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PROBABILISTIC RAINFALL THRESHOLDS FOR SHALLOW LANDSLIDES INITIATION – A CASE STUDY FROM THE NILGIRIS DISTRICT, WESTERN GHATS, INDIA

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Abstract: Rainfall is one of the major causes of landslides/landslips across the globe. The fatalities and damage caused by rainfall induced landslides increased in recent days. The Nilgiris district in Western Ghats part of Tamil Nadu state is one of the very high to severe landslide hazard prone areas of India. The present study is focused on estimation of rainfall thresholds and temporal probability of landslides in different landslide prone slopes in part of The Nilgiris district. The landslide prone areas identified in earlier research are used for the present study. The landslide locations data for the years 1824 to 2018 were collected and a spatial database on landslide inventory was created. A detailed inventory carried out on the 2009 landslides were analysed and used for the calculation of rainfall thresholds. Monthly and Yearly Rainfall data for the years 2000 to 2011 were collected for 37 rainguage stations from various government agencies. Based on the quality and quantity of data, the rainfall thresholds for 14 different locations were estimated viz., Aderly, Coonoor, Coonoor Railway, Governor Sola, Ooty (Near Botanical Garden), Runnymede, Burliar where the probability of landslide occurrences is high. The temporal probability of landslide was calculated for four years viz., 1, 3, 5 and 10 years. The present study can be used as a key to develop an early warning system in The Nilgiris District.

Key Words: Landslide, Rainfall, Threshold, Probability, Western Ghats, The Nilgiris

1. Introduction

Knowing the duration, intensity and amount of precipitation triggering landslides is of great importance for landslide risk management. Global, regional and local studies carried out by the researchers revealed that the rainfall-induced landslides occur after rainfall exceeding a certain threshold value. The rainfall threshold is the minimum intensity or duration of rainfall required to initiate the landslide and it can be estimated by different empirical methods (Jaiswal and Van Westen 2009). Shallow landslides usually involve a small volume of earth and/or rubble, but they are distinguished by high speed and high energy from impact. Furthermore, during intense rainstorms many shallow landslides initiate almost simultaneously (Giannechini et al. 2012). The rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years successfully used for landslide studies by Hershfield (1961). Many researchers established relationship between rainfall and landslides (Bran et al. 1984; Pasuto and Silvano, 1998; Chleborad 2003; Aleotti 2004; Dahal RK, Hasegawa S, 2008; Guzzetti et al. 2008; Papa et al. 2013; Tien et al. 2013; Mathew et al. 2014; Segoni et al. 2014 and 2015; Dixit and Satyam 2018; Segoni et al. 2018).

Crozier (1999) used antecedent water status model to predict rainfall induced landslides. Coe et al. (2000) used historic records to identify the recurrence intervals, and exceedance probabilities of Seattle, Washington region. Glazier et al. (2009) applied probability determination to refine landslide-triggering rainfall thresholds using an empirical antecedent daily rainfall model. Squarzoni et al. (2003) carried out spatial and temporal probability by using SAR interferometry. Probabilistic forecasting of shallow rainfall-triggered landslides using real-time numerical weather predictions was tested by Schmidt (2008). Jaiswal and Van Westen (2009) carried out a study on temporal probability of landslides in transport corridors. Segoni (2009) established a definition of a real-time forecasting network for rainfall induced shallow landslides. A distributed hydrological–geotechnical model using satellite-derived rainfall estimates for shallow landslide prediction system at a catchment scale was carried out by Apip et al. (2010). Baum et al. (2010) successfully estimated the timing and location of shallow rainfall-induced landslides by using a model for transient unsaturated infiltration. Temporal probability analysis of landslides triggered by intense rainfall in the Bamenda Mountain Region, Cameroon was carried out by Afungang and Bateria (2016). Dixit and Satyam (2019) carried out study on estimation and validation using monitoring system by Probabilistic rainfall thresholds in Chibo, India.

India is one among the countries prone to rainfall-induced landslides. The landslide hazard zonation atlas of India shows that many part of India is prone for very high to severe landslide hazard (BMTPC 2003; Bhandari 2006; Rajarathnam and Ganapathy 2006). Some of the densely populated areas fall under these hazardous zones. The Nilgiris district has a history of many landslides which has generated more damage to property and infrastructure however the loss of life is less when compared to the number of landslides (Ganapathy and Hada 2012; Ganapathy and Rajawat 2015). In the recent times causalities and damages due to landslides have increased in the Nilgiri Hills (Nilgiris 2015 and The Hindu 2009). Many researchers carried out studies on landslide susceptibility and hazard mapping; however not much work reported on rainfall thresholds and temporal probability of landslides in The Nilgiris District. The objectives of the present study are to develop Rainfall Thresholds for different landslide prone areas and to estimate the temporal probability of landslides in part of the The Nilgiris District of Western Ghats, India

2. Study Area and its Site Characteristics

The study area covers a stretch of 80Km from Hillgrove Station to Gudalur city, part of The Nilgiris district in the Western Ghats hill ranges of State Tamil Nadu, India (Fig.1). The district has an area of 2552.50Sq.km with a population of 0.735 million as per the Census of India 2011 and the district head quarter is Ooty (Udhagamandalam). The elevation varies from 1000 to 2633m above mean sea level. The highest peak in the district is Doddabetta with a height of 2,663m. The topography of the district is undulating with steep escarpment and about 60% of the cultivable land slopes ranging from 16 to 30 degree slope. The Nilgiri district is underlain entirely by Achaean Crystalline formations with recent alluvial and colluvial deposits (GSI 2000).

Landslide Hazard Zonation Atlas of India classified the Nilgiris district as high to severe landslide prone areas. The Study area also falls under severe landslide prone areas. The landslide activity in the district is almost seasonal during every year (Seshagiri et al. 1982). The months of October & November are prone to landslides. The years 1902, 1978, 1979, 1993, 2001, 2006 and 2009 are notable years for landslides in the history of The Nilgiris district. In November 1891 heavy rain caused many landslips on the Coonoor Ghat, and created more damage to the Kotagiri - Metuppalayam road (Ganapathy and Rajawat 2015). Recently, in the Nilgiri Hills, casualties and damage caused by landslides have increased (Thanavelu and Chandrasekaran 2008; Chandrasekaran et al. 2013). In 2009, heavy rains triggered a series of landslides in The Nilgiris regions of Ooty, Coonoor and Kotagiri. On 10th November 2009, 42 people died within 48 hours (Thennavan and Ganapathy 2020). The details of landslide/landslip occurrences in different corridors during the year 2009 are listed in Table 1. The district receives rainfall both during southwest and northeast monsoons. The southwest monsoon is more active contributing nearly 50 percent in the west and 40 percent in the east. The northeast monsoon is moderate, contributing nearly 40 percent. The intensity of rainfall gradually decreases from west to east. The rains during the winter and summer periods are significant. The minimum and maximum annual rainfall varies from 750mm to more than 3000mm and the number of rainy days varies depending on the season and the area (CGWB 2008). Since most of the landslides in the district are triggered by rainfall, a study is carried out to establish the rainfall thresholds for the different slopes and to analyse the temporal probability of annual exceedance of the landslides between Hillgrove to Gudalur stretch of The Nilgiris District.

3. Approach

The present study focuses on estimating rainfall thresholds and temporal probability analysis of annual exceedance of the landslides in the study area. To identify the vulnerable slopes, landslide hazard map prepared by Geological Survey of India (Seshagiri et al. 1982) is revised by using additional information like latest landslide location, Size, Volume of material involved, built area near the landslide, fatalities, reactivation etc. A detailed landslide inventory data collected from various sources as well as by limited field investigations is used in GIS platform to locate the vulnerable slopes. Based on the analysis, 18 landslide hot spots were considered (Fig. 2) as most vulnerable locations in the study area, however the details of rain gauge stations were not available for all the locations to fix the rain fall thresholds. Based on the availability of the data, 14 vulnerable locations are selected for the present study (Fig. 3). Monthly Rainfall Data were collected for 52 years for the study area from India Meteorological Department (IMD) to analyse the rainfall pattern. Monthly Station wise rainfall data

were collected for the year 2001 to 2011 from Revenue Department, Government of Tamil Nadu and daily hourly rainfall data (for 1st to 30th November 2009) were collected for the present study.

4. Rainfall Thresholds

Many researchers carried out studies and compared the empirical relationship between rainfall duration, rainfall intensity and slope instability. Estimation of rainfall thresholds is an important parameter for landslide warning systems (Clark 1987; Jibson 1989; Keefer et al. 1987; Neary and Swift 1987; Wilson and Wiczorek 1995). Caine (1980) suggests a general threshold that works for time periods between 10 minutes and 10 days for 73 events in different geologic and climatic conditions. On the other hand, empirical models are obtained by analyzing the rainfall events which resulted in landslides. Such kinds of studies measure the severity and length of the rainfall resulting in landslides using statistical data and obtain a threshold value. The relationship of this threshold value is generally obtained by drawing lower bound lines to the conditions of rainfall which resulted in landslides in cartesian, semi-logarithmic or logarithmic co-ordinates (Guzzetti et al. 2007). Researchers carried out study on automatic calculation of rainfall thresholds for landslide studies (Melillo et al. 2018; Gariano et al. 2019).

4.1. Temporal probability assessment

The time series of daily rainfall $R_d(t)$ in mm day⁻¹, where t is time. For a landslide (L) to occur, the daily rainfall must exceed a threshold, which is a function $R(t)$ of the daily rainfall in a period, and of the amount of the antecedent rainfall $R_{ad}(t)$, i.e., rainfall that have occurred prior to the day of landslide occurrence (Jaiswal and Van Westen 2009; ITC Netherland 2013).

$$R(t) = f(R_d(t), R_{ad}(t)) \quad (1)$$

Where $R_{ad}(t)$ is the antecedent rainfall in mm. This function of R defines the probability of occurrence of the landslide L : $P(L)$. If R_T is the threshold value of R then,

$$P(L|(R > R_T)) = 1 \text{ and } P(L|(R \leq R_T)) = 0 \quad (2)$$

Thus, in this simplified model, landslides always occur when R exceeds R_T and does not occur when value of R is lower than or equal to R_T . In the previous case, the likelihood of occurrences of landslide $P(L)$ depends on the exceedance probability of $P(R > R_T)$, i.e., $P(L) = P(R > R_T)$.

Thus, the probability of landslide occurrences can be given by the intersection of two probabilities,

$$P((R > R_T) | L) = P(R > R_T) \times P(L|(R > R_T)) \quad (3)$$

4.2. Estimating Rainfall threshold for a given day

The Rainfall threshold can be estimated from the daily rainfall data which is collected from the rainguage. The methodology used by Jaiswal and Van Westen 2009 and ITC Netherland 2013 are used for the present study. Daily hourly data from particular rainguage station closer to the different dates of landslide location were considered in the same month. The 5-Days Antecedent (5-AD) rainfall for each year from daily rainfall of landslide events calculated (for 5-days AD, add the previous 5 days of daily rainfall). For Example, the 5-AD for November 6th will be sum of daily rainfall of November 5th to November 1st. Then the daily rainfall and the corresponding 5-AD rainfall for the all the landslide event in the same period will be plotted. A line drawn manually such that it demarcates the lower end of the plotted points and extend it up to the x and y axis. The line is a straight line with negative slope of the type $y = -mx + c$, where m is the slope and c is the intercept. The equation computed for the line for example $m = (y_2 - y_1) / (x_2 - x_1)$. For this line the equation can be written as $RT = K - p \cdot R_{5ad}$. Here K , p are constants. RT = Rainfall Threshold. R_{5ad} = Rainfall 5 Day Antecedents. Using this equation the rainfall Thresholds are calculated for the 14 different locations viz. Adarly, Coonoor, Coonoor_Rly, Governersola, Gudalur, Currency, Hillgroove, Kethi, Naduvattam, Ooty, Ooty_scr, Runnymedu, Valvewoodest, Burliar. The K value varies from 65 to 220 in these locations. The RT graphs for the 14 locations are presented in Fig. 4 and Table 2. The threshold exceedance of a given calculated by using the daily rainfall and rainfall threshold of the day. It will be expressed as Threshold exceedance = Daily rainfall - Rainfall threshold.

