Improvising Security of HSZ Areas on Google Map Satellite Images of India via COTPCSD Mechanism

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ABSTRACT
The demand for Geospatail based services is improving day-to-day, due to its wide range of applications. But security is a major constraint for the satellite images with respect to Google Earth applications. In the recent times people are travelling easily to remote locations with a short span of time using the Google Earth application in the smart phones. In addition to that, it became a powerful tool for the antisocial elements in the society to execute terror attacks and bomb blasts at the right place. Especially India like country are prone to the terror and extremist attacks, which resulted in the greatest loss of thousands of lives. This problem can be addressed via., a novel Chaotic-One-Time-Password based Cryptic Satellite Data (COTPCSD) algorithm. The COTPCSD comprises of the Logistic map based chaotic image encryption and a One-Time-Password (OTP), which will strengthen the Quality-of-Security (QoS) for Google Earth Satellite data and reduces the Network Delay (ND) when compared to the existing Chaotic Multi-level Remote Sensing Data encryption (CMRSDE) algorithm. Our research outcomes show that the Overall Perfromance (OP) of COTPCSD is good compared to CMRSDE.

General Terms
Security, Algorithms, GIS.

Keywords
Satellite Data Security, Chaotic, Logistic encryption, COTPCSD, CMRSDE, Chaotic Multi-level Remote Sensing Data encryption, Chaotic-One-Time-Password based Cryptic Satellite Data, GIS, Remote Sensing, Matlab.

1. INTRODUCTION
With the ever-increasing demand of Geospatial data and its applicability taken a giant leap in the arena of Information and Communication Technology (ICT). Especially Geospatial applications involve many Geographic Information Systems (GIS) like smart cities, Google Earth, Global Positioning System, Geo-tagging, Disaster Management, Flood warning systems, Climate change, Environmental pollution, rainfall prediction, many location based services are more popular [1]. Exclusively Location-Based-Services through Google Earth (GE) satellite data plays a vital role in this digital age. Beside many usages with GE, finding a remote location and finding the shortest path between source and destination station applications is more popular. Also GE helps in finding the nearby important places like tourism spots, restaurants, government offices, rescue shelters, etc. are some of the fruitful works of the GE [2] [3]. Adjacent to that, GE became a robust device for the extremists or terrorists. With the help of GE map information, anti-social elements performed big bomblasts and terror operations all around the globe. Which in turn resulted in a big number of loss of lives and asserts. 26/11 Mumbai terror Attack is one such big instance, where militants used google maps for planned and executed perfectly, yield result in the loss of 171 deaths [4]. In another instance 42 people killed and 119 injured in the Hyderabad twin blasts in the 2007 year. Statstics were collected from various sources from the year 1984 to 2014. It is observed that on an average more than 40 people are killed by the terrorist every year in India. The terror attacks information is gathering of many newspaper articles information. This information provides for the past 30 years, approximately 59 incidents took place and more than 1889 deaths registered [AppendexI]. Any Country's own security is a core element for the development and prosperity of the nation. In the literature of the google map's security the country is further bifurcated into three categorical zones, they are High Prority Zone (HPZ), Average Prority Zone (APZ) and the Low Priority Zone (LPZ). Later cryptic algorithms were applied to the zones for their confidentiality.

To predict and prevent the terror attacks is still a million dollar question to the administers, scientists and defense forces. Previously proposed many studies were made and solutions proposed, but the QoS is high and ease of use is complex [5][6]. This work describes the privacy and confidentiality of the HPZ, APZ and LPZ based on the importance of the area in the society by maintaining reliability and fastness. The important contributions for the work are as follows: (1) a study and analysis terror attacks in Inida;(2) a Chatoic and OTP based Cryptic Satellite Data Algorithm; and (3) a novel performance metric by comprising security both QoS and ND; (4) an online working model where the COTPCSD mechanism is implemented and verified successfully. The organization of the paper is as follows. Background works described in Section 2 in the area of Chaotic logistic maps, Geospatail applications, and terrorist operations. The proposed solution COTPCSE algorithm is explained in Section 3. Online map server encryption experimentation and results discussed in Sections 4. The paper ended in section5 with a conclusion and future scope.

