Journal of Energy Research and Environmental Technology (JERET)
p-ISSN: 2394-1561; e-ISSN: 2394-157X; Volume 6, Issue 2; April-June, 2019, pp. 84-86

http://www.krishisanskriti.org/Publication.html

Ground Motion Hazard Estimation of a Region by GIS Approach

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Abstract—*This paper contains the basic applications of Geographic Information System (GIS) in estimating ground motion hazard by taking the historical data of earthquakes. The obtained data with the help of ARC GIS software georeferencing has been done with the help of shape file and earthquake prone zone plotted on the map. The region considered for the study is Delhi. The plotted map shows the magnitude variation of earthquake with different epicentral region. GIS mapping technique shows the clear view of earthquake magnitude variation in the selected region.*

Keywords*: Magnitude, intensity, response spectra, peak ground acceleration.*

Introduction

On the earth, there are several types of natural disaster like, earthquakes, floods, landslides, cyclones, forest fires, droughts, avalanche, volcanic eruptions and they are quite common [1 - 2]. These disasters lead to the structural or property damage, loss of life, socio- economic disruption. Due to increase in physical resources and population these losses have grown over the years. Earthquake phenomenon is very destructive and highly frightening among the natural disasters [3 - 4]. This kind of disaster is not possible to prevent from occurring. Therefore, we need scientific understanding of its nature, magnitude, frequency, causes, and intensity, to minimize its disastrous effect. Due to higher population density in developing countries the losses are not uniformly distributed and more prevalent [5].

The Indian Himalayan region belongs to the most earthquake prone areas. Higher magnitude earthquakes of 8 or above have occurred in these areas in last few centuries, and these earthquakes were responsible for great damage, heavy casualties and economic loss [6]. To mitigate the potential of an earthquake, seismic hazard analysis is carried out. The seismic hazard assessment helps us to describe fault rupture, ground shaking, and liquefaction. Seismic hazard estimation of the future earthquake for a particular site of interest is also a part of seismic hazard analysis (Reiter, 1990). The strong ground motion is estimated based on the available data on seismicity, tectonics, geology, and attenuation characteristics of that region. The estimation of ground motion provides the information of the severity of ground shaking of particular region of interest during future earthquakes (Gupta, 2002) [7-10]. In the present study, the Delhi region has been selected for the estimation of ground motion.

GIS Application for Seismic Hazard Estimation of Delhi Region

Federal Department of Forestry and Rural Development, Ottawa, Ontario, Canada developed first GIS in 1960. Development of many important theoretical concepts took place in the Laboratory for Computer Graphics and Spatial Analysis at the Harvard Graduate School of Design (LCGSA 1965–1991) formed by Howard T. Fisher in 1964. Journey of GIS from research laboratories into corporate world started in 1986 when, Mapping Display and Analysis System (MIDAS), the emergence of the first desktop GIS product for the operating system DOS happened [11].

Cartography, statistical analysis, and database technology are merged in GIS and it works with many operations. GIS has applications in numerous fields like engineering, planning, management, transport, and business etc. Therefore, it can be very effectively and efficiently used for location-enabled services that depend on analysis, visualization and subsequently helps in dissemination of results for collaborative decision making.

It is an information system, in which the data are integrated, stored, edited, analyzed, shared, and displayed geographic information for informing decision making. This has the applications tools related to creation of interactive queries, analysis of spatial information, editing of data in maps, and presentation of results obtained from these operations. GIS has the wide applications in engineering field for different prediction, loss assessment after disaster, decision making after and before the disaster, reliability analysis etc [11]. In this present work, the historic epicentral data taken for GIS applications are shown in the following table (Table 1). The georefrencing of desired locations using GIS software (Figure

1) and map of epicentre location around Delhi region (Figure 2) are presented.