5. Annual Exceedance Probability (AEP)

The Annual Exceedance Probability (AEP) is the estimated probability that an event of specific magnitude will be exceeded in any given year (Fell et al. 2005). For a given rain gauge Annual Exceedance Probability of the threshold $P(R > RT)$ was determined using a Poisson probability model. Coe et al. (2000, 2004); Guzzetti et al. (2005) and Chleborad et al. (2006) successfully used a model to determine the exceedance probability of landslide in time.

$$P[N(t) \geq 1] = 1 - \exp(-t/\mu) \quad (4)$$

Where, μ is the mean recurrence interval between successive landslide events which can be obtained from the multi-temporal landslide inventory data. The probability prediction for 14 locations for the different return periods viz, 1, 3, 5 and 10 years were calculated and presented in Table 3 and Fig. 5. The likelihood of having one or more rainfall events that can trigger landslides in any given years varies from 0.48 to 2.60. Similar kinds of rainfall events are capable of triggering one or more landslides in the months of October to December.

6. Conclusions

The present study of rainfall threshold and temporal probability from Hill grove to Gudalur is carried out because of the vulnerability of slopes and its risk towards the settlement areas. Rainfall threshold were calculated for 14 sites in the district depending on the availability of rainguage network and data availability. Based on the value individual sites were assessed. The Annual Exceedance Probability calculated for 4 Years viz 1, 3, 5, and 10. Out of 14 Sites

6 sites viz, Coonoor Railway, Governersola, Gurrency, Kethi, Naduvattam and Valvewoodest were having high probability of landslides in a year chances of 1 time if the same antecedent's rainfall occurred in the particular site. The location Hillgrove will have chances in three years once and Ooty (Scr) will have chances in five years once. Among all Valvewoodest and Kethi are the two locations more vulnerable based on the annual probability exceedance of landslides. The study has its own limitations. The rainfall data were used from various agencies (Government and Non-Government), so the calibration of instruments is not known for some of the stations. Another limitation is the availability of the rainfall data. Most of the historical period data were not available and a good record of data after 2007 only available. The date of inventory also plays a major role when it compared with rainfall occurrence and accumulation period. Generally landslides happened during rainy season and the documentation of landslide will be carried out by the agencies after few days. The dates of landslides are based on local interview. The present methodology can be applicable for other part of the district having same geo-climatic conditions. The people in the high vulnerability areas should be trained for landslide response. The present study can be used as a key for landslide early warning in the study area. Also guidelines should be prepared for assessing, planning policy and consent requirement for landslide prone lands in The Nilgiris District.

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Table 1. Landslide incidences in different corridors in The Nilgiris districts during the Year 2009

Sl.No	Road Corridors	Number of Landslides/Slips
1	As reported from petitions received from public	91
2	NH 67 – (Mettupalayam – Coonoor- Ooty)	160
3	Other District roads Municipalities, Town Panchayats and Village Panchayats	544
4	Ketty – Palada Seles Road	26
5	Kattabetta – Iduhatty Road	26
6	Coonoor – Kattabetta Road	33
7	Kundah Begumbella Road	39
8	Coonoor – Kundah Road	50
9	Ooty Avalanchi Kundah Thai Sola Road	59
10	Ooty – Kotagiri – Mettupalayam Road	122

Table 2. Calculated threshold values for different sites in the study area

Sl. No.	Raingauge Name / Location	Threshold
1	Adarly	$RT = 130 - 0.79 * R_{5AD}$
2	Coonoor	$RT = 90 - 0.86 * R_{5AD}$
3	Coonoor_rly	$RT = 100 - 0.67 * R_{5AD}$
4	Governersola	$RT = 75 - 0.63 * R_{5AD}$
5	Gudalur	$RT = 135 - 1.7 * R_{5AD}$
6	Currency	$RT = 89 - 0.64 * R_{5AD}$
7	Hillgroove	$RT = 110 - 1.1 * R_{5AD}$
8	Kethi	$RT = 120 - 0.8 * R_{5AD}$
9	Naduvattam	$RT = 65 - 0.45 * R_{5AD}$
10	Ooty	$RT = 150 - 0.83 * R_{5AD}$
11	Ooty_scr	$RT = 66 - 0.69 * R_{5AD}$
12	Runnymedu	$RT = 180 - 0.93 * R_{5AD}$
13	Valvewoodeast	$RT = 102 - 0.82 * R_{5AD}$
14	Burliar	$RT = 220 - 0.61 * R_{5AD}$

Table 3. Probability Prediction of location wise landslide probability

Sl.No	Location	Years			
		1	3	5	10
1	Adarly	0.70	0.75	0.75	0.73
2	Coonoor	0.48	0.48	0.48	0.48
3	Coonoor Railway	1.60	1.90	1.91	1.91
4	Governersola	1.28	1.80	1.85	1.86
5	Gudalur	0.79	0.91	0.92	0.92
6	Gurrency	1.47	2.22	2.32	2.33
7	Hillgroove	0.89	1.00	1.00	1.00
8	Kethi	1.38	1.76	1.78	1.78
9	Naduvattam	1.22	2.16	2.41	2.50
10	Ooty	0.48	0.48	0.48	0.48
11	Ooty (Scr)	0.81	0.99	1.00	1.00
12	Runnymedu	0.28	0.37	0.38	0.38
13	Valvewoodest	1.47	2.39	2.56	2.60
14	Burliyar	0.46	0.70	0.73	0.73