2. RELATED WORKS
The secure satellite data view on google maps is initiated by Rajesh Duvvuru et al., and proposed Chaotic Multilevel Remote Sensing Data Encryption (CMRSDE) Algorithm. They used double chaotic, based cryptic security of the satellite data and also categorized with various zones according to the geographical importance. In CMRSDE algorithm the ND takes more time with respect to the improvement in the QoS [7]. Whereas Xiaoqiang Zhang et al., proposed a Discrete Wavelet Transform (DWT) and Inverse Discrete Wavelet Transform based on two-dimensional logistic map [8]. Next to that Jin Liu and team addressed the problem of distributing the remote sensing image using Multi-rank encryption framework. The Multi-rank encryption mechanism depends on the usability level of the data for various users [9]. Recently Feifei Xin and group proposed a novel security mechanism using Terahertz wave for remote

sensing images [10]. Nevertheless, more research has to perform on the Terahertz waves. Muhammad Usama used chaotic approach alone for the satellite data security [11]. Whereas google earth is all about integration of various NASA satellite images and other satellite repositories as Geographical Information System (GIS). Satellite data can broadly classify into spectral, temporal, Geometric, radiometric and spatial. Presently, Google satellite images comprise of mostly LandSat 8 satellite data. It contains 11 bands for various operations like coastal, aerosol studies and surface temperature, etc., with various spatial resolutions [12].

But the existing algorithms don't sustain the purpose of secure access to the HSZ. The proposed Chaotic-One-Time-Password based Cryptic Satellite Data (COTPCSD) algorithm is discussed in the next section and diagrammatically represented in figure 2.

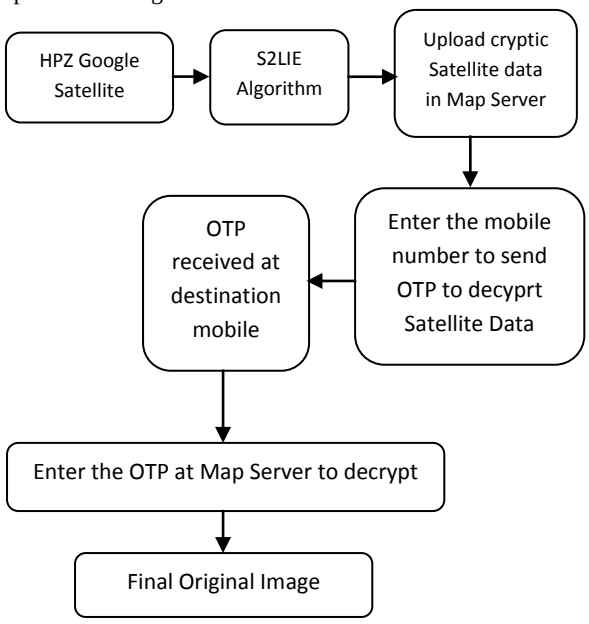

Fig 2: The data flow diagram of the COTPCSD mechanism.

The 2D Logistic Chaotic can be represented mathematically by the following equation.

$x_{i+1} = r\,(3_y + 1)\,x_i\,(1 - x_i)$ and

$y_{i+1} = r\,(3_x + 1)\,y_i\,(1 - y_i)$ ------- (1)

Where Logistic(x_{i+1}, y_{i+1}) is the spatial coordinates of i ranges from 1,2,3….n and r is a chaotic behavior parameter with value 1.19 [13].

3. CHAOTIC-ONE-TIME-PASSWORD BASED CRYPTIC SATELLITE DATA ALGORITHM

3.1 Notations and Assumptions

The COTPCSD algorithm is designed and implemented with certain assumptions. The number of users access the google maps or google earth is assumed using Random Probability Distribution (RPD) function per day. It is precept that OTP generated will expires within 1 hour for one particular HSZ. The HSZ was identified according to area importance. The HSZ are as follows:

- Central Ministry Offices and Residential in Delhi .
- All Centrally funded Research Laboratories like the Baba Atomic Research Center (BARC), Council of Scientific & Industrial Research (CSIR), Indian Space Research Organizations (ISRO), Defense Research Development Organization (DRDO) etc.
- State VIP Offices and Residences.
- Defense area in India.
- Popular pilgrim areas like Tirumala (Tirupati), Macca Majid (Hyderabad), St. Phelemon Church (Mysore), Varanasi temple etc.

3.2 The Packet Model Adopted

Various packet models were used in the architecture. Firstly the communication between client and server and Secondly the communication between Server and Mobile Phone via SMS. In general, the standard Peer-to-Point Extensible Authentication Protocol (PPP EAP) designated as RFC 2284 by Internet Engineering Task Force (IETF) adopted for the Mapserver-Mobile Network [14]. Whereas popular Hyper Text Transfer Protocol Secure (HTTPS) is inherited for the Client-Server communication [15].