Table 1: Historic epicentral data taken for GIS applications (assumed)

Epicentre	Magnitude	Year	Latitude	Longitude
DELHI	6.6	1720	28.61	77.23
BANK OF GANGA	6	1764	30.98	78.92
MATHURA	6.5	1803	27.49	77.67
MUSSOORIE	5.5	1842	30.46	78.07
MOUNT ABU	6	1848	24.59	72.71
MEERUT	5.75	1852	28.98	77.71
KANGRA	≥8	1905	32.1	76.27
MOUNT ABU	5	1906	24.59	72.71
KHURJA	6.7	1956	28.15	77.67
GURUGRAM	6	1960	28.2	77.4
SONEPAT	5.75	1964	28.29	77.01
ROHTAK	5.3	1971	28.89	76.6
UTTARKASHI	6.6	1991	30.73	78.43
DELHI	4	1994	28.61	77.23
CHAMOLI	6.8	1999	30.29	79.56
BHUJ	6.9	2001	23.24	69.67

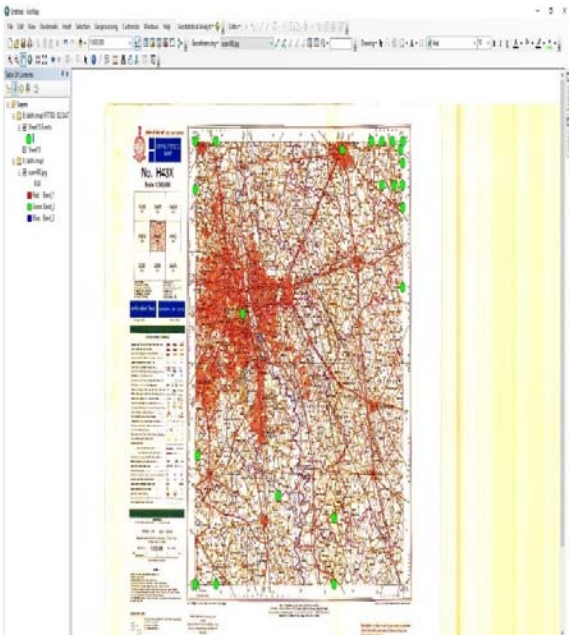

Figure 1: Georefrencing of desired locations using GIS software

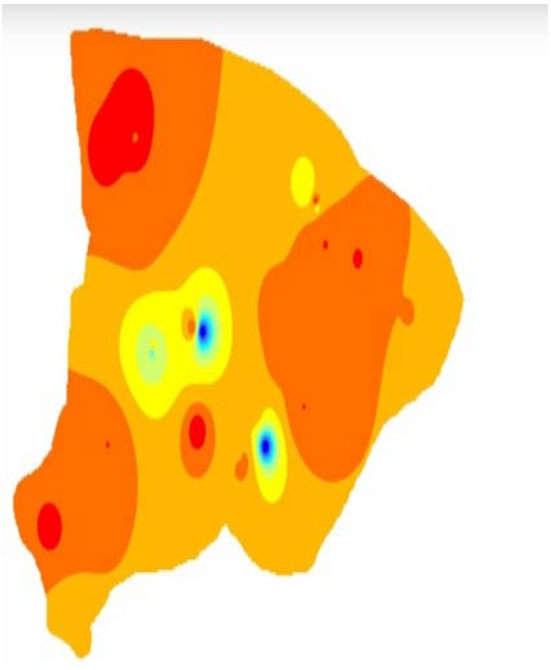

Figure 2: Map of epicentre location around Delhi region

Conclusions

The location of Delhi region lies in the North-west region (NWR) which is one of the seismically active regions. There were several small to moderate earthquake had occurred in this region which caused high loss of lives and economy. Delhi region lies in zone IV, and this zone is highly severe to earthquake as stated in Indian standard code of practice for earthquake resistant design of structures in the country (IS-1893:2016).

In this paper, Arc GIS applications are carried out in earthquake engineering, which provide clear pictorial view of magnitude and epicentral position of desired location. Using Arc GIS software, the most severe location in any desired region or around it can be identified. This software provides inter-plot for future forecasting of earthquake.

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