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Environmental Impact Assessment: Uttarakhand Disaster (June-July 2013)

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***Abstract*: Environment has become a major issue of great concern in recent years. India has been traditionally vulnerable to natural disasters on account of its unique geo-climatic conditions. Floods, droughts, cyclones, earthquakes and landslides have been recurrent phenomena. In June2013, Uttarakhand was wrecked by Flash Floods and Landslides. As a result, 80% of Uttarakhand was flooded, almost 10,000 people lost their lives, and the infrastructural systems suffered lengthy breakdowns. Consequently, basic services such as water, food, sewage, electricity, heating, communications, transportation and shelter were severely compromised.**

The paper attempts to carry out a quantitative analysis of Uttarakhand disaster within the framework of Hazard Assessment *(evaluation of the severity, and probable occurrence of the disasterin a given time period)*, Vulnerability Assessment *(estimate of the degree of loss or damage to property, population, environment, economic activities and public services etc.)* and Response Assessment*(effectiveness and efficiency of post-disaster recovery)*.

The paper shows that in case of Uttarakhand, the devastation and consequent collapse cannot be attributed to 'Act of God' alone. Political apathy, economic imprudence and poor environment management played an important role.These were further amplified by the inadequate state of preparedness, mitigation and response of various disaster management agencies during the crisis.It emerges that if the portends of the disaster, ominously evident all the time, not been repeatedly ignored, the aftermath of the tragedy, waiting to happen, could have been largely mitigated.

***Keywords*: Risk Assessment, Hazard Assessment, Vulnerability Assessment, Response Assessment, Disaster Management Operations.**

I. BACKGROUND

"*Misfortunesenter when window is left open to them"*

From 14 to 17 June 2013, the Indian state of Uttarakhand and adjoining area received the heaviest rainfall in 88 yrs, which was about 375% more than the benchmark rainfall during a normal monsoon.This abnormally high amount of rainfall has been attributed to the fusion of Westerlies with the Indian monsoonal cloud system. This caused the melting of Chorabari Glacier (Five km long flowing in the northwest direction and terminating at an elevation of 3800m) and eruption of RiverAlaknandaalong with its tributary Mandakini. Mandakini, flowing along National Highway (NH)-109 joins Alaknanda at Rudraprayag. Alaknanda continues on its course all along NH-58 till Devaprayag where the river Bhagirathi joins it to form the River Ganges. Due to various hydroelectric projects and debris from other construction activities, both Alaknanda and Mandakinihad gradually abandoned their old course and shifted their alignment. Over a period of time, several shops, hotels and resorts came up on these dry beds. On that fateful day when Alaknanda and Mandakini erupted, the overflow from both the rivers once again started flowing along their respective old courses. The

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Fig 1 :Map of Affected Areas : Uttarakhand

consequences were disastrous. The flash floods and massive landslides destroyed the buildings and other infrastructure that came in its way, killing those who were trapped.

The hallowed Hindu Chardham pilgrimage centers in the region viz Gangotri, Yamunotri, Kedarnath and Badrinath, are visited by thousands of devotees, especially during the months of May to September. An important Sikh Pilgrimage Centre Hemkund Sahib is also located in the region. Due to heavy floods, GobindGhat (the last common halt for Badrinath), Hemkund Sahib and Valley of Flowers suffered devastation. Entire villages and settlements such as Gaurikund and the market town of Ram Bada (a transition point to Kedarnath) were obliterated, while the market town of Sonprayag suffered heavy damage and loss of lives. National Highway 58, an important artery connecting the region, was either damaged or washed away at many places resulting in huge traffic jams and even causing many cars and other vehicles to be washed away (Fig. 1).Over a lakh people were stranded in these regions for days together because of damaged roads, landslides and flash flood induced debris.

