing diseases (cardiovascular, respiratory illness, diabetes) and on certain medications;
- People with limited mobility, impairment, as well as reduced ability to see changes in temperature; and engaged in outdoor occupations.

6.2.9 Reasons for inadequate coping:

1. Not knowing the issue of heat alerts.
2. Lack of awareness of precautionary measures (Dos & Don'ts).
3. Not knowing Symptoms of Heat related illness and immediate treatment.
4. Lack of proper connectivity to Primary Health Centres (PHCs).
5. Lack of access to urgent medical attention at local levels (in villages).
6. No access to shaded areas and cooing places.
7. Non availability of adequate water.
8. No knowledge of Services available etc.

6.2.10 Special care for vulnerable population groups

- Once people at risk have been identified special care and interventions need to be implemented through the local healthcare and social services.

- It's vital to easily identify susceptible people for outreach services.
- Possible methods of identification include: local community groups and social services and active registration of individuals with a general practitioner or social services.

6.2.11 Heat Alert Warning Systems (HAWS)

1. Accurate and timely alert systems are essential. Collaboration with IMD is needed to develop heat warning systems (HWS), trigger a warning, determine the threshold for action and communicate the risks. It is important that a HHWS is targeted to the local needs and is accurate and timely.
2. India Meteorological Department (IMD) is forecasting Heat Waves, as defined by forecasts of day and night temperatures and their duration well in advance and communicating the details of forecasts, in addition to posting them on their web site: www.imdhyderabad.gov.in
3. Also, the GoAP have installed Automated Weather Stations (AWS) across the state. These weather stations report temperature and Relative Humidity on hourly basis. The data from these stations are uploaded on real-time on www.apsdps.gov.in web portal. The real time data from AWS shall be used to monitor heat wave conditions in respective areas.
4. Also, the possible 'Heat Wave' impact maps generated by IMD / AP State Development Planning Society (APSDPS), based on the simulations made, shall be used as guidance maps for taking precautionary measures by various departments.
5. Three target groups were suggested to receive different, but coherent messages:
   (a) People (individuals) at risk (general population);
   (b) The voluntary care takers of the people at risk; and
   (c) The professional care and health system.
6. Public information services are necessary for disseminating information to the population in a timely and adequate manner. Communication with the media needs to be ongoing and aimed at providing enough coverage in informative programs for topics related to protection from heat-waves.
7. During heat-wave periods, daily announcements should comprise information on the following indicators:
   (a) On the daily temperature;
   (b) Consequences for population's health; and,
   (c) Activities undertaken apropos recommendations for public to pursue, etc.

Preparedness at community level - Do's and Don'ts

Sl. No	Do's	Don'ts
1	Try to stay in cold places	Expose to direct sun light or hot breeze
2	Use umbrella during hot days	Move under hot sun without umbrella
3	Wear thin loose cotton garments, preferably of white colour.	Use of black and synthetic, thick clothes during summer season
4	Wear a hat of cotton or a turban	Move under the hot sun without a hat or turban
5	Avoid outdoor physical activity from 12 to 3 p.m. if unavoidable attend to only light physical activity under the hot sun.	Attend to strenuous physical activity under the hot sun.
6	Take ample water along with salted butter milk or glucose water.	
7	Take measures to reduce the room temperature like watering, using window shades, fanning and cross ventilation	Allow direct hot air into the living rooms
8	Shift the person with heat stroke symptoms to a cool dwelling	Delay in shifting the person suffering with heat stroke to a cool place
9	The person suffering with heat stroke should have minimum clothing	The person suffering with heat stroke to have thick clothing
10	The person suffering with heat stroke has to be sponged with cold water, indirect application of ice packs.	The person suffering with heat stroke to be sponged with hot water and to be exposed to hot air.
11	The person suffering with heat stroke should be kept in between ice blocks	
12	If the persons affected with heat stroke and are not showing any improvement, he/she should be shifted to a hospital immediately, preferably with cooling facility.	Delay in shifting the person affected with heat stroke whenever there is no improvement in his condition

7. Conclusion

All the stakeholders, viz., departments/agencies shall take timely action, with the participation of Communities, ULBs, PRIs and NGOs, to implement the Heat Wave Action Plan to mitigate adverse effects of emergencies with commitment.

Domain Specialist, DRR Hyderabad

DISASTER Response & Management

March 2019, Volume 6, Number 1

LBSNAA

CENTRE FOR DISASTER MANAGEMENT

Lal Bahadur Shastri National Academy of Administration
Mussoorie - 248179, Uttarakhand, India
EPABX : (0135) 2632236, 2632489, 2632374
Phone & Fax: (0135) 2632655, Fax: 2632350, 2632720
Email: cdm.lbsnaa@nic.in
website: lbsnaa.gov.in