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Data Article

Inventory data on the sinkhole occurrences from Proterozoic Cuddapah Basin, India

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ABSTRACT

This data article provides the inventory data on sinkhole occurrences for the first time from Proterozoic Cuddapah Basin, India. Unexpected ground subsidence incidents are taking place with ground breaking sounds and forming in the Cuddapah Basin since 2007 and their frequency increasing from 2015 to 2017 (15 sinkholes over night in and around Buggavanka River). Such incidents are creating panic situations in the general public of this area which was not experienced in this region ever before. It is interesting to note that majority of sinkholes are forming subsequent to heavy rains and sudden recharge, especially in and around Buggavanka and Chitravati River beds. Hence, there is a strong need for the data on the sinkhole occurrences for detailed field investigations in future. Since, sinkhole inventory is a vital and pioneering step in sinkhole hazard analysis, the consistency of sinkhole hazard and vulnerability maps and the efficiency of the mitigation measures chiefly rely on the accuracy, completeness, and fidelity of the sinkhole inventories. Geospatial technologies played a major role in this inventory in terms of data collection, editing and analysis of various thematic maps.

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Specifications table

Subject area	Earth Sciences
More specific subject area	Sinkholes- Environmental geology
Type of data	Table, images and figures
How data was acquired	GPS (Garmin etrex 10) survey, Field Survey (SOI Toposheets)
Data format	Raw and analyzed
Experimental factors	Geo-referencing and Geometric corrections
Experimental features	Sinkhole locations were collected using GPS, Field Survey and executed in the ARCGIS Software.
Data source location	Parts of YSR (Cuddapah) and Anantapur districts in the state of Andhra Pradesh, South India. Individual locations of each sinkhole and its latitude & longitude values given in the table below.
Data accessibility	All data are available in this article
Related research article	Prasad, M., Ramakrishna Reddy, M., Sunitha, V., 2017. Bedrock structural controls on the occurrence of sinkholes: a case study from part of Cuddapah basin, South India". The Journal of Indian Geophysical Union, 21, (2), pp. 124–139 [1]

Value of the data

- Data presents the first inventory on the sinkhole occurrences from the Proterozoic Cuddapah Basin, India, during 2007, 2015 and 2017.
- Data is very useful for the local administration and policy makers to implement safety measures in future to avoid the risk and damage to the households.
- This data act as baseline for further research and monitoring through detailed investigations and preparation of sinkhole's hazard zones and risk assessment maps in future.
- Data also suggests that majority of sinkholes occurring on riverbed (Buggavanka, Chtravathi Rivers) in Limestone/ dolomite.

1. Data

Sinkhole inventory data from parts of Proterozoic Cuddapah Basin, India is given in the Table 1. Fig. 1 depicts the individual sinkhole locations. Fig. 2 gives the glimpse of the field photographs collected by the authors during the survey from various locations viz Chintakommadinne, Pendlimarri, Vempalli revenue mandals from YSR District and Yellanur mandal in Anantapur district from Andhra Pradesh, South India. Fig. 3 provides the long-term precipitation trend. Fig. 4 illustrates the monthly average rainfall from 2005-2017. Fig. 5shows sinkhole traces captured on the satellite image from Buggavanka River in chintakommadinne mandal. Figs. 6 and 7 present the integrated maps that demonstrate the geological setting along with the sinkhole locations.

2. Experimental design, materials and methods

2.1. Location

The Crescent shaped Proterozoic Cuddapah sedimentary basin extends over a significant part of the southern part of Andhra Pradesh and Telangana States of Southern India. Lithostratigraphically, the Cuddapah basin is divided into Cuddapah super group represented by three sub-basins/groups - Papaghni, Chitravathi, and Nallamalai and Kurnool group; The basin has aggregate thickness of 6–12 km of discontinuous sedimentary pile, which composed of a suite of arenaceous and argillaceous strata with interbedded limestones at top [2,3] in which these sinkholes are occurring. These carbonate rocks are of strategic importance for local communities as they provide the main water source for irrigation and domestic use. Field observations indicate the extensive karstification of the three-carbonate formations present within the Cuddapah sedimentary basin, namely the Vempalle dolomite, the Narji and Koilakuntla limestone, which together cover about 17% of this basin. Due to intensive irrigated agriculture, parts of the limestone aquifers of the Cuddapah sedimentary basin are overexploited [4].