3.3 The COTPCSD Algorithm

Step1: User access the Google Maps (GM) to access the HSZ.

Step2: Map Server raise and authentication interupt to the user.

Step3: Call Satellite 2D Logistic Image Encryption routine.

Step4: The send the KEY as OTP to the user using PPP EAP.

Step5:IF the sent OTP is received by the user,

GOTO Step6

ELSE Step7.

Step6: Re-request for the OTP on the GM. GOTO Step4.

Step7: Enter the key to access the original HSZ map.

IF == KEY, then redirected to the original map

ELSE, GOTO Step1.

Step8: Stop.

3.3.1 Satellite 2D Logistic Image Encryption (S2LIE) Algorithm

Step1: Apply the Region-of-Interest (ROI) [16] on the HSZ of Google map images to perform segmentation.

Step2: Convert the segmented HSZ 3D images to 2D gray color images.

Step3: Perfrom the 2D Losgistic encryption on the 2D HSZ.

Step4: Replace the original image with the cryptic 2D HSZ.

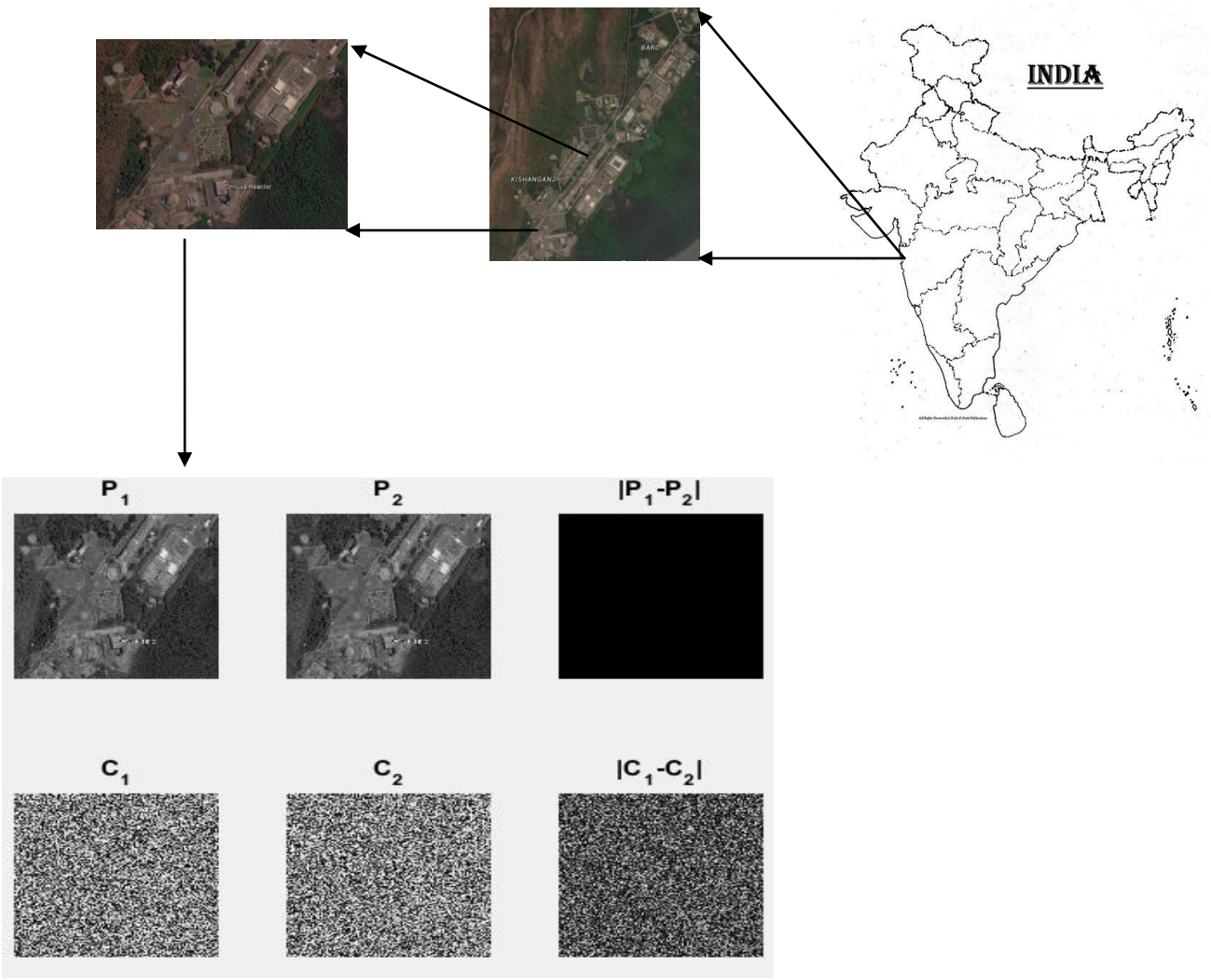

Fig 3: The S2LIE algorithm simulation results, where HSZ Study has been shown using India map.