While there has been no clarity on how many people lost their lives in Uttarakhand floods, IBN Live quoted National Disaster Management Authority (NDMA) Vice Chairman Shashidhar Reddy on 30 June 13 that the death toll might cross 10,000. The loss of property is estimated to be over 3,500 Crores, while the damage to environment cannot be evaluated in terms on moneyand will take decades to recover. The question is ***'Could the huge loss of life, property and environment have been avoided and, if so, to what extent'?*** To answer these questions, this paper aims to carry out an objective Hazard, Vulnerability and Response Assessment of the State of Uttarakhand.

II. HAZARD ASSESSMENT

"Hazard is Natural but Devastation is due to Human Actions"

Hazard Assessment is based on the likely occurrence of each type of disaster both in terms of frequency and magnitude. It also encompasses combination of more than one disaster occurring concurrently or in quick succession.

Uttarakhand is a multi-hazard prone State. This geo-dynamically active terrain is characterized by complex geo-environmental conditions which place this fragile landscape in a high vulnerable category for natural disasters.This area is also seismically very active with most of the Statelying either in Seismic Zone IV or V. However, since this study pertains to the June 2013 disaster, it is restricted to Hazard Assessment due to landslides and floods only.

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Landslides

Depending on lithological, geostructural and geomorphic conditions, the types and extent of Landslidesrangefrom **Low, Moderate, High**to **Very High**. Susceptibility mapping of Uttarakhandhas been carried out using Multivariate Statistical Method (Logistic Regression) and rock mass classification based Slope Stability Probability Classification (SSPC) method. Both these have relied on historical landslide data for the last 25 years collected from Border Roads Organization (BRO), geospatial data like thematic maps, remote sensing data derived from the high resolution CARTOSAT-1 and RESOURCESAT-1 imagesand geomorphological maps (Fig. 2).Based on the analysis,**large parts of Uttarakhandare placed in High Susceptibility Zone**.

Floods

There are four stagesof flooding viz**Action** (the water surface is generally near or slightly above the top of its banks, but no man-made structures are flooded), **Minor***(minor flooding, few buildings may be inundated and roads may be covered with water)*, **Moderate***(inundation of buildings, roads likely to be closed, some areas cut off leading to some evacuations)* and **Major***(life-threatening flooding alongwith complete inundation of low-lying areas and submerging of some some structures necessitating large-scale evacuations)*.**Uttarakhand is prone to moderate and major floods**ranging from Cat III (58.33) to Cat I (75) frequently cause ng a great deal of damage to life and property (Fig. 3).

Fig 2 :Landslide Prone States

Fig 3 : Flood Prone Areas

Geomorphology

Geomorphological Study of Uttarakhand in terms of its lithology, structure, basin geometry and other morphometric factors indicates that the area is in a young stage of evolution. The surface slopes are steep consisting mostly of fluvio-glacial (associated withglaciers,ice sheets, orice caps) or fluvial (associated withriversandstreamsand thedepositsandlandforms created by them) materials, which are mostly loose and unstable in nature.

The Drainage Studies carried out using topographical maps, aerial photographs and satellite imageries indicate a migratory or shifting nature of the river systems. The river bed is full of large boulders and sediments. The rives also have high sinuosity that causes aggradations on the concave end of the river and degradation or toe erosion on the convex part of the river. It is pertinent to note that the erosive power of river with sediments is almost square of the erosive power without sediments. Erosion intensity can be categorized into five different zones i.e Very High, High, Moderate, Gentle and Very Gentle. Uttarakhand lies in High and Very High Erosion Intensity Zones.

The probability of one or more natural disasters striking Uttarakhand is high especially during the monsoon season from late June to September. Thus, there is no justification for the state of Uttarakhand to have ignored the writing on the wall and being caught unprepared. In fact, on 14 June 13, the India Meteorological Department (IMD) had issued warnings followed by several advisories to the Uttarakhand government, warning it about heavy rains and massive landslides. The warnings were published in newspapers and a press release was also issued. IMD had asked the state government to move people to safer places and also advised the state government to scrap the ChardhamYatra. However, the warnings were reportedly ignored. The ensuing disaster is well documented.