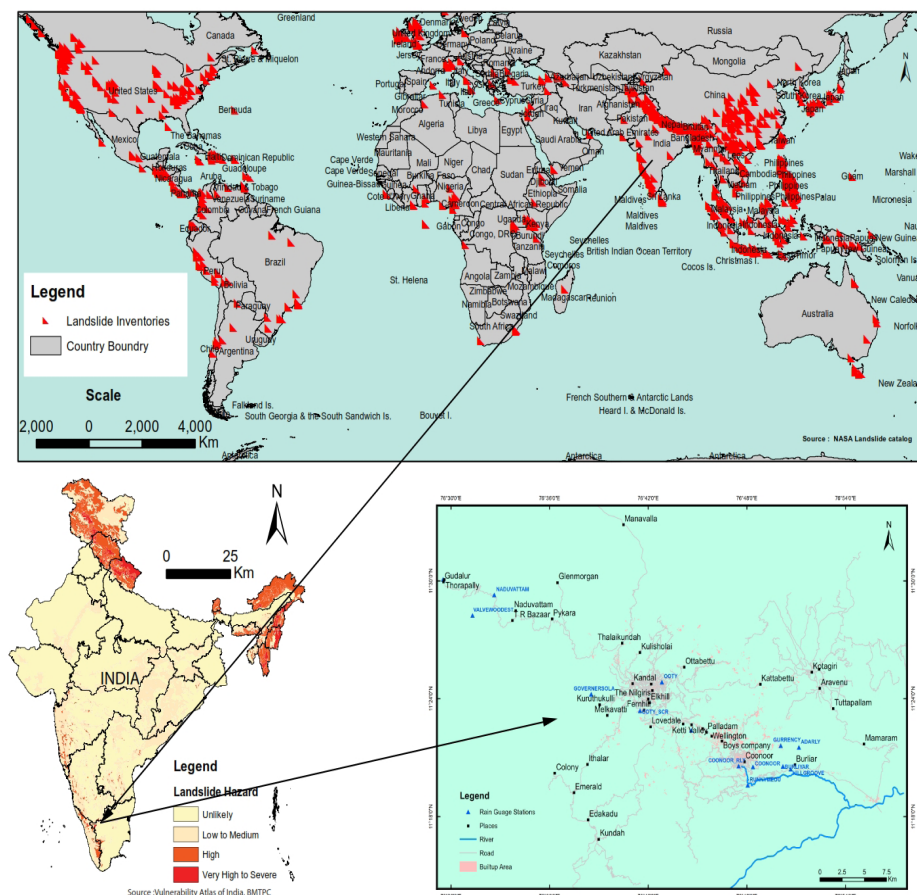


Fig. 1 Study area and its Landslide Hazard Severity

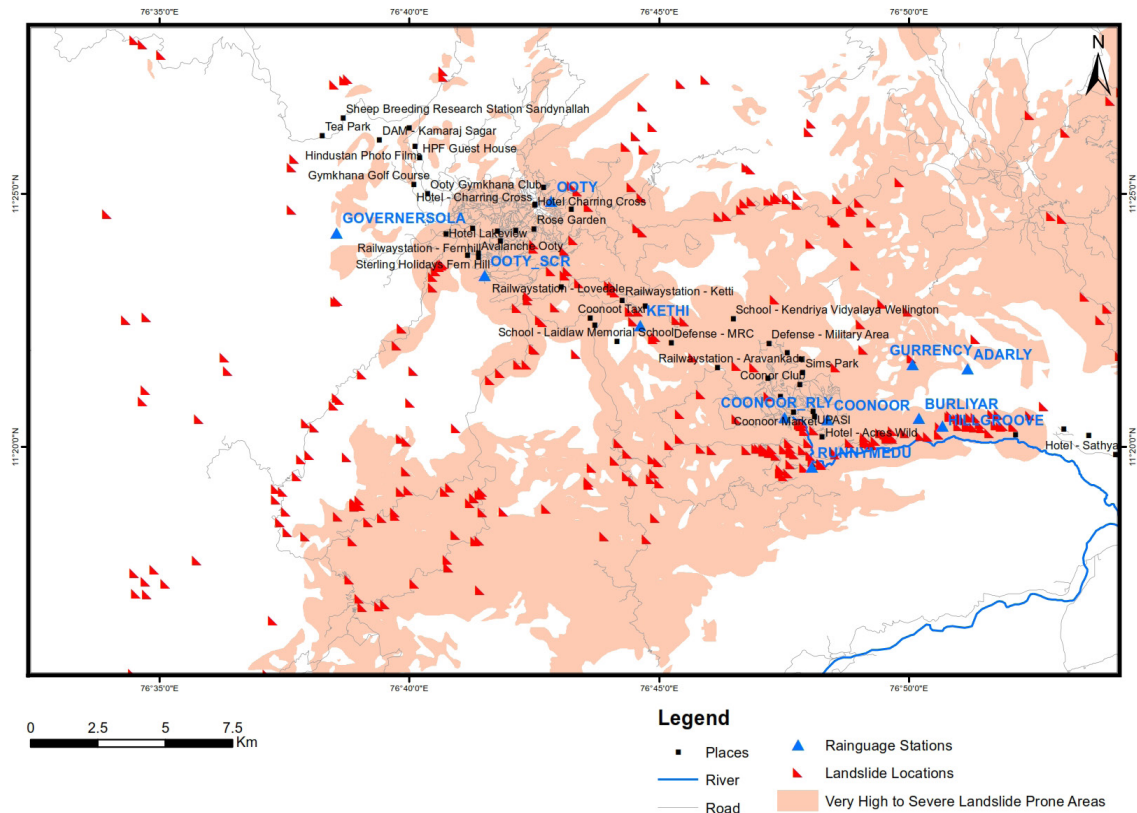


Fig. 2 Revised Landslide Hazard impact areas considered for the study

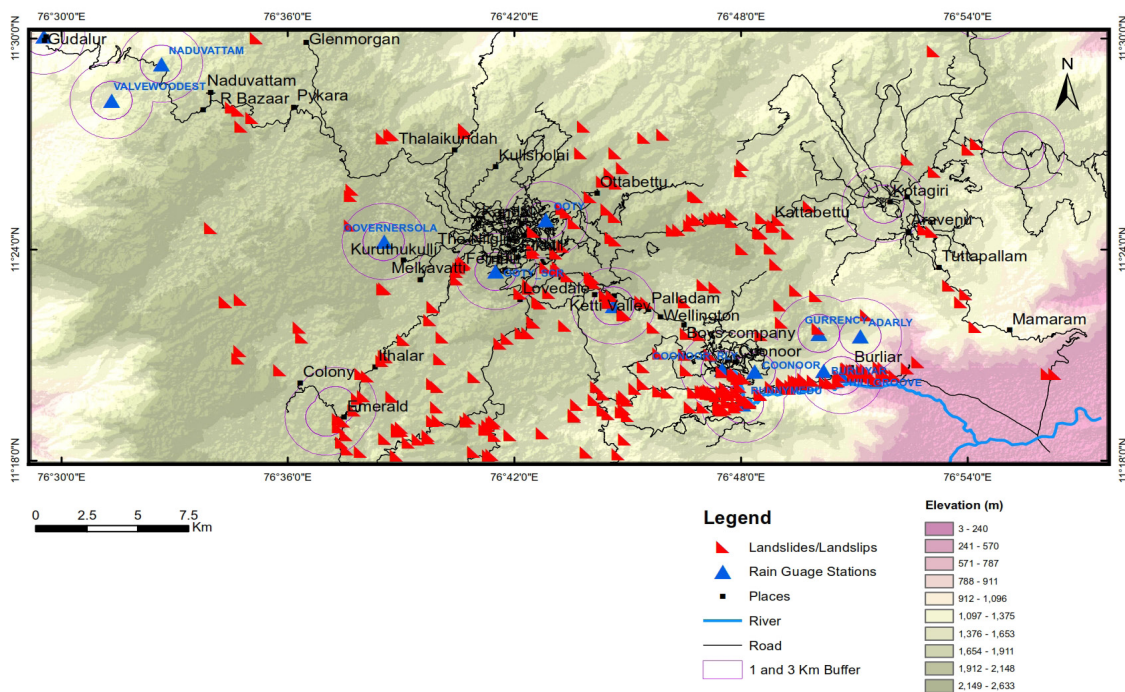


Fig. 3 Selected Locations for Rainfall Threshold Calculations within the buffer zone of rainguage stations

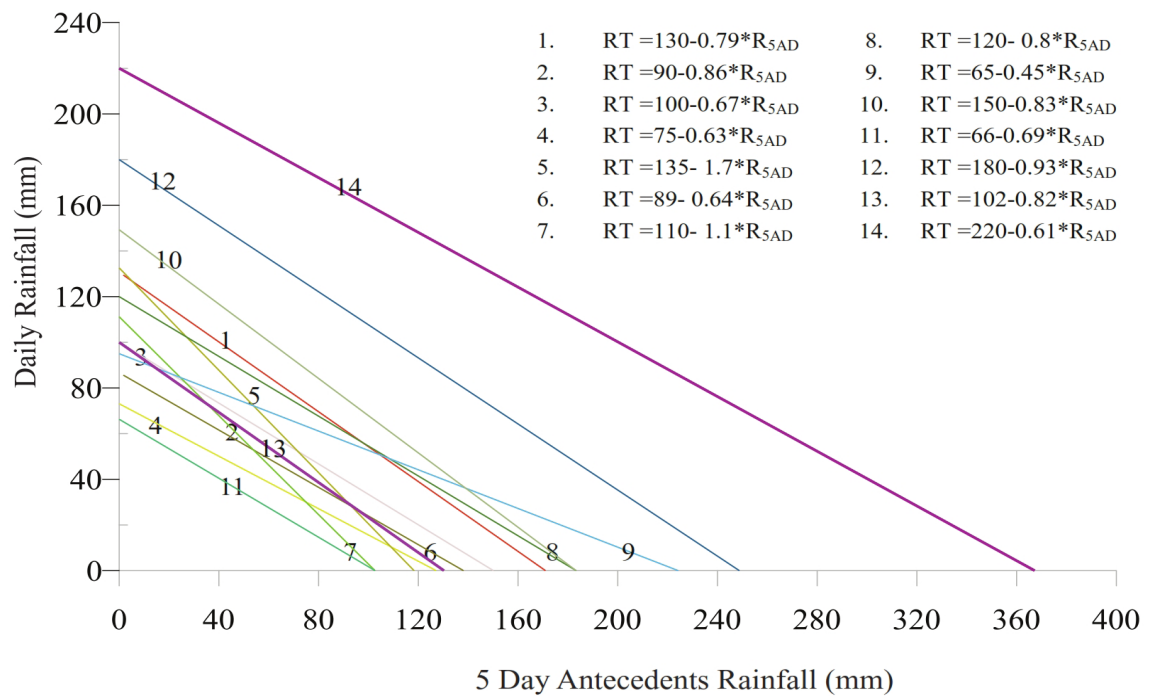


Fig. 4 Estimated rainfall thresholds for 14 different locations in the study area

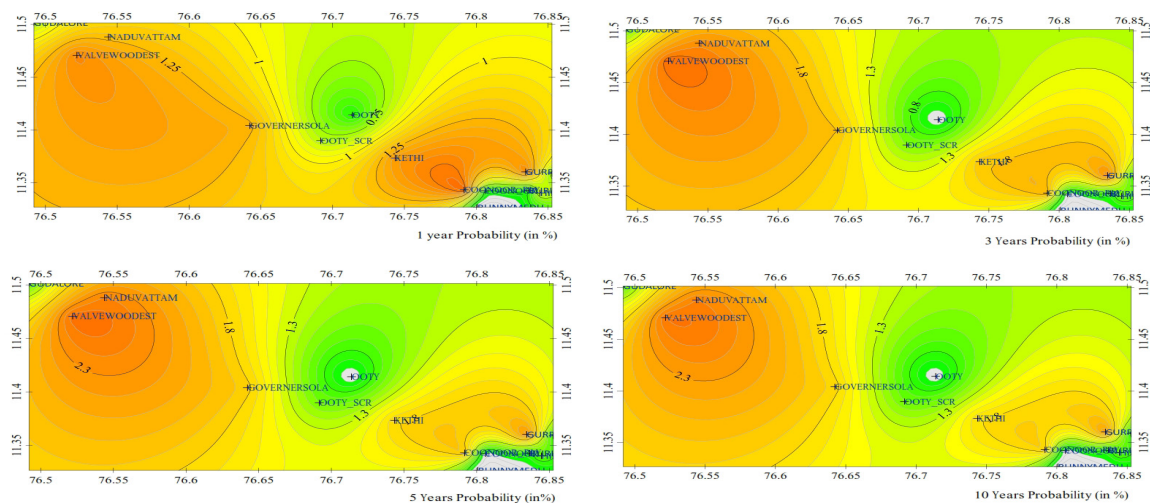


Fig. 5 Annual Probability of Landslides (percentage of exceedance for 1, 3, 5 and 10 Years)

DISASTERS AND EXEMPLIFIED VULNERABILITIES IN A CRAMPED PUBLIC HEALTH INFRASTRUCTURE IN INDIA

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Abstract: The varied connotations to the term 'Development' are been channeled through perception. The perception of a political stakeholder differs from that of a rich-businessman, and again, from those who are lesser endowed. There is a pressing need for the government, to identify and maintain checks and balances between exploitative and responsive governance.

The extension of the healthcare sector is an integral part of this holistic growth, while the customer base has largely financed the industry; the obligation on the hand of government needs to increase. The out of pocket spending by patients covers the finances of the sector by 64.2%. (NSSO, 2014 report). The lesser amount of government spending in the healthcare system is a drawback and has effects on the Industry in a negative frame in a large manner, only 28.6% of Total Health Expenditure is financed by Govt. of India and therefore, calls for the need for better financing mechanisms in the country in the form of insurance schemes and a smoother flow of the already existing policies and frameworks

In the debate of private v/s public hospitals, the paper presents reasons that create a barrier on effective utilization of benefits provided, and further constructs the viewpoint that though expensive, private healthcare services provide more assurance to the population in general. The over-crowding of these public institutions in times of epidemics or otherwise, is a self-indication of the dearth of infrastructure and the kind of impacts the interventions has had in terms of alleviating such grievances.

The several debates that I have tried to analyze and interpret include those of the intersections the individuals of the country and the lawmakers have crossed in terms of developmental projects and whether these promises hold true in terms of concrete reality. The depth of understanding and entering these discussions is only a gateway to more pertinent questions of whether the present infrastructure has dwindled due to disasters in the past? Are we actually moving to building resiliency or is it just a mock-up present on paper only?

The paper reflects qualitatively on several government reports on health and the state of the hospitals presented within various contexts of Disasters in the past. The analysis of the National Rural Health Mission, National Urban Health Mission and various others programs initiated by the Government of India and the scope that it has to remove the present day struggled faced by an over-crowded and pressurized public sector healthcare structure.

Key Words: Disasters, Exemplified vulnerabilities, Public Health, Infrastructure

1. Introduction

The ability of a state to provide basic education and healthcare is an important characteristic of a developed nation, as socio-economic parameters have gained vitality in the discussion and discourse on development, and are essential parameters to demarcate the shortcomings and fallouts of a governing regime. In a country that spends only 1.4% of its GDP on healthcare, it is important to question the vision that the state structure envisages for their population and the healthcare system. The development of a nation is incomplete without considering the progress of all its components and by constantly making an effort to improve the quality of service, ensuring equitability and accessibility to all citizens.

Disasters impede the process of growth, and in some manner, give rise to these perceptive mechanisms. In times of a catastrophe, what might have felt like a milestone in the past may seem as a burden and a liability at present. It is highly likely for income to play a role in determining the parameters for development, i.e. rich countries might enjoy the benefits of spending on a technology that seems like a far-fetched concept for the low-income countries. These conditions thus, predispose certain vulnerabilities to nations with limited resources. Despite of all the challenges that present themselves, there are certain aspects to development that cannot be ignored, primarily, the effective proliferation of education and health sector that constitute a part of the socio-economic component of development. The shift from a purely GDP oriented outlook to growth, to the conception of a rather socially competent nation is an essential turn-around over the years.

There is a growing concern with environment uncertainties, and social vulnerabilities make certain sections susceptible to higher damage than others. Sustainable Development Goals, therefore, focus on eradicating causes of social vulnerability by providing equitable access to basic infrastructure, and thus, a resultant change in the way we perceive development, being an improvement in the holistic human standards, and not just economical gains. The uneven accessibility of resources has been rampant in growing economies, and needs to be altered in order to achieve uniform development. The question therefore, remains of perceptive understanding. In further section, the paper explores the efficiency of private and public healthcare sector, and questions the exploitation of the already vulnerable. Health is a state subject; therefore, center's contribution in improving the conditions has been conflicting, and rather vague. The following paper, therefore, presents arguments from the angle of policy undertaking and the multi-dimensional nature of social development. It deepens the understanding on the existing vulnerabilities, and questions the resiliency of the systems to disasters.

2. Healthcare Policies in India – Implications and Challenges

Securing public health and characterization of the declining health statistics in rural India as the need of the hour, drove the resultant shift in policy planning and implementation in the sector. The governmental schemes have been portrayed as being directed at populations that are devoid of basic health benefits and thus aim at enhancing the reach of these policies as well as the quality of healthcare. However, privatization of health system structure, as explored in the further sections, has gained momentum in recent times as private entities are considerably better oriented towards quality and performance based service. In the race of gaining economic benefits, and rising above the competing countries, the ideological shift has become a means to an end approach rather than an all-inclusive endeavor.

There are several challenges to the approach as it negates the responsibilities of the state and results in inequitable distribution of services on a global index, it has shown some advantages, thus, bypassing the checks that should be considered while constructing such policies.