4. SIMULATIONS AND RESULTS

4.1 Simulation of S2LIE

The HSZ satellite images are identified on the Google map India. The identified satellite images are segmented using ROI. The segmented images are in a 3 dimensional format. The 3D image encryption is a complex process and it takes more time and space to get encrypted. In order to get reduce the computation and beside maintaining the high security. The 3D images are converted into 2D images. By applying the rgb2gray() method; the 3D color images are converted into 2D gray scale images. The resulted HSZ grayscale satellite images are subjected to the 2D Logistic Encryption. The 2D Logistic encryption method contains Logistic-MDS(), Logistic-Permutations(), Logistic-Substitutions() and Logistic2D-image-cipher().

In this experiment, the 25 HSZ satellite data were collected on Google map India images [17]. Among them Defense Research Development Organization Laboratory (DRDOL, Hyderabad), Baba Atomic Research Centre (BARC, Mumbai) and Indian Space Research Organization (ISRO, Banglore) are presented in the paper. The experimental results of S2LIE are shown in figure 3. The figure contains India map, segmented BARC image in color, segmented BARC image in grayscale and cryptic BARC Image. The step-by-step demonstration was shown below. Where as figure 4 and 5 the simulation results regarding cryptic DRDO and ISRO satellite data.

Table 1: Data used for the simulation

HSZ	Spatail Coordinates	Elevation (ft)	Eye alt (ft)	Date of Image Acquired
DRDOL	$17^0 20^1 20.60^{11}$ N $78^0 30^1 48.58^{11}$ E	1720	2545	7/11/2014
BARC	$19^0 00^1 34.88^{11}$ N $72^0 55^1 34.96^{11}$ E	36	3520	15/4/2015
ISRO	$12^0 57^1 35.02^{11}$ N $77^0 39^1 22.16^{11}$ E	2933	3771	29/5/2015

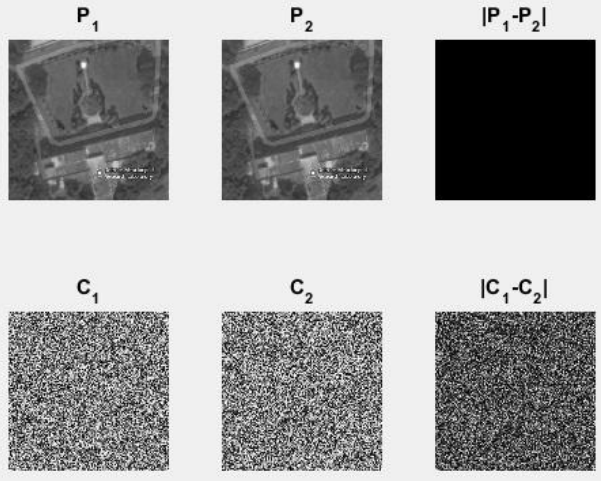

Fig 4: The S2LIE algorithm simulation results, where HSZ (DRDO Lab in Hyderabad).

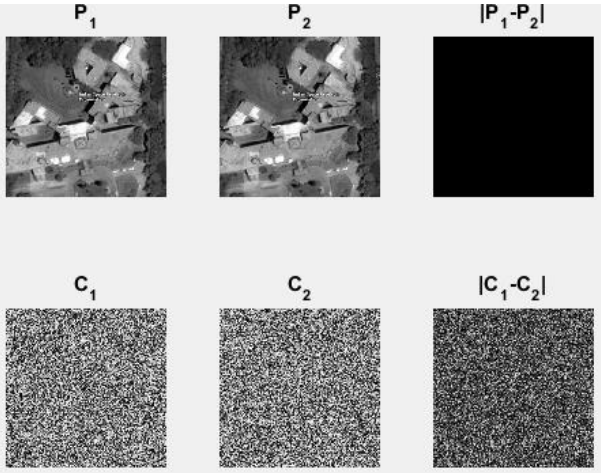

Fig 5: The S2LIE algorithm simulation results, where HSZ (ISRO in Banglore).