Thus, it is evident that based on Geographical (location and extent), Temporal (frequency and duration) and Dimensional (scale and intensity) Analysis, **Uttarakhand rates very high in Hazard Assessment**.

III. VULNERABILITY ASSESSMENT

"When heaven sends down calamities there is a hope of weathering them, but when man brings them upon himself there is no hope of escape."

Vulnerability results from the combination of Susceptibility *(elements and people potentially at risk due to proximity and exposure)* and Resilience*(self-protection capabilities and effective prevention or preparedness measures to reduce the risk).*If susceptibility is very low and resilience very high, the vulnerability of a given area would be minimal. A combination of low susceptibility and low resilience or high susceptibility and high resilience would imply moderate vulnerability. Whereas, high susceptibility and low resilience are indicative of an area which is highly vulnerable to disasters.

With Uttarakhand having such a high hazard probability, one would have expected the state government to have taken adequate social, ecological, economic and cultural measures towards building adaptive resilience for vulnerable communities and households and supporting mitigation. However, statistics and hard facts reveal the state of unpreparedness by the State government in managing disasters.Major vulnerabilities in the State are highlighted in succeeding paras.

Tourism

Leisure, adventure, and religious tourism play a prominent role in Uttarakhand's economy. While the total population of Uttarakhand, as per 2011 census, is 1.02 Crores, the State receives over 3 Crore tourists (300% of the population of the state) every year. This inflow puts tremendous pressure on existing resources and infrastructure. The unplanned development at certain scenic or religious spots, coupled with inadequate management planning, increase in traffic and pollution has not only had a severe and negative impact on the environment but also **exponentially increased the vulnerability** to disasters.

Infrastucture Development

Ever since the formation of the state on 09 November 2000, Uttarakhand has seen ill-planned and unscientific developmental activities on a large scale. These, along with increasing population and its demand on natural resources, have put immense pressure on fragile eco-system of the State.

- ***Roads*** :As per Statistical Year Book, India (2013), Uttarakhand has a total road length of 49,227 km, of which only 54% is surfaced. In Road Density, the State ranks 15th at 0.96 km/sq km much below the national average of 1.2 km/sq km. The existing road network is inadequate, in terms of capacity, to cater for a population ranging from approx 1.02 Crore (normal)surging to over 4 Crores during tourist season. Further, having come up in a haphazard manner, it does not provide alternate mobility corridors to facilitate any disaster relief operations, thus, enhancing vulnerability.
- ***Hydroelectric Projects*** :Several large and small hydroelectric projects have come up in Uttarakhand in the upper-Ganga area, especially Bhagirathi and Alaknanda rivers and their tributaries,diverting the water to tunnels or reservoirs. This has had a serious impact on the ecosystem and biodiversity of the surrounding areas. It is pertinent to mention that on 13 August 2013 the Supreme Court directed the Ministry of Environment and Forest (MoEF) not to grant further clearances for hydroelectric power projects and asked the government to examine if construction of such projects was responsible for the recent Uttarakhand tragedy.

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- ***OtherInfrastructure Projects***: In addition to building of Roads and Hydroelectric Projects, Uttarakhand has also seen a spate of construction activities like underground tunnels, new resorts and hotels built on fragile river banks and indiscriminate encroachments of riverbeds. Infrastructure development entails operations like blasting, excavation and chipping of mountain slopes. These activities create disturbance of geological strata, movements of slip zones and causing cracks, fissures and weak planes. The natural inclinations of hill faces are disturbed increasing the vulnerability of downhill movement of landslide material. Construction of bridges and culverts often leadto eroding of banks and sometimes formation of lakes by accumulation of debris from the excavated material and landslides. A large quantity of excavated material disposed on the down hill slopes is carried by the river that gets accumulated in the dams and reservoirs reducing their depth and increasing the chances of unchanneled spillover. All these worsen the impact of the natural calamity.