Table: 1
showing the village wise sinkhole locations along with their GPS coordinates and dimensions.

Sinkhole no	Village or area of sinkhole occurrence	Latitude	Longitude	Avg. Diameter (in feet)	Depth (in feet)	Frequency (Year)	Remarks
1	Bugga kottala	14°18′36.65″N	78°24′20.34″E	24	10	2015	extended cracks with 96
2	Bugga kottala	14°18′36.77″N	78°24′20.35″E	15	9		feet diameter; Unsorted clay to boulder supported fan
3	Buggavanka Riverbed	14°25′30.53″N	78°49′28.72″E	18	9		Cluster of sinkholes in Buggavanka River bed with
4	″	14°25′30.33″N	78°49′28.66″E	17	8		matrix supported boulder
5	″	14°25′31.01″N	78°49′29.92″E	38	24		bed with circular/symmetrical
6	″	14°25′32.45″N	78°49′31.05″E	25	9		opening with water
7	″	14°25′31.42″N	78°49′32.34″E	23	8		at their base
8	″	14°25′30.31″N	78°49′28.28″E	29	11		
9	″	14°25′29.61″N	78°49′27.08″E	26	10		
10	″	14°25′29.64″N	78°49′28.83″E	28	10		
11	″	14°25′30.65″N	78°49′29.24″E	18	8		
12	Nayanoripalle	14°25′32.92″N	78°50′14.78″E	41	25		Near to Public School overhead tank (20 feet) collapsed into the sinkhole; Calcareous unconsolidated soil bed.
13	″	14°25′32.93″N	78°50′15.32″E	28	14		Vegetative stress
14	Musalreddypalle	14°25′31.25″N	78°50′05.10″E	4	38		Deep sinkhole with small opening, gravel bed at base and sand with lime stone leaching at top
15	''	14°25′32.68″N	78°49′54.06″E	24	5		Subsidence in crop lands
16	Buggavanka Riverbed	14°25′32.10″N	78°49′32.50″E	11	4		
17	Gudavandlapalle	14°25′18.20″N	78°49′25.80″E	28	22		Boulder bed, filled with water at the base of sinkhole.
18	Nagireddy palle (buggapalle)	14°24′41.88″N	78°48′41.18″E	30	10	2017	Within Banana plantation adjacent to small stream;
19	″	14°24′41.91″N	78°48′41.19″E	40	22		clay/loamy soil
20	Chagaleru	14°24′05.15″N	78°21′46.21″E	10	20	2007	Croplands
21	Chagaleru	14°24′04.11″N	78°21′41.20″E	8	12		Crop lands
22	Kammavaripalle	14°25′10.17″N	78°43′33.99″E	30	25		First formed sinkhole; weathered Limestone
23	Chitravathi River Bed	14° 35′ 49.6″N	77° 59′59.5″E	25	15	2015	Opened with big sound
24	Chitravathi River Bed	14° 35′42.8″N;	78° 0′ 15.4″E	30	25	2017	Formed in the dried river bed, near the cluster of bore wells

2.2. Sinkholes in YSR district

2.2.1. Chintakommadinne mandal

This area lies in Chintakommadinne Revenue Mandal of YSR District of Andhra Pradesh, India. The proposed area lies in Survey of India topographic sheets # 57J/11 on 1:50,000 scale, bounding with latitudes from 14° 20′ 41″ N to 14° 29′ 51″N and longitudes 78° 39′ 1.11″E to 78° 56′ 37.57″E. Nayanoripalle, Balijapalle, Peddamusalreddy palle, Buggaletipalle and Nagireddy palle are the nearby habitations from the sites. Majority of the sinkholes formed in this area during 2015 and 2017. In geological point of view, this area falls in south western part of Proterozoic Cuddapah Basin, consisting of late Archean or early proterozoic (~2000-4000my) crystalline basement, overlained by middle and upper proterozic sedimentary rocks mainly composed of quartzites, limestones ($CaCO_3$) and shales of Papaghni, Nallamalai and Kurnool group of rocks.