4.2 Simulation of COTPCSD Algorithm

The COTPCSD algorithm includes S2LIE simulation and PPP EAP implementation. To float the realtime PPP EAP implementation, a pack of 500 promotional, SMS is hired from the trusted third party from 'SMS Gateway Provider' company [18]. The simulation hosted on the Syamala Education Society (SES) website. The SES website is hosted on Linux-Apache-MySQL-PHP (LAMP) server and the SMS Interface was developed in PHP. Methods like curl_init($fullapiurl) and curl_setopt($ch, CURLOPT_RETURNTRANSFER, true) are used for secure password transformation. The SMS test is conducted for 42 mobile numbers and SMS is Sent Suessfully with various SMS delivered timely. Figure 6 shows the complete output of the COTPCSD, where the selected HSZ are encrypted using the 2D Logistic map.

Fig 6: 2D Logistic map encryption performed on selected areas in India, Google satellite map.

4.3 Impact of Encryption Time on Satellite images

The COTPCSD compared with the CMRSDE based on the Encryption Time (ET). The CMRSDE has consumed more time than COTPCSD mechanism, because CMRSDE is an double encrypted mechanism, whereas COTPCSD is a single encryption algorithm. Figure 7 shows the comparative graph between the COTPCSD and CMRSDE based on ET.

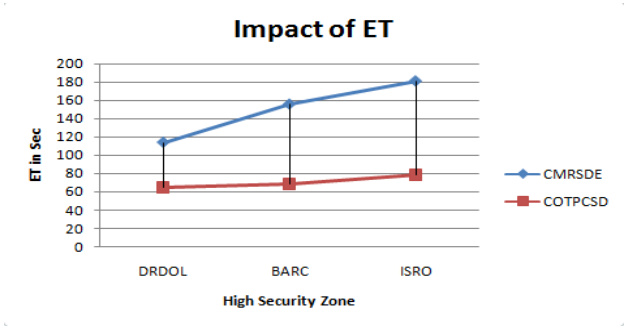

Fig 7: Impact of Encryption time on HSZ Satellite data.

4.4 Impact on Overall Performance

The Overall Performance (OP) can be calculated in the following the equation 2.

$$OP = Logistic(x_i,y_i) – ET + SMSND \quad \text{------ (2)}$$

Where SMSND is the SMS network delay, which is assumed using RPD and the rest of the parameters are defined in the earlier sections.

5. CONCLUSIONS AND FUTURE SCOPE

Security to the satellite images is a key issue in the area of Geographic Information Systems. Beside maintaining the QoS and reducing the network delay is a big challenge to the researchers. This paper introduces the a novel COTPCSD, which uses the S2LIE Algorithm and PPP EAP for the secure and fast transmission of satellite data of HSZ, Google Satellite images. S2LIE uses the 2D Logistic Chaos map based encryption on the satellite data. PPP EAP is implemented by hiring the services of the SMS Gateway provider for the secure password transaction. The COTPCSD performance is comparatively better than CMRSDE, w.r.t. ET and OP.

In future the 2D logistic map encryption can be replaced with more stronger chaotic map encryption for higher security.

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7. APPENDIX

Table 2: List of Terror attacks in India and resulted deaths

DATE	INCIDENT	PLACE	DEADLINESS	HURT
08/02/1984	Meenambakkam Bomb Blast	Tamil Nadu	30	25
07/07/1987	Punjab Killings	Punjab	36	60
15/06/1991	Punjab Killings	Punjab	90	200
03/12/1993	Bombay Bomb Blasts	Mumbai	259	713
30/12/1996	Bramhaputra Mail Train Bomb Blast		33	150
14/02/1998	Coimbatore Bomb Blast	Tamil Nadu	58	200+
22/12/2000	Terrorist Attack On Red Fort	Delhi	3	14
10/01/2001	Jammu and Kashmir Legislative Assembly Attack	Jammu And Kashmir	38	0
13/12/2001	Indian Parliament Attack In New Delhi	Delhi	7	0