Understanding the trajectory of expenditure, the health expenditure had declined from 1.3% of GDP in 1990 to 0.9% of GDP in 1999. The state-central ratio of health expenditure was 85-15 percent respectively. National Rural Health Mission (NRHM) was launched in 2005, with a vision to improve the health status of rural India, which is predisposed to vulnerabilities due to lack of accessibility to quality healthcare (Gopalakrishnan & Immanuel, 2017).

The aim of NRHM was to also make healthcare affordable, effective, accountable, and reliable, with special focus on 18 states (North Eastern States + Empowered action group states [socioeconomically backward states – Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Orissa, Rajasthan, Uttarakhand, and Uttar Pradesh] + 2 hilly states (Himachal Pradesh, Jammu & Kashmir). The National Health Accounts (NHA) 2004-05 data shows that at the State level, 38% of health expenditure is spent on primary health care, 18.67 % on secondary health care, 21.84% on tertiary health care and rest on direction and administration and other services. (Gopalakrishnan & Immanuel, 2017)

Studying the reports by World Health Organization report, (2018) suggests that the situation has changed for better, with number of under 5 deaths reducing from 2049 in 2005 to 1139 (thousand) in 2015, the infant mortality rate has reduced to over the course of 10 years, from 60% in 2005 to 35.3% in 2015, though the number still remains large, and there are aspects that do need attention. The presence of ASHA workers in villages, accredited social health activists does make a difference, and has been observed with the changing statistics over the years of Infant Mortality Rate, Maternal Mortality Rate and Under 5 mortality rate, but the broader question remains, as to whether there is a loophole that is concerning when it comes to providing opportunities. Though, there have been cases where the vulnerabilities of the poor has been high-lightened even in the present scenario, in 2016, Dana Majhi, a tribal from Orissa had to carry his wife from the hospital due to the lack of ambulance, in May 2017, a similar incident occurred in Ettawah, Uttar Pradesh to a man who had to carry his deceased son on his shoulders. The cases are many and the fact that these incidents are encountered is a depiction of the stark reality, which should be enough for us to question the kind of policies that have been implemented, and the emergency of bringing a change, in order to be capable of fulfilling the sustainable developmental goals. (Mishra & Agarwal, 2017)

The draft National Health Policy 2015 had emphasized, “universal access to good quality health-care services without anyone having to face financial hardship as a consequence” (Dey, 2018). However, the 2017 National Health Policy has maneuvered the control to the private entities, by increasing the fund allocation to them. Thus privatization of health system has become a major focus of the current policy initiatives.

Programs like Janani Suraksha Yojana and Pradhan Mantri Surakshit Matritva Abhiyan (PMSMA) were envisaged to control the increasing maternal mortality rate, though with its implication as well, India could not achieve the Millennium Development Goals (MDGs) significantly in the past. National Urban Health Mission, launched in 2013, a counterpart of NRHM (sub sections of National Health Policy) is coined to require Rs.3, 391crores per year according to the government estimates for it to be effective, though in 2017, the project got an allocation of only Rs.752 crore (Mishra & Agarwal, 2017).

The inability to achieve MDGs was a mirror to showcase the shortcomings of not implementing holistic approaches in the interventions. The challenges with achieving targets set by these policies remain that of, weak infrastructure and lack of human resources in healthcare services. Primary health centers need to be considered essential and thus, improving and strengthening the PHCs has to be one of the initial targets of the government.

The lack of skilled personnel providing sufficient and efficient healthcare is and will continue to be a block in eliminating the gaps. The state of public infrastructure is disappointing, and privatization of health system has become a major focus of the current policy initiatives, which has implications of its own, and forms the basis of the arguments explored further in this paper.

3. Private vs. Public Healthcare

Despite of the discussion regarding the importance of social parameters that halt the process of development, it has been difficult to eliminate the economic needs of a country, thus the bias towards private sector is prominent, and is fostered by providing the private players a larger space in the health sector. There are factors that prove to be in favor of privatization, as it inculcates the attitude of being result driven. The economic sightedness of the private sector makes them a much better option for the government to put their bets on. The activity of funding private healthcare institutions through various schemes, as described above, is therefore defended by their ability to provide quality, technologically advanced health care services. There are various actors involved in the private sphere of healthcare, including non-profit organizations, which are driven by the need to improve and make efficient healthcare available to all. A study by Basu S, Andrews J, Kishore S, Panjabi R, Stuckler D (2012) has evaluated various secondary sources and have corroborated six factors that influence the argument on public vs. private healthcare options in middle and low-income countries, and describe the preference of one over the other through the lens of a patient. There are multiple factors that affect the choice; the study reviews six themes derived from the WHO framework for health system assessment, including accessibility and responsiveness; quality; outcomes; accountability, transparency and regulation; fairness and equity; and efficiency. The findings are worth to note, as they look at a spectrum of low, middle-income countries. Another study indicates that in 19 of the countries studied, both wealthy and poor families received more care from the private than the public sector, but only when the private sector included private drug shops and similar informal providers (Basu, Andrews, Kishore, Panjabi, & Stuckler, 2012).

This is indicative of the performance criteria of the private sector providers. The 71st round of NSS on health showcases the dwindling trust in the public health system, as it reports of 58% rural population and 68% urban population of preferring private hospitals compared for inpatient care.⁶ Thus, even more patients prefer to be treated in private hospitals, as they trust and feel more secure in the environment, though the study also notes that private institutions do not follow codes and standards, thus also limits their credibility. Being more driven towards, cutting their costs, understaffing and burdening the existing staff is a potential drawback that is prominent in the current scenario of the health sector. Private healthcare sector also runs higher chances to prescribe medicines unnecessarily, as well as suggesting expensive procedures. The exploitation of the patient is impervious and has to be checked in order to increase the efficiency of the private sphere.

In the debate between private and public actors, the ambiguity of what constitutes these actors, also remain a problematic premise, as there are multiple actors, which do not practice legally and are a cause of jeopardy for the vision of creating a sustainable health sector. The accessibility of these services though, is limited, as only few such institutions are affordable and accessible to the weaker sections of the society. As pointed in the previous section, the cases of medical negligence are not fading away, and are significant in highlighting the drawbacks of insufficient funding in the public sector. On the front of equitable services, A World Bank study in Ghana pointed at the lack of evidence noting the difference of user fees in

public and private sector; however, the data presents the fact that out of pocket expenditure is highest for private not for profits, minimum for public institutions and intermediate for private self financed organizations (Basu, Andrews, Kishore, Panjabi, & Stuckler, 2012).

Thus, the capacity of the public sector needs to be enhanced looking at the negative factors that make the private sector inaccessible to the vulnerable population. The study also presents the debate on the inclusion of private sector in an efficient manner, though it would also require transparency, which is missing in the present scenario. It is imperative to understand that public private partnerships cannot be biased or directed towards an economic goal, and need to take the perspective of inclusivity. The lack of data to report inefficiencies of programs is a block in forming a PPP that can be successfully implemented. In contemporary times, the debate has taken the form of a competition. The effect of crowding out has resulted in transfer of public funds to private sector, as envisioned by the Health Policy of 2017, India. There are many shortcomings of the public sector, described in the coming section. Though, its ability to provide to a larger population, and being affordable cannot be disputed. On the account of making private sector more affordable, these steps fail to achieve their goals, while also decreasing the funds for the public sector.

Due to better job opportunities in the private sector, physicians too, find it beneficial to run their private practice, and thus, in turn, deepen the exploitation of the patients, by offering their services at a higher rate. Thus, there are always intricacies in the aspect of providing care, and ethics and moral codes are tested, and there needs to be a higher ground in analysing the stand of the medical professionals by bettering prospects in the public sphere as well.

4. Disasters and Health Infrastructure

The health infrastructure of India is a little complex to understand within the dynamic state role in the health system structure. It is of little doubt, that there are huge gaps in providing sufficient care to the patients. The dichotomy of public and private sector is in itself unclear, due to lack of data, as mentioned above, though there are clear discrepancies in their functioning.

The Centre's allocation for health has increased from 38cr in 2016-2017 to 47cr in 2017-2018, but the implications of this remain unclear, as it could possibly be directed towards private health systems, which are increasing the burden of demand on public sector from the weaker section. The budget for Pradhan Mantri Swasthya Suraksha Yojana—the Prime Minister's Health Protection Scheme—increased 103% from Rs 1,953 crore in 2016-17 to Rs 3,975 crore in 2017-18 (D'Cunha, 2017).

As per Rural Health Statistics, 2016 primary and community sub centers are short on human resources by 22% and 30% respectively. The understaffing of health centers is an indication on the rise of inadequacies being suffered by those, who do not have the capability to avail care from technologically, advanced hospitals (D'Cunha, 2017).

The cases of Non-communicable and chronic diseases have significantly increased and have taken a turn on the death tolls. Rural health facilities are devoid of basic infrastructure; facilities fall short of water supply, electricity, and connectivity. In case of emergencies, there is a lack of transportation. The statistics are staggering, 63% of the primary health centers do not have an operation theatre, and while community health centers fall low on specialists, surgeons, gynecologists and pediatricians by 81.5%.

Primary and Secondary care centers are prominently under-staffed and highly insufficient for providing effective solutions, therefore, the tertiary centers are burdened and are

not able to fulfill the overgrowing demand. These fall short on equipment, and labor to cater to the patients.

There is a growing need for enhancing the human resources, building capacities in order to fulfill the demand and cover all aspects of healthcare. In India, out of the total 1.37 million hospital beds, only 540,000 beds are available in the public hospitals, out of which only 50% are functional and are concentrated in the top cities. The state of public hospitals in India is poor in terms of infrastructure and more so deficient with respect to the staff. Disasters have the capacity to overwhelm the existing structures, and therefore, the status of the health-care structure in India is already predisposed to huge economical and structural setbacks in events of a disaster.

The statistics of public and private financing in healthcare all point out towards a lack in quality of services and moreover, a lack of interest in engaging in an efficient manner as a cascading effect of an infrastructural deficiency. The increasing pressure on hospitals to maximize revenues and minimize costs has created a bump in providing efficient and sustained health care to the patients and the situation worsen in times of adverse events (Weismann, et.al, 2007). The Institute of Medicine has defined two major goals in redesigning the system by improving patient safety and enhancing the efficiency, which is been contradicted by the large shortage in demand and supply chain.

Every year, the spread of dengue, chikunguniya, and malaria showcase the inherent inefficiencies of the health system of the country, and manages to take huge number of lives, due to the inaccessibility and lack of availability of doctors, and space. The question of space is a big one, in an ever-growing economy, notably, second largest we cannot overlook the necessities and adapt to the circumstances, it is essential to grow resiliency, and introspect the implications and the effects of national policies and actions. Despite a history of annual outbreak and spread of vector-borne diseases, these States have not been able to prevent and manage any outbreak.

In the case of earthquakes, floods, and other catastrophes, where the existing hospitals are also affected, and destroyed, the presence of skilled professionals, and an empowered structure is essential in resisting the aftereffects of the disasters. The development of the mental health institutions, and personnel thus also become imperative and a debate that has been rather a part of the long term

Throughout, the various segments of the paper, the emphasis on the interventions in healthcare have been critiqued through the lens of policy operationalization, and farsightedness of paper and reality. Therefore, there is a pressing need to acknowledge the gaps, and work towards creating an equitable and accessible healthcare structure that does not overwhelm the capacities of those involved, as well as complies with the SDGs.