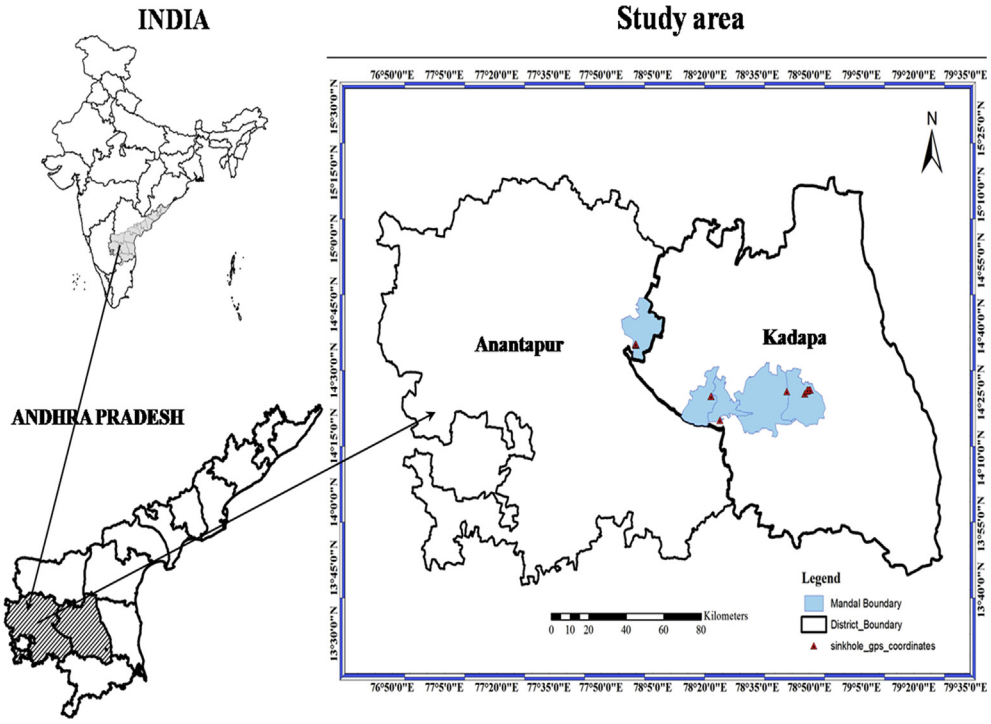

Fig. 1. Location map of the study area.

2.2.2. Pendlimarri Mandal

A sinkhole is formed in the agricultural fields of Kammavaripalle Village of Pendlimarri Mandal in 2007 and it is the first known sinkhole occurrence in YSR District**.** The GPS Coordinates, latitude 14°25′10.02″N, longitude 78°43′34.0″E, falling on SOI toposheet No. 57J/11 and this land belongs to B. Venkatasubba Reddy (Survey no: 1224). It was formed as circular depression with deep hole and thereafter is has been widening till to date with a diameter of around 11 m. Weathered Limestone is well exposed in the sinkhole.

2.2.3. Vempalli mandal

Two huge sinkholes are formed in Buggakottala Village near Vempalli Revenue Mandal, YSR District. The noticed two sinkholes are falling on SOI toposheet # 57J/7. The GPS coordinates are latitude 14° 18′ 36.72″ N longitude 78° 24′ 20.04″ E and 14° 18′ 36.80″ N longitude 78° 24′ 20.26″ E respectively with one-meter distance in between and extended crack circumference about 35.4 m. Sinkholes are formed in agricultural land adjacent to forest, geomorphologically this location is situated on a pediment alluvial fan.

2.2.4. Vemula mandal

Couple of sinkholes formed in the agricultural fields of Chagaleru Village in Vemula Revenue Mandal, YSR District. The GPS Coordinates, latitude 14°24′5.20″N, longitude 78°21′46.20″E, Veera Pakkiraiah's Cropland and latitude 14°24′4.59″N; longitude 78°21′40.97″E Y. Ramulamma's Cropland. These two subsidences happened during the heavy rains in the years 2008 and 2015 monsoon periods correspondingly.

Fig. 2. Showing the field photographs collected during the sinkhole inventory from the study area. A- E) Sinkholes formed in and around Buggavanka River form Chintakommadinne mandal; F) Sinkholes in Buggakotttala village In Vempalli mandal; G) First formed sinkhole in 2007 near Kammavaripalli in Pendlimarri mandal; H) expansion of sinkhole (G) in 2017; I). Subsidence in Chitravathi River Bed; J) Cluster of 40 bore wells adjacent of Chitravathi river 500 mts away from the subsidence.