13/05/2002	Janupur Train Crash	Uttar Pradesh	12	80
12/06/2002	Mumbai Bus Bomb Blasts	Mumbai	2	14
21/12/2002	Kurnool Train Crash	Andhra Pradesh	20	80
09/10/2002	Rajiganji Train Disaster	Bihar	130	300
24/09/2002	Terrorists Attack The Akshadharam Temple in Gujarat	Gujarat	31	0
27/01/2003	Mumbai Bomb Blasts	Mumbai	1	0
13/03/2003	Mumbai Train Bomb Blasts	Mumbai	11	0
28/07/2003	Mumbai Bus Bomb Blasts	Mumbai	4	32
25/08/2003	Mumbai Bomb Blasts	Mumbai	52	0
15/08/2004	Dhemaji School Bomb Blast	Assam	18	40
28/07/2005	Janupur Train Bomb Blast	Uttar Pradesh	13	50
29/10/2005	Three Powerful Serial Blasts In New Delhi At Different Places	Delhi	70	250
03/07/2006	Varanasi Bomb Blasts	Varanasi	21	
07/11/2006	Mumbai Train Bomb Blasts	Mumbai	209	500
09/08/2006	Malegaon Bomb Blasts	Maharashtra	37	125
18/02/2007	Samjhauta Express Bomb Blast	Harayana	68	0
18/05/2007	Mecca Masjid Bomb Blast	Hyderabad	13	0
DATE	**INCIDENT**	**PLACE**	**DEADLINESS**	**HURT**
25/08/2007	Hyderabad Bomb Blast	Hyderabad	42	0
10/11/2007	One Blast At A Shrine Of A Sufi Muslim Saint In The Town Of Ajmer	Rajasthan	3	0
14/10/2007	One Blast In A Movie Theater In The Town Of Ludhiana Of Muslim Holy Day Of Eid-Ul-Fitr	Ludhiana	6	0
24/11/2007	A Series Of Near-Simultaneous Explosions At Courthouse Complexes In The Cities Of Lucknow, Varanasi and Faizabad	Uttar Pradesh	16	70
01/01/2008	Terror Attack on CRPF Camp In Rampur, Uttar Pradesh By Lashkar-E-Taiba	Uttar Pradesh	8	5
13/05/2008	Jaipur Bomb Blasts	Jaipur	63	200
25/07/2008	Banglore Serial Bomb Blast	Banglore	2	20
26/08/2008	Ahmedabad Blasts	Gujarat	29	110
13/09/2008	Delhi Bomb Blasts	Delhi	33	130
27/09/2008	Western India Bomb Blasts	Maharashtra	10	80
10/01/2008	Agartala Bomb Blasts	Agartala	8	100

21/10/2008	Imphal Bomb Blasts	Imphal	17	40
30/10/2008	Assam Bomb Blasts	Assam	77	300
26/11/2008	Mumbai Attacks	Mumbai	171	239
01/01/2009	Guwahati Bomb Blasts	Assam	6	67
04/06/2009	Assam Bomb Blasts	Assam	7	62
13/02/2010	Pune Bomb Blasts	Pune	17	60
12/07/2010	Varanasi Bomb Blasts	Varanasi	1	20
13/07/2011	Mumbai Bomb Blasts	Mumbai	26	130
09/07/2011	Delhi Bomb Blasts	Delhi	19	76
13/02/2012	Attacks On Israeli Diplomats	Delhi	0	4
08/01/2012	Pune Bomb Blasts	Pune	0	1
21/02/2013	Hyderabad Bomb Blast	Hyderabad	16	119
13/03/2013	Srinagar Attack	Jammu and Kashmir	7	10
17/04/2013	Banglore Blast	Bengaluru	0	16
25/05/2013	Naxal Attack In Darbha Valley	Chhattisgarh	28	32
DATE	**INCIDENT**	**PLACE**	**DEADLINESS**	**HURT**
24/06/2013	Srinagar Attack	Jammu and Kashmir	8	19
07/07/2013	Maoist Attack In Dumka	Chhattisgarh	5	0
07/07/2013	Bodh Gaya Bomb Blasts	Bihar	0	5
27/10/2013	Patna Bomb Blasts	Bihar	5	66
25/04/2014	Blast In Jharkhand	Jharkhand	8	45
28/04/2014	Blast In Budgam District	Jammu and Kashmir	0	18
05/01/2014	Chennai Train Bomb Blast	Tamil Nadu	1	14
05/12/2014	Maoist Blast In Gadchiroli District	Jharkhand	7	2
28/12/2014	Bomb Blast At Church Street Banglore	Bengaluru	1	5
20/03/2015	Jammu Attack	Jammu and Kashmir	6	10
27/07/2015	Gurdaspur Attack In Dina Nagar, Gurdaspur District	Punjab	10	15