5. Conclusion

The paper attempts to review and combine the various dimensions that are important to be considered in order to strengthen the health care system of India. There are multiple factors that influence the smooth functioning of the healthcare facilities, and more often than not; the implications of policy actions determine the nature and efficiency of care. The current dilemma of private vs. public is crucial to understand and contextualize events that demarcate the preference of one over the other. Though, the problems are clearly defined, the solutions are hardly discussed. The widespread advocacy of Public-Private-Partnership is problematic as it results in higher out of pocket expenditure, and thus, contradicting the aim

with which, the programs have been implemented. The integrated approach to solving such inadequacies is important, as the responsibilities of the state in improving the socio-economic components of the nation has to be the topmost priority as it leads to the generation of a healthy and active service sector. In addition to encountering such situations in times of hazards, the implications of construction more number of AIIMS would not solve the issue at hand, as the existing infrastructure are impaired and need to be improved at a reasonable scale before we can take on more number of institutions. The need to improve data collection, and checks on policy is paramount, as it creates a bigger and better picture for us, to analyze and interpret the lacks of the functioning. The provision of better technology in public institutions thus make an important step in creating a strong and resilient public health system, as it provides better opportunity to the public and helps the vulnerable section of the society rather than burdening them with higher expenditure in a private facility. The component of a competition between the private and public needs to be revisited as the common goal should be welfare. In order to develop economically, one cannot regress socially. Especially, with increasing cases of medical negligence, and disasters that impede the progress, we cannot proceed without working on the following aspects. Epidemics have been on the rise, and with lack of intent on the part of the stakeholders, to expect change is a lost cause; therefore, one needs to revisit the decisions in the context of the changing environmental conditions, and the uncertainty that it brings along with its nature. In any case, no single effort can be recognized until it involves all those affected by the impeding conditions of our healthcare system.

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PRIVATE SECURITY PREPAREDNESS FOR DISASTERS CAUSED BY NATURAL AND ANTHROPOGENIC HAZARDS

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Abstract: The subject of the research is to examine the private security preparedness for disasters caused by natural and anthropogenic hazards. In addition, the relationship between preparedness levels and various demographic and socio-economic factors is examined. The survey was anonymous with 4-point Likert scale questions (1- I absolutely disagree; 4- I absolutely agree). It was conducted at the University of Criminal Investigation and Police Studies in Belgrade, during the initial course for obtaining a private security license and the course for combating domestic violence were attended by members of the police from all over Serbia. Data for the study were collected from a total of 178 members of private security. The research was conducted from April to June 2019. Within the first part of the questionnaire, there were questions concerning demographic and socio-economic characteristics of the respondents (gender, age, education, marital status, working experience, served military status), while the second part contained questions about the private security preparedness for disasters caused by natural and anthropogenic hazards (e.g perception of the degree of responsibility due to the type of work performed in case of natural and anthropogenic disasters, perception of the level of preparedness of a private insurance company, knowledge of safety procedures for disaster response, evaluation of the response efficiency of first responders, etc.). The results of the multivariate regressions of preparedness subscale showed that variables (e.g., gender, age, education, marital status) were not significantly affected by preparedness.

Keywords: security, disaster, preparedness, private security, natural and anthropogenic hazards, Serbia.

1. Introduction

The traditional view that only the police are responsible for security, largely leaves in the sense that private security has a more important place (Janković, 2020). Although traditionally responsible for the realization of public safety, the police are not able to make it happen without adequate planning, organized and sustained cooperation with other state and local authorities, and increasingly the subjects of private security (Lončar, Radivojević, Radošević, & Mirković, 2019b). This is shown by the data on the increase in the volume of work entrusted to the private security industry, as well as the increase in the number of employees in it (Janković, Cvetković, & Ivanov, 2019). Thus, estimates of the number of employees in the industry in the Republic of Serbia, ranges from 30,000 (Davidović & Kešetović, 2017), over 40-50,000 (Nalla & Gurinskaya, 2017), according to the latest data, the number goes up to 60,000 employees (Milošević, 2018).

Members of private security perform a wide range of tasks. They perform various tasks that include patrol and surveillance duties, crime prevention, information security, risk management, improving preparedness for disasters (Cobbina, Nalla, & Bender, 2013; Nalla & Cobbina, 2017). Besides of securing property and persons in normal circumstances, a private security plays an important role and tasks in risk prevention (Davidović & Kešetović, 2017). The destructiveness and unpredictability of various natural and anthropogenic disasters imposes the need for short-term and long-term planning in order to prevent or mitigate the consequences of such events. Integrated disaster risk management, which should include private security, implies taking various structural and non-structural measures to mitigate the consequences of future disasters. Although some studies have indicated that the police are generally the first civil service to respond to natural disasters (Milojković et al., 2015), it is also necessary to improve the preparedness of all other first responders in order to provide an appropriate response in the event of a disaster. Such activities relate to the education of members, equipping and technical improvement of services, continuous implementation of training and coaching and continuous improvement of knowledge and skills in terms of providing answers at all strategic, tactical and operational levels. Cvetković, Nikolić, Nenadić, Ocal, and Zečević (2020) in their research on the catastrophe caused by COVID-19, they point out that all cities and towns in Serbia need to have disaster plans that are tailored to specific scenarios and locations, not preconceived generalized plans, communications need to be standardized and supported and triage needs to be thought through more clearly. Also, they highlighted that airport plane crashes, stadium catastrophes, and remote mass transit accidents are all very different from those caused by deadly infectious microorganisms such as COVID-19 and require different responses.

2. Literary review

Very few studies directly investigate the role of private security in emergencies (Lončar et al., 2019b). Thus, Lončar et al. (2019b) analyze the legal provisions related to the role of private security in the Republic of Serbia and the cooperation of private security with the police. The authors came to the conclusion that private security, if we exclude the undertaking of certain measures within the facility to be secured, is not included during disasters, ie it does not undertake protection and rescue activities on a wider scale. They came to the conclusion by analyzing the Law on Private Security ("Zakon o privatnom obezbeđenju," 2013) in which there are no provisions on the possibility of engaging private security in cases of declaring emergencies, while the Law on Disaster Risk Reduction and Emergency Manage-

ment (“Zakon o smanjenju rizika od katastrofa i upravljanju vanrednim situacijama,” 2018), private security is not explicitly mentioned at all as one of the strengths of the disaster risk reduction and emergency management system (Lončar, Radivojević, Radošević, & Mirković, 2019a). During an emergency situation, private security has the task of implementing measures, but again within the protected facility, issued by the competent emergency headquarters (Lončar et al., 2019a). In contrast to Serbia, a good example is Romania, which has stipulated in its regulations that members of private security react as the first force in the event of fires and disasters (Nalla & Gurinskaya, 2017).

Other research may indirectly reveal the role of private security in emergencies. We are of the opinion that the scope of engagement of members of private security in certain situations does not follow the research in this area. That a large number of private security personnel may be engaged during emergencies is indicated by the fact that during Hurricane Katrina in 2004, an estimated 20,000 private security personnel were deployed in New Orleans (Nalla & Crichlow, 2017). This leads to the conclusion that in emergency situations there is a need for special and additional engagement of state bodies, but also various non-state entities, such as private security (Lončar et al., 2019a). Their engagement in emergencies should be set through an integrated approach to security, which means putting crime on a par with catastrophes, such as fires and health epidemics (Steden, 2007). Adopting this approach would lead to the drafting of a protocol setting standards for public / private cooperation during any emergency, and putting private umbrellas on private security teams, with all other entities (Steden, 2007). The role of members of the private security system may be particularly pronounced in emergencies caused by viral epidemics, when the infection of police officers may result in their absence from work, illness or death, when certain agencies may be involved in law enforcement (Brito, Luna, & Sanberg, 2009). Pandemic planning is particularly complicated because it requires coordination with a wide range of other public and private agencies (Luna, Brito, & Sanberg, 2007). At the beginning of such epidemics, the protection of hospitals and other critical infrastructure facilities is planned, which is carried out more often by the police, or as was the case in Serbia during COVID-19, health facilities were protected by the army (Djordjevic, 2020). Because police resources are limited, some police organizations hope that private security agencies could take over this function to some extent in order to reduce security threats (Luna et al., 2007). Private security agencies can play an important role in emergencies, if not identical to what the police have, then they can play an important complementary role through assistance to police organizations (Nalla & Gurinskaya, 2017). Starting from this assumption that private security can play a significant role in disasters, the authors seek to establish whether they are members of private security prepared to justify the importance of their role, or how much they are prepared to engage in emergency situations.

3. Methods

The subject of the research is to examine the private security preparedness for disasters caused by natural and anthropogenic hazards. In addition, the relationship between preparedness levels and various demographic and socio-economic factors is examined. The survey was anonymous with 4-point Likert scale questions (1- I absolutely disagree; 4- I absolutely agree).

3.1. Questionnaire Design

During February 2019, a pilot pre-test of the questionnaire was conducted in Belgrade with 15 members of private security) to test the comprehensibility and performance of the questionnaire developed for this research. All respondents voluntarily agreed to participate in the research. The research was conducted at the University of Criminal Investigation and Police Studies in Belgrade, during the initial course for obtaining a private security license and the course for combating domestic violence were attended by members of the police from all over Serbia. Data for the study were collected from a total of 178 members of private security. The research was conducted from April to June 2019. Within the first part of the questionnaire, there were questions concerning demographic and socio-economic characteristics of the respondents (gender, age, education, marital status, working experience, served military status), while the second part contained questions about the p the private security preparedness for disasters caused by natural and anthropogenic hazards (e.g perception of the degree of responsibility due to the type of work performed in case of natural and anthropogenic disasters, perception of the level of preparedness of a private insurance company, knowledge of safety procedures for disaster response, evaluation of the response efficiency of first responders etc.).

3.2. Socio-Economic and Demographic Characteristics

Out of 178 members of private security, 93.3% are men, while 6.7% are women. Given the ages of respondents, most of the private security members are 51-60 years old (30.3%), and the fewest are over 60 (6.7%). In relation to the level of education, the majority of respondents have a high school degree (87.6%), and the minority have higher education (5.6%). Regarding work experience, most respondents have over 15 years of work experience, and the majority of them did not serve military service (Table 1). The conducted research is part of a more extensive study on the relationship between the police and private security in the execution of tasks in the field of security.

Table 1. Demographic characteristics of private security respondents (n/percent)

Variable	Category	Security (n = 178)
Gender	Male	166 (93.3)
	Female	12 (6.7)
Age (years)	18-25	16 (9.0)
	26-35	14 (7.9)
	36-45	42 (23.6)
	46-50	26 (14.6)
	51-60	54 (30.3)
	Over 60	12 (6.7)

Education level	Secondary school	156 (87.6)
	High school	12 (6.7)
	University	10 (5.6)
Marital status	Married	104 (58.4)
	Single	64 (36)
	Divorced	10 (5.6)
Working experience	No	20 (11.2)
	1-5 years	30 (16.9)
Served military service	6-10 years	16 (9.0)
	11-15 years	32 (18)
	Over 15 years	78 (43.8)
	Yes	144 (80.9)
	No	32 (17.9)

3.3. Analyses

Socio-demographic characteristics of the respondents were explored using descriptive statistical analyzes. The analysis of variance (one-way ANOVA) and the regression analysis were used to examine the relation between the variables (gender, age, education, marital status, military service, previous experience) and the participants' attitudes. Analyses showed that the assumptions of normality, linearity, multicollinearity and homogeneity of variance had not been violated (Montgomery, Peck, & Vining, 2012). The internal consistency of Likert scales for Preparedness Subscale (5 items) is good with a Cronbach's alpha of 0.81, for Knowledge Measurement Subscale (5) 0.82, Responsibility subscale (5) 0.84, and Response efficiency Subscale (5 items) 0.84. All tests were two-tailed, with a significance level of $p < .05$. Statistical analysis was performed using SPSS Statistic 17.0 (IBM SPSS Statistics, New York, United States). This research conformed to the Helsinki Declaration, outlining the principles for socio-medical research involving human subjects and participants provided informed consent to participate in the study.