Deforestation

As per data from the Union Ministry of Environment and Forests (MoEF), approx45,000 hectares of forestland hasbeen diverted to non-forest use in Uttarakhand since 1980. Of this, 9,500 hectares has been diverted for construction of roads, 5,500 hectares for hydel projects and 3,100 hectares for transmission lines (Fig. 4). 68%of the diversion has taken place after the formation of the state in November 2000.Under the Forest (Conservation) Act, 1980, a project developer is supposed to plant trees in a non forest area equal to the forest area it is clearing, or on degraded forest land which is double the project area, to compensate for forest loss. However, compensatory afforestation seems to be ineffective in the state as only 12% of this has been achieved so far. This has disturbed the ecological balance of the hills leading to huge erosion, soil movement and to loss of reinforcing power (shear strength) of roots which is directly proportional to the root density.

Soil Erosion

Soil erosion is a constant problem in Uttarakhand, with about 88% area experiencing soil erosion above permissible soil loss limit of 10 tons/hectare/year and about 35% area suffering from very severe soil erosion of more than 40 tons/hectare/year.The soil erosion and resultant rise in temperature further affect the health of the nearby forests thus making the already fragile eco-system of the State even more unstable. The priorities for soil and water conservation programmes in critically affected regions need no emphasis.

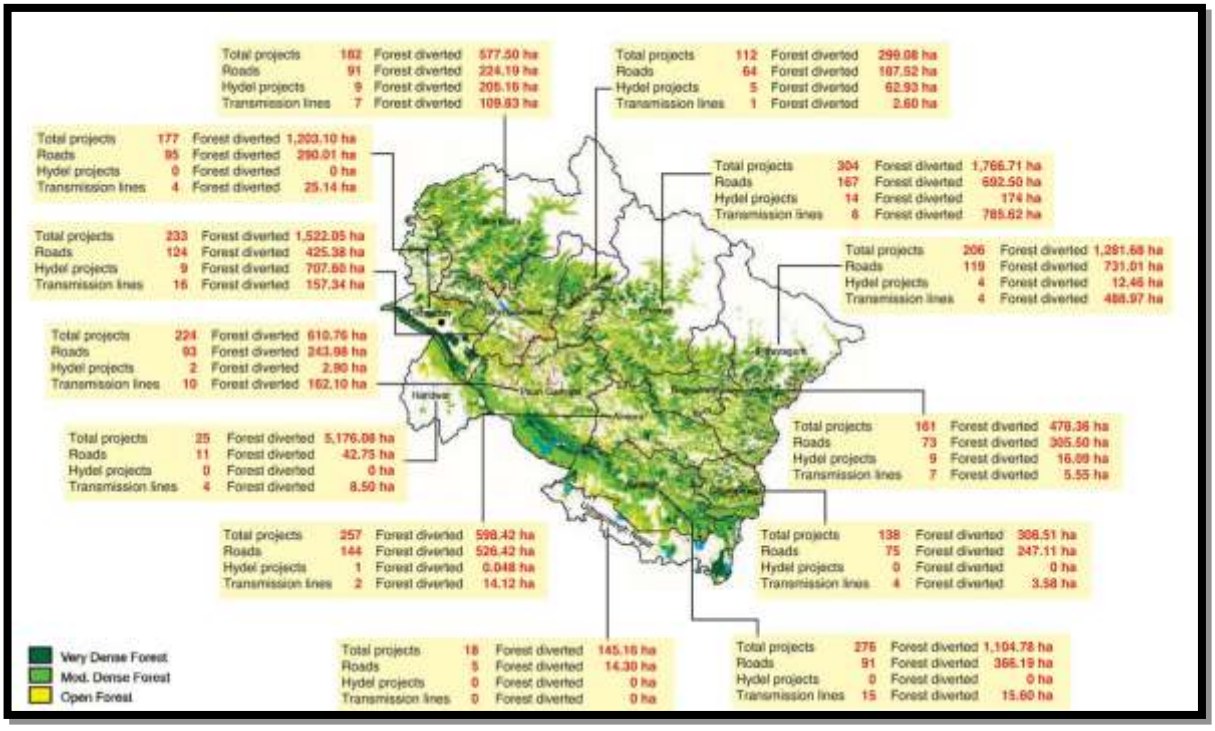

Fig 4 :Deforestation Map

The event in Uttarakhand reveals shocking tale of vulnerable establishments and lack of any credible mechanism to ensure compliance of environmental regulations. Above all, it exposes glaring inadequacies in risk reduction and disaster management preparedness in the state of Uttarakhand.

IV. RESPONSE ASSESSMENT

"We cannot stop natural disasters. But, we can prevent loss of lives by being prepared"

Response Assessment is acumulative evaluation of post-disaster activities to measure how effectively and efficiently the disaster hit areas can recover from a disaster. It takes into account the speed of casualty evacuation, appropriate medical care for injured, provision of food and shelter and all activities imperative to stabilize the affected area to minimum acceptable level.

In areas having high hazard probability, two things are imperative:-

- First, to put in place effective vulnerability reduction measures to avoid and withstand the impact of the disaster.
- Second, to enhance the response mechanism to speedily stabilize and restore the affected areas to their previous state.

Uttarakhand fell short on the vulnerability reduction measures. Let us now examine the various response mechanismsinstituted in the State.

The Disaster Management Act, 2005 lays down institutional and coordination mechanisms for effective disaster management at the national, state, and district levels. It provides a framework for creation of a multi-tiered institutional system, consisting of:-

- The National Disaster Management Authority (NDMA), headed by the Prime Minister.
- The State Disaster Management Authorities (SDMA), headed by the respective Chief Ministers.
- District Disaster Management Authorities (DDMA), headed by the District Collectors and co-chaired by elected representatives of the local authorities of the respective districts.

Uttarakhand, having a very high hazard probability, needed to put in place the disaster management framework and coordination mechanism on a war footing.But the CAG's performance audit of the functioning of the NDMA, which entered public domain on 15 March 2013, observed the following:-

- NDMA guidelines for preparation of State Disaster Management Plan (SDMP) were issued in July 2007 and SDMA in Uttarakhand was constituted in Oct 2007. However, it had neither formulated any rules, regulations, policies and guidelines nor prepared any actionable programmes for various disasters.
- As of September2012, the SDMA in Uttarakhand had never met since its constitution, the State Advisory Committee on Disaster Management met only once after it was constituted in February 2008 and the State Executive Committee had not met even once since its creation in January 2008.
- Emergency Operation Centresrequired to be set up at State and District level for receiving and dissemination of information to various stake holders were either nonexistent or inadequately staffed.
- Requisite tools and mechanism for providing early warning of impending disaster were not in place. This had clearly led to situations when critical information reached vulnerable populations after considerable delay. Test check of records indicated that due to inadequacy of reliable communication system, sharing of disaster information was delayed by more than three hours in 50-86% of cases.
- For accurate weather forecasting and predicting cloud burst, the Government of India had sanctioned Doppler Radars for Uttarakhand in June 2008. These were to be purchased, installed and manned by Indian Meteorological Depaartment. The state government was to make available land for this purpose at Nainital, Mussoorie and Joshimath. These radars are yet to be installed due to non-availability of land!

- For preparing detailed topographic maps of very high accuracy, Airborne Laser Terrain Mapping and Digital Camera System were procured in the year 2004. While expenditure worth Rs 23.75 crore had been incurred, the survey has so far covered less than 10% of flood prone areas.
- Uttarakhand, being a special category State, gets 90% share of its State Disaster Response Funds (SDRF) from the Centre while the State government contributes the remaining 10% .The release of Central Funds have often been delayed from three to six months due to late submission of utilisation certificates and other requisite documents by SDMA.
- Although the Geological Survey of India had identified 101 villages in Uttarakhand as *'Vulnerable'* in June 2008, the State government has not taken any measures for their rehabilitation till date.

There is no gainsaying that **Uttarakhand fails miserably both on account of vulnerability reduction measures as well as various response mechanisms instituted in the State**. In fact, on 13 August 2013, the Supreme Court ordered the SDMA in Uttarakhand to submit a report to the Court as to why 'no disaster management plan existed in the State.'

The saving grace for Uttarakhand was the post disaster rescue and search operations by Army (10,000 soldiers and 11 helicopters),Navy (45 divers) and the Air Force (43 aircrafts including 36 helicopters). Together, the Defence Services flew close to 2200 sorties despite inclement weather, rescued over 65,000 stranded people and helped deliver approx 800 MT of essential commodities and relief material. In addition, the Indo-Tibetan Border Police (ITBP), Border Security Force (BSF), National Disaster Response Force (NDRF) and many NGOs and volunteers played key role in rescue operation and management of relief centres.

V. CONCLUSION

"Procrastination is the foundation of all disasters."

Although very little can be done to change the incidence or intensity of most natural phenomena, the society needs to play an important role in ensuring that natural events are not converted into disasters and their impacts are not increased manifold for anthropogenic reasons.

What unfolded in Uttarakhand was a human tragedy of abominable proportion. However, the truth is that the warnings and advisories regarding the impending disaster, issued by IMD, were ignored by the State. The loss of life, property and environment was exacerbated, to a large extent, due to the negligence and apathy of the administrative machinery, inadequate disaster management infrastructure and lackadaisical response of the Uttarakhand government.

In contrast, on 8 October2013, when IMD issued a warning that a Category 5 cyclone was approaching Odisha, all government officials were ordered to report to work, train services to costal areas suspended, electric supply shut and over 9,73,000 people evacuated to safety within the next 36 hours, before Cyclone Phailin made a landfall in Ganjam district on 12 October2013, thus saving precious lives. The post disaster response of Odisha Disaster Rapid Action Force (ODRAF) assisted by NDRF flown in from Delhi, was equally swift and commendable.

Thus, the key to effective disaster management lies in instituting efficacious vulnerability reduction measures and enhancing the response mechanism. A few of these are enumerated in succeeding paras. These are neither comprehensive nor intended to be. They are only indicative of the preliminary initiatives in disaster preparedness and response:-

- Firstly, there is a need to carry out credible environmental-impact assessment of infrastructure projects like dams, tunnels, blasting, power-house, muck disposal, mining, deforestation etc in these highly ecologically sensitive areas of Uttarakhand in a scientific manner.
- Secondly, disaster prevention, mitigation, preparedness and relief measures alongwith environmental protection policies are imperative for implementation of sustainable developmental process.In Uttarakhand, landslides and floods are primarily happening due to human interventions. Blatant violation of building laws and land use, roads and settlements along rivers and reclamation of river have increasedthe State's vulnerability to disasters. Thesemust cease forthwith.
- Thirdly, technology must be optimally leveraged for a holistic management of disaster in a pro-active manner.Theseinclude setting up of robust real time communication network, installation of Early Warning Systems

like Automatic Danger Level Overflow Alarm System using intelligent sensors, especially in areas where flash floods are frequent;Remote Sensing, GPS linked Geographic Information Systems (GIS), Virtual Simulations of flood scenarios and use of Social Media.

Finally, a clean and healthy environment is a fundamental right under Article 21 (Protection of Life and Personal Liberty) of the Indian Constitution. Time has now come to consider Disaster Management under the purview of this Article, so that it can be enforced at National Level as a Constitutional Duty.

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