4. Results and discussion

Firstly, we tested the central hypothesis that gender, educational level, and age were predictive variables of private security preparedness for disasters caused by natural and anthropogenic hazards. Multivariate regression analysis was used to determine the extent to which four scores of the subscales (preparedness, knowledge, responsibility, response efficiency) were associated with fourth socio-economic variables: gender, age, marital status, education level. The results of the multivariate regressions of preparedness subscale showed that variables (e.g., gender, age, education, marital status) were not significantly affected by preparedness. This model ($R^2 = 0.026$, Adj. $R^2 = -.007$, $F = .784$, $t = 10.78$, $p > 0.01$) with all mentioned

independent variables do not explain variance of preparation. Besides that, the results of the multivariate regressions of the knowledge subscale show that the most important predictor is the marital status ($\beta = .375$), and it explains 37.5% of the variance in the knowledge subscale. The remaining variables (e.g., gender, age, education level) did not have significant effects on knowledge. This model ($R^2 = .137$, Adj. $R^2 = 0.108$, $F = 4.66$, $t = 10.83$, $p = 0.002$), with all mentioned independent variables, explains 10.8% of the variance of knowledge subscale. The results of the multivariate regressions of responsibility subscale showed that variables (e.g., gender, age, education, marital status) were not significantly affected by preparedness. This model ($R^2 = 0.070$, Adj. $R^2 = .038$, $F = 2.21$, $t = 6.04$, $p > 0.01$) with all mentioned independent variables do not explain variance of responsibility subscale. Lastly, the results of the multivariate regressions of the response subscale show that the most important predictor is the marital status ($\beta = .213$), and it explains 21.3% of the variance in the knowledge subscale. The remaining variables did not have significant effects on the response subscale. This model ($R^2 = .053$, Adj. $R^2 = 0.021$, $F = 1.63$, $t = 12.28$, $p = 0.170$), with all mentioned independent variables, explains 10.8% of the variance of response subscale (Table 2).

Table 2. Results of a multivariate regression analysis concerning subscales (preparedness, knowledge, responsibility, and response) for private security preparedness for disasters caused by natural and anthropogenic hazards ($n = 178$)

Predictor Variable	Preparedness subscale			Knowledge subscale			Responsibility subscale			Response efficiency		
	B	SE	β	B	SE	β	B	SE	β	B	SE	β
Gender	.019	.260	.007	.083	.232	.033	.269	.186	.139	.081	.246	.032
Age	-.124	.226	.226	-.279	.202	.202	.233	.162	.138	.373	.214	.168
Education level	-.303	.194	.194	-.193	.173	.173	-.022	.139	-.015	-.002	.184	-.001
Marital status	.047	.129	.129	.375	.115	.115*	-.180	.092	-.184	.274	.122	.213*
Adjusted R^2	-.007			0.108			0.038			0.63		

* $p \leq 0.05$; ** $p \leq 0.01$; B: unstandardized (B) coefficients; SE: std. error; β : standardized (β) coefficients. Note: males, young, high school, married have been coded as 0; 1 has been assigned otherwise.

In further work, the influence of age, marital status and level of education on subscales as preparedness, knowledge, responsibility and response was examined. The obtained results show that respondents aged 51-60 years to a greater extent than respondents aged 36-45 years assess private security preparedness for disasters caused by natural and anthropogenic hazards ($p = .022$). It can be assumed that the obtained research results primarily depend on the previous experience of the respondents with members of private security. Respondents aged 18-26 years are more likely to assess responsibility compared to respondents aged 46-50 and 50-60 years ($p = .010$). When it comes to marital status, it was found that married respondents marry knowledge to a greater extent than single respondents ($p = .002$). Also, it was found that singles were more responsive than respondents who were married ($p = .009$). In relation to the level of education, no statistically significant correlation was found with preparedness ($p = .109$), knowledge ($p = .515$), responsibility ($p = .560$) (Table 3).

Table 3. ANOVA results between demographic variables and subscales as preparedness, knowledge, responsibility, and response ($n = 178$)

Variables	Categories	Preparedness X (sd)	Knowledge X (sd)	Responsibility X (sd)
Age	18-26	2.60 (.91)	2.25 (1.12)	1.62 (.40)
	26-35	2.30 (.80)	2.20 (.92)	1.25 (.28)
	36-45	3.01 (.66)	2.82 (.51)	1.28 (.34)
	46-50	2.70 (.38)	2.88 (.30)	1.15 (.26)
	51-60	2.55 (.59)	2.65 (.60)	1.35 (.35)
	+60	3.00 (.23)	2.80 (.46)	1.00 (.000)
	<i>F/Sig.</i>	2.76 (.022*)	2.15 (.065)	3.19 (.010*)
Marital status	Single	2.67 (.64)	2.47 (.67)	1.55 (.71)
	Widow/er	3.00 (.000)	2.60 (.000)	1.00 (.000)
	Divorced	2.55 (.38)	2.40 (.45)	1.16 (.30)
	Married	2.74 (.71)	2.90 (.57)	1.25 (.32)
	<i>F/Sig.</i>	.378 (.769)	5.20 (.002)*	3.99 (.009)*
Education	Secondary Sch.	2.69 (.67)	2.72 (.64)	1.33 (.49)
	High Sch.	3.40 (.69)	3.20 (.000)	1.50 (.57)
	Bach./faculty	2.80 (.30)	2.86 (.20)	1.16 (.12)
	<i>F/Sig.</i>	2.25 (.109)	.667 (.515)	.583 (.560)

* $p \leq .05$ ** $p \leq .01$

Starting from the research question how members assess the level of responsibility in relation to various natural and anthropogenic disasters, it was found that most respondents, 62.9%, point out that it is necessary to improve the level of responsibility for responding to fires, while the least emphasis is on responsibility for extreme temperatures. 42.7%). The obtained results unequivocally indicate the need to improve the preparedness of these services to respond in such situations (Aleksandrina, Budiarti, Yu, Pasha, & Shaw, 2019; Cvetkovic, 2019; Kumiko & Shaw, 2019; Ocal, 2019; Ocal, Cvetković, Baytiyeh, Tedim, & Zečević, 2020) (Table 4).

Table 4. Perception of the degree of responsibility due to the type of work performed in case of natural and anthropogenic disasters

Opasnosti	Da		Ne	
	N	%	N	%
Fire	112	62.9	10	5.6
Earthquakes	92	51.7	30	16.9
Floods	98	55.1	20	11.2
Extreme temp.	76	42.7	44	24.7
Terrorist attacks	84	47.2	38	21.3

In situations where the stability of the functioning of society is disturbed, the efficiency of the response largely depends on the level of individual preparedness. Starting from the research question on the level of individual preparedness, it was determined that members are most ready to react in disasters caused by fires ($M = 3.11$), and least in disasters caused by floods ($M = 2.61$) (Table 5).

Table 5. *Perception of the level of individual preparedness (knowledge, training, plans, etc.) for disasters caused by natural and anthropogenic hazards.*

Hazards	Very unprepared		Unprepared (2)		Prepared (3)		Very prepared(4)		Mean
	N	%	N	%	N	%	N	%	
Fire	8	4.5	14	7.9	58	32.6	44	35.5	3.11 (.848)
Earthquakes	12	6.7	32	18	68	38.2	12	6.7	2.65 (.788)
Floods	14	7.9	34	19.1	62	34.8	14	17.9	2.61 (.833)
Extreme temp.	16	9	30	16.9	54	30.3	24	13.5	2.69 (.930)
Terrorist attacks	18	10.1	40	22.5	48	27	18	10.1	2.53 (.915)

In addition to the individual preparedness of members of private security, it is very important to consider the level of readiness of companies that hold private security to respond to such situations. Guided by these reasons, the obtained research results show that companies are the most prepared for fires ($M = 3.10$) and the least prepared for terrorist attacks ($M = 2.58$) (Table 6).

Table 6. *Perception of the level of preparedness of a private insurance company for disasters caused by natural and anthropogenic disasters.*

Hazards	Very unprepared		Unprepared (2)		Prepared (3)		Very prepared(4)		Mean
	N	%	N	%	N	%	N	%	
Fire	8	4.5	18	10.1	48	27	46	25.8	3.10 (.893)
Earthquakes	12	6.8	28	15.6	54	30.3	24	13.5	2.76 (.893)
Floods	12	6.7	28	15.7	54	30.3	24	13.5	2.66 (.879)
Extreme temp.	14	7.9	28	15.7	48	27	26	14.6	2.74 (.943)
Terrorist attacks	20	11.2	34	19.1	4	22.5	24	13.5	2.58 (.999)

In terms of knowledge of security procedures, they were found to know best fire safety procedures ($M = 3.10$), then earthquakes ($M = 2.75$), floods ($M = 2.67$), extreme temperatures ($M = 2.66$) and finally terrorist attacks. ($M = 2.52$) (Table 7).

Table 7. *Knowledge of safety procedures for disaster response caused by natural and anthropogenic disasters.*

<i>Hazards</i>	<i>Not (1)</i>		<i>Partially (2)</i>		<i>Mostly(3)</i>		<i>Yes (4)</i>		<i>Mean</i>
	<i>N</i>	<i>%</i>	<i>N</i>	<i>%</i>	<i>N</i>	<i>%</i>	<i>N</i>	<i>%</i>	
<i>Fire</i>	/	/	26	14.6	58	32.6	38	21.3	3.10 (.721)
<i>Earthquakes</i>	8	4.5	32	18	60	33.7	18	10.1	2.75 (.797)
<i>Floods</i>	8	4.5	36	20.2	64	36	12	6.7	2.67 (.748)
<i>Extreme temp.</i>	10	5.6	38	21.3	52	29.2	18	10.1	2.66 (.839)
<i>Terrorist attacks</i>	14	7.9	44	24.7	48	27	14	7.9	2.52 (.850)

In addition to security procedures, the effectiveness of first responders' responses was assessed. The highest efficiency scores were rated for firefighters rescuers ($M = 3.72$), followed by military ($M = 3.63$), emergency service ($M = 3.38$) and finally shelves ($M = 3.21$). Thus, according to the obtained results, the efficiency rating is the highest for firefighters rescuers and the lowest for shelves (Table 8).

Table 8. *Evaluation of the response efficiency of first responders in natural and anthropogenic disasters.*

<i>Hazards</i>	<i>Very inefficient</i>		<i>Inefficient (2)</i>		<i>Efficient (3)</i>		<i>Very efficient (4)</i>		<i>Mean</i>
	<i>N</i>	<i>%</i>	<i>N</i>	<i>%</i>	<i>N</i>	<i>%</i>	<i>N</i>	<i>%</i>	
<i>Police</i>	8	4.5	12	6.7	48	27	54	30.3	3.21 (.874)
<i>Firefighters rescuers</i>	2	1.1	2	1.1	24	13.5	92	51.7	3.72 (.582)
<i>Emergency service</i>	2	1.1	12	6.7	44	24.7	62	34.8	3.38 (.735)
<i>Military</i>	2	1.1	2	1.1	34	19.1	80	44.9	3.63 (.610)

The question of whether you have received some training for dealing with disasters caused by natural and anthropogenic hazards was answered by 120 respondents (67.4%). Out of the total number, 66 (37.1%) respondents answered that they had completed certain training, while 52 (29.2%) respondents answered that they had not completed such training. In relation to the total number of respondents who did not complete the mentioned training, the reasons for non-attendance are the following: I do not have time - 22 (12.4%), I do not have money - 26 (38.2%), I think it does not matter - 2 (1.1%), does not think about it - 6 (3.4%), information is not available to him - 8 (4.5%), etc.

5. Conclusions

Members of the private security are mostly accustomed to facing threats that come primarily from people, and that is why the level of their preparedness to react to disasters caused by natural or anthropogenic influences remains at a very low level. On the other hand, the increase in the number and severity of disaster consequences simply imposes the need for further training and training to respond to disaster-induced conditions. The obtained research results clearly indicate the urgent need to design appropriate strategies and programs within which to design better education and training of members of private security. A very low level of training attendance was identified, which would enable members to better pre-

pare so that the level of response efficiency would be at a much higher level. The limitations of the conducted research are reflected in the insufficient number of respondents covered by the research as well as the insufficient representation of various private security agencies. In further research, it is necessary to look even more deeply and comprehensively at all the needs and possibilities of members of private security for a more efficient way of reacting in given situations.

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ENVIRONMENTAL PLANNING FOR DISASTER RISK REDUCTION AT KADUNA INTERNATIONAL AIRPORT, KADUNA NIGERIA

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Abstract: The compatibility of an airport with its environs can be achieved by proper environmental control and planning of the airport, control of pollution-generating sources, and land use planning of the area surrounding the airport are paramount if disasters are to be averted or reduced to the acceptable standard. This study was carried out to assess the compliance to standards of the activities relating to environmental control and planning at Kaduna International Airport as contained in International Civil Aviation Organization (ICAO) and other Airport regulations Guidelines. The objectives including assessing the environmental impact associated with aviation activities, assessing environmental consequence and control measures and assessing land use planning at the Airport. The Airport Environmental Management Handbook, Federal Airport Authority of Nigeria (FAAN) Hand book, ICAO Documents, Maps and other relevant information were consulted. Questionnaires were distributed and percentage distribution was used in analyzing the objectives. Results from this study has shown an acceptable level of compliance in Environmental Planning by the relevant authority of Kaduna International Airport. The results from this study will be useful to FAAN, ICAO and other relevant Agencies in enhancing Environmental Control and Planning at Airports for Disaster Risk Reduction.

Keywords: Environmental Planning, Disaster Risk Reduction, Airport, ICAO, FAAN

1. Introduction

The types of environmental emergencies at the airport include, but not limited to, fuel and chemical spills and incidents involving dangerous good or hazardous material that may affect the environment, (ICAO, 1997). Some degree of air pollution associated with an airport is unavoidable, but this can be substantially reduced with proper pre-development planning and mitigation measures. Air pollution associated with airports is generated by aircrafts, vehicles and facility operations (FAAN, 2018). Airports are subject to both state and local environmental regulation which may include both quantity and quality discharge limits. Airport waste must be treated before being discharge so as not to pollute ground water or nearby streams (ICAO, 1997). Aircraft maintenance areas, as well as automotive and equipment service ar-

eas, should be provided with oil-water separators which are, in turn, connected to sanitary sewers leading to the municipal waste treatment plant serving the airport, (ACI,1996). The problem of aircraft noise is so serious in the vicinity of many of the world's airports that public reaction is monitoring to a degree that give cause for great concern and requires urgent solution, (ICAO, 1996). The balance approach to noise management consists of identifying the noise problem at an airport and then analyzing the various measures available to reduce noise through the exploration of four principal elements, namely reduction at source, land use planning and management, noise abatement operational procedures and operating restrictions with the goal of addressing the noise problem in the most effective manner. All the elements of balanced approach are addressed in the guidance on the balanced approach to aircraft noise management, (ICAO, 1996). Although in most countries, land-use planning and management are the responsibility of national and/or local planning authorities rather than aviation authorities, the International Civil Aviation Organization (ICAO) has developed guidance material which should be used to assist planning authorities in taking appropriate measures to ensure compatible land-use management around airports to the benefit of both the airport and the surrounding communities (Airport Planning Manual, Part 2, Doc 9184). Location for measuring noise from aeroplane in flight shall be surrounded by relatively flat terrain having no excessive sound absorption characteristics such as might be caused by thick. Matted or tall grass, shrubs or wooded areas. No obstruction, which significantly influences the sound field from aeroplane, shall exist within a conical space above the measurement position, the cone being defined by axis normal to ground and by a half angle from the axis. If the height of the ground at any measuring point on the runway by more than 6m, corrections shall be made (ICAO, 1997). Capacity Constraints at airports and airspace are becoming an increasing challenge to the continued growth of air transport in some regions, the limited availability and/or utilization of infrastructure has already led to serious problems, notably in the form of flight delays, with spillover effects worldwide. Current ICAO forecast estimate an increase in the global demand for air transport at an average annual growth rate of 4.5 percent for the period 1997-2020, with aircraft movements growing at an average annual growth rate of 3.5 percent. In response to this demand the world aircraft fleet is expected to accommodate 2.7 fold increase in passengers traffic and doubling aircrafts movements by the year 2020. These forecasts are predicted on the assumption that sufficient system infrastructure and capacity will be available to handle the demand and this is equally an important aspect of environmental control and land use planning in the airport (ANS CONF, 2000). Selecting a new airport site is a complex, time consuming and expensive proposition. Local governments usually make decision to construct or expand public airports. The money to fund the construction comes from taxes or from the sale of bonds. Airport sites are selected based on airport traffic volume, the nearby population, availability of ground access and existing air traffic flows, (Microsoft Encarta, 2007). A combination of comprehensive planning and zoning, together with real estate disclosure as a legal obligation is considered as the most effective measure for the controlling the use of land around airports especially for new "Green Field" situations. For existing situation the effectiveness of land use planning control is considered limited (ICAO, 1997). Pollution occurring, in and around the airport has the potential to affect not only the immediate area, but also the surrounding area, because it can effect on human health and the ecology of the surrounding area, (Transport Canada, 1994). An effective waste management programme can be enhanced by employee awareness programmes including training, participation in special events, information session and informative newsletters. An effective energy strategy will include a statement of objectives to make all personnel aware of what the organization is committed to achieve, but the pursuit of environmental performance without regard for cost is not a plan for success (ICAO, 1996). Although the ultimate goal of proactive environmental strategy is to minimize the creation of environmental problems in the interim, there is a need for a remedial measures

to correct situations resulting from material handling and management practices of the past (Airport Council International, 1996). Commercial activities can be situated in areas subject to higher noise levels than residential development; they generally cannot be carried out in the areas as industrial operations, which are performed primary indoors and have a higher associated noise level (ICAO, 1997). All agricultural uses have proven to be compatible with aircraft noise with the exception of poultry farm. Location of these farms within approximately 5km of an airport is not recommended because of the adverse reaction of the fowl to high level of aircraft noise. It should be noted that birds may be attracted to some pig farm where garbage is used as fodder (Airport services manual, doc 9137). If land is used for recreation, it should be remembered that it must not present or create hazard to aircraft operation such as attracting birds (ICAO, 1997). The sitting of municipal utilities at an airport is not only compatible but logical. The industrial, residential and commercial growth in the airport creates increasing demand for water, sewage disposal and power utilities and concentration of these municipal activities requirement in the airport has proven to be economical and wise (Airport service manual, Doc 9137). Airport capacity is said to be bottleneck in the growing aviation industry about 20% of the 50% largest European airports have already or almost reached capacity constraints forecast for the year 2025. The European Commission therefore, encourages all actors in the aviation sector to rethink airport capacity and its use (EC, 2007). Capacity constraints are said to be counterproductive to overall economic competitiveness. In North America and Asia, airport expansion and green field developments seems to face less political and legal constraint which can be considered as obstacle to economic growth and this calls for proper environmental control and land use planning (EC, 2007).

STUDY AREA

Kaduna is located in the northern Guinea savannah zone of Nigeria. It lies between latitudes $10^{\circ}11'N$ and longitude $7^{\circ}8'E$ an altitude of 645 m above sea level. The city's central location makes communication with the rest of Nigeria relatively easy. The Kaduna Airport (IATA: KAD, ICAO: DNKA) is an airport serving Kaduna, the capital of Kaduna State in Nigeria. The airport is around 22 kilometres (14 mi) northwest of the city. The airport opened in 1982 with latitude $10^{\circ}41'45''N$ and longitude $7^{\circ}19'15''E$ see (Fig. 1).

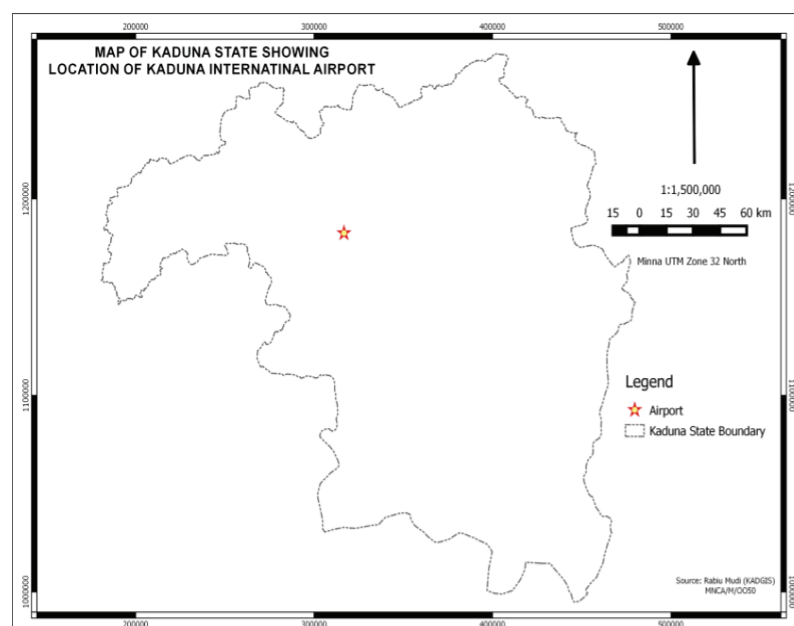


Fig 1: Map of Kaduna Showing the Airport

Climate

Two major weather systems regulate Kaduna's climate. These are the Sahara high pressure system and the Atlantic low-pressure system. The interface between the two, known as the Inter-tropical Convergence Zone, is a front which moves irregularly in March up to October when it retreats. After October, the Sahara system dominates the weather. The rainy season in the Kaduna city region starts around March and ends in October. Annual rainfall averages around 1200 mm. The rainfall pattern is traditionally characterized as monomodal with peak precipitation between July and August.

The Kaduna area is characterized by a dry season with dry, cold conditions from November to February when the "Harmattan" wind blows from the east-northeast; and a rainy season with warm, humid conditions with southwest winds from March through to October. The mean monthly temperature generally varies between 26 °C and 34 °C with maximum temperatures occurring in February, March and April and minimum temperatures in the "Harmattan" months of November, December and January.

Soil and Vegetation

Generally, the soil and vegetation are typical red brown to red yellow tropical ferruginous soils and savannah grassland with scattered trees and woody shrubs. The soils in the upland areas are rich in the red clay and sand but poor in organic matter.

However, soils within the "Fadama" areas are richer in Kaolinitic clay and organic matter, very heavy and poorly drained, characteristics of vertisols. Fringe forest in some localities, and especially in the southern local government areas of the state are presently at the mercies of increasing demands for fuel wood in the fast growing towns and urban centres.

MATERIALS AND METHODS

A reconnaissance survey was carried out in order to familiarize with the study area and make a physical observation of some of the facilities and land that calls for a proper environmental control and land-use planning. Also a visit to some of the departments responsible for environmental management in the Airport i.e. Kaduna International Airport was made.

Questionnaires were administered to the key officers in the departments of land, water and survey, safety and operations of FAAN. In addition, oral interviews were conducted on the staff of other agencies within the industry and some visitors; this was to compliment the research observations and questionnaire findings. Departmental interview were conducted based on the services, functions they provide and how these functions affect environmental.

The heads of safety, land, water and survey and operations departments being the technical departments responsible for environmental management were consulted for technical questions and answers. Relevant question as related to functions and services rendered were presented to the respondents such as the adequacy of expertise and facilities to deal with the issue of environmental control and land use planning. A total of 20 visitors and other facilities users were systematically interviewed.

Percentage distribution statistical method was used for the analysis of data obtained from primary sources. Tables were used to show various distribution and interpretation drawn from them. This equally helps in arriving to a satisfactory conclusion.

RESULTS AND DISCUSSIONS

The questions presented here were technical and answers were provided by the relevant technical department of FAAN.

Table 4.1. *Aircraft noise in the Vicinity of the Airport*

Variables	Number of respondent	Percentage (%)
Disturbing	2	20
Very disturbing	0	0
Acceptable	8	80
Total	10	100

(Source: Authors' fieldwork, 2019)

From the table 4.1, 20% of the respondent believed that the noise is disturbing while 80% indicates that the noise is acceptable. From the observation made during a tour of the airport by the researcher, the noise within the vicinity is acceptable due to the distance of aircraft landing area and the offices of the various agencies.

Table 4.2. *Effect from Emissions from the Aircraft*

From the table 4.2 all the respondents attest to the fact that the emissions from aircraft does not affect them, may be because the effect is not visible. My observation is that because of bio-accumulation some may not feel the effect now but later.

Variable	Respondents	Percentage (%)
Yes	0	0
No	10	100
Total	10	100

(Source: Authors' fieldwork, 2019)

Table 4. 3. *Disease(s) as a result of Pollutants*

Variables	Respondents	Percentage (%)
Yes	0	0
No	10	100
Total	10	100

(Source: Authors' fieldwork, 2019)

From Table 4.3 all the respondents have not experienced any sickness related to emission from the aircraft as at the time this research was carried out.

Table 4.4. *Tap water at the Airport*

Variables	Respondents	Percentage (%)
Yes	9	90
No	1	10
Total	10	100

(Source: Authors' fieldwork, 2019)

From table 4.4, ninety percent believe that the water is safe for drinking.

Table 4. 5. *The source of the Drinking Water*

Variables	Respondents	Percentage (%)
Pipe	0	0
Bore-Hole	10	100
Well	0	0
Total	10	100

(Source: Authors' fieldwork, 2019)

Table 4.5 shows that the airport depends entirely on bore-hole as a source of water supply.

Table 4.6. *The Effects of Construction/Expansion on Commercial Activities*

Variables	Respondents	Percentage (%)
Yes	2	20
No	8	80
Total	10	100

(Source: Authors' fieldwork, 2019)

From table 4.6 results, it is clear that construction/expansion work has not displaced any business activity, only 20 percent believed that construction has affected commercial activities.

Table 4.7. *Effect of Displacement on Socio-Economic Activities*

Variables	Respondents	Percentage (%)
Fair	8	80
Poor	2	20
Devastating	0	0
Total	10	100

(Source: Authors' fieldwork, 2019)

Table 4.7 shows that 80 percent of the respondents believe that construction/expansion has not affected the socio-economic activities in the airport while 20 percent believes it does.

Table 4.8. *Effect of Washing of Aircraft in terms of Environmental Management*

Variables	Respondents	Percentage (%)
Satisfactory	9	90
Poor	1	10
Total	10	100

(Source: Authors' fieldwork, 2019)

Table 4.8 shows that washing activities in the airport is regulated since 90 percent of the respondents believed it is satisfactory.

Table 4. 9. *Oil Leakages from the Aircrafts*

Variables	Respondents	Percentage (%)
Wash and Drain	10	100
Just wash/Clean	0	0
Total	10	100

(Source: Authors' fieldwork, 2019)

From table 4.9, 100% of the respondents attested to the fact that oil leakages from the aircraft are washed and drained.

Table 4.10. *Drainage System in the Airport*

Variables	Respondents	Percentage (%)
Yes	6	60
No	4	40
Total	10	100

(Source: Authors' fieldwork, 2019)

From table 4.10, 40 percent of the respondent believed that the drainage system in the airport should be improved.

Table 4.11. *Waste Treatment Plant in the Vicinity of the Airport*

Variables	Respondents	Percentage (%)
Yes	0	0
No	10	100
Total	10	100

(Source: Authors' fieldwork, 2019)

From table 4.11, all respondents stated that the airport has no waste treatment plant.

Table 4.12. *Waste Disposal*

Variables	Respondents	Percentage (%)
Transport and dispose	10	100
Contracted out	0	0
Total	10	100

(Source: Authors' fieldwork, 2019)

From the result in table 4.12, waste generated from the airport is transported and disposed.

Table 4.13. *Constant Electricity Supply by KAEDCO*

Variables	Respondents	Percentage (%)
Yes	7	70
No	3	30
Total	10	100

(Source: Authors' fieldwork, 2019)

Table 4.13 shows that 70% of electricity supply is from the distribution company.

4.2.3 Extent of land use in the Airport

Table 4.14. *Land allocated in the airport*

Variables	Respondents	Percentage (%)
State or LGA	0	0
FAAN	10	100
Total	10	100

(Source: Authors' fieldwork, 2019)

From table 4.14 Land allocation within the airport is the sole responsibility of FAAN.

Table 4.15. *Community Involvement in Land Use Management*

Variables	Respondents	Percentage (%)
Yes	8	80
No	2	20
Total	10	100

(Source: Authors' fieldwork, 2019)

Table 4.15 shows that 80 percent of the respondents indicate that the community within the vicinity and surrounding of the airport are taken into consideration in terms of land matters while 20 percent believed that the community is not involved.

Table 4.16. *Land Reclamation*

Variables	Respondents	Percentage (%)
Naturally	1	10
Artificially	0	0
Both Natural and Artificially artificial	9	90
Total	10	100

(Source: Authors' fieldwork, 2019)

Table 4.16 shows that land is reclaimed from using both natural and artificial ways as indicated by the respondents.

Table 4. 17. *Revenue Generated from Land Uses*

Variables	Respondents	Percentage (%)
Yes	10	100
No	0	0
Total	10	100

(Source: Authors' fieldwork, 2019)

From 4.17 all respondents stated that revenue is generated from the use of land.

Table 4. 18. *Land Planning Schedule in the Airport*

Variables	Respondents	Percentage (%)
Yes	10	100
No	0	0
Total	10	100

(Source: Authors' fieldwork, 2019)

From table 4.18, respondents attest to the presence of land planning schedule

Table 4.19. *Land use According to ICAO Standard*

Variables	Respondents	Percentage (%)
Yes	0	0
No	10	100
Total	10	100

(Source: Authors' fieldwork, 2019)

Land uses are planned according to ICAO standards as shown in the table 4.19.

EIA as one of the key components of environmental management, development or modification of infrastructure in the airport must undergo a socio-economic or technological impact assessment.

Table 4.20. *Environmental Impact Assessment (EIA) in Land Development*

Variables	Respondents	Percentage (%)
Yes	10	100
No	0	0
Total	10	100

(Source: Authors' fieldwork, 2019)

From the responses on table 4.20, it is clear that the airport is using EIA on any developmental projects.

Table 4. 21. *Environmental Control and Land Use Planning in the Airport*

Variables	Respondents	Percentage (%)
Very Good	6	60
Fair	2	20
Poor	2	20
Total	10	100

(Source: Authors' fieldwork, 2019)

Table 4.21 shows that 60 percent believed that environmental control and land use planning at the airport is very good, 20 percent said it is fair while another 20 percent believed it is poor.

Table 4.22. *Airport in terms of Environmental Friendliness*

Variables	Respondents	Percentage (%)
Very Good	5	50
fair	2	20
Poor	3	30
Total	10	100

(Source: Authors' fieldwork, 2019)

From table 4.22, 50 percent believed that the environmental friendliness of the airport is very good, 20 percent believed it is fair while 30 percent believed it is poor.

Table 4.23. *Aircraft Noise*

Variables	Respondents	Percentage (%)
Yes	3	15
No	12	60
Indifferent	5	25

(Source: Authors' fieldwork, 2019)

From the table 4.23 only 15 percent of the respondents stated that aircraft noise constitute nuisance to them while 25 percent are indifferent.

Table 4.24. *Airport Rating in Terms of Facilities*

Variables	Respondents	Percentage (%)
Very Good	3	15
Fair	12	60
Poor	5	25

(Source: Authors' fieldwork, 2019)

Table 4.24 shows that 60 percent of the respondent believed that facilities in the airport are fair, 15 percent says they are very good while 25 percent believed they are poor.

Table 4.25. *Threat to Life due to Aircraft Activities*

Variables	Respondents	Percentage (%)
Yes	4	20
No	16	80
Total	20	100

(Source: Authors' fieldwork, 2019)

Table 4.26. *Threat Related Issues*

Variables	Respondents	Percentage (%)
Emissions	0	0
Noise	2	10
Birds	2	10
None	16	80
Total	20	100

(Source: Authors' fieldwork, 2019)

AS seen from the responses on table 4.26, 80 percent believed that there are no threats from all the factors mentioned 10 percent believed that birds posed a threat to the aircraft and 10 percent stated that noise is a serious threat and a nuisance.

Table 4.27. *Sanitation Related Facilities in the Airport*

Variables	Respondents	Percentage (%)
Good	6	30
Fair	8	40
Bad	6	30
Total	20	100

(Source: Authors' fieldwork, 2019)

As seen from the table 4.27, 30 percent says the sanitation related facilities in the airport are bad, 40 percent stated that they are fair while another 30 percent believed they are good.

Table 4.28. *Large-scale Agricultural/Industrial Activities in the Airport.*

Variables	Respondents	Percentage (%)
Yes	0	0
No	20	100
Total	20	100

(Source: Authors' fieldwork, 2019)

From table 4. 28 all respondents show that they have not seen any large-scale Agricultural/ Industrial activities in the airport.

Table 4.29. *Environmental Control and Land use Planning in the Airport*

Variables	Respondents	Percentage (%)
Good	12	60
Poor	8	40
Total	10	100

(Source: Authors' fieldwork, 2019)

Table 4.29 shows that 60 percent believed it is good and 40 percent believed it is poor.

CONCLUSION

In this study an attempt was made to look into the Environmental control and Land Use Planning at Kaduna International Airport, Kaduna state, Nigeria. During the course of the research, both primary and secondary data were used. Questionnaires were designed to elicit relevant information from respondents.

The heads of safety, land, water and survey and operations departments being the technical departments responsible for environmental management were consulted for technical questions and answers. Relevant question as related to functions and services rendered were presented to the respondents such as the adequacy of expertise and facilities to deal with the issue of environmental control and land use planning. A total of 20 visitors and other facilities users were systematically interviewed.

Results from this study has shown an acceptable level of compliance in Environmental Control and Planning by the relevant authority of Kaduna International Airport. The results from this study will be useful to FAAN, ICAO and other relevant Agencies in enhancing Environmental Control and Planning at Airports.

Environmental management is a very vital tool to the achievement of a safe and sustainable environment in the aviation industry. Aviation industry is a very sensitive sector where proper environmental management should be the order of the day. The control and planning of the environment in the aviation industry will lead to a better and safer environment in terms of flying and dwelling. Based on the data presented, it is clear that environmental control and land use planning in Kaduna International Airport has attain an acceptable level according to the ICAO standards. More efforts are being articulated by the Federal Ministry of Aviation to innovate ways for a better and sustainable way of managing the environment. All the Aviation agencies are collaborating with the airlines operators to achieve this quest.

RECOMMENDATIONS

Based on the research findings, the following recommendations are made:

- The land use system in place should reflect an integrated approach adopted jointly by the airport operators, the state government and the local authorities.
- Commercial building and houses in the airport should adequately be sound- proofed.
- Airport environment should be given special control to keep the land free from food and shelter for birds.
- There must be as appropriate a Comprehensive Environmental Impact Assessment (EIA) for any airport improvement to assess the technological and socio-economic impact of improvements.
- Government with the support of private participation should made fund available to the airport for a better land use and environmental control.
- Training and re-training of personnel especially those involved with environmental management should be given due consideration.
- Air quality test should be conducted at intervals to check the safety of the air.
- Further research can be done specifically on waste management at the airport.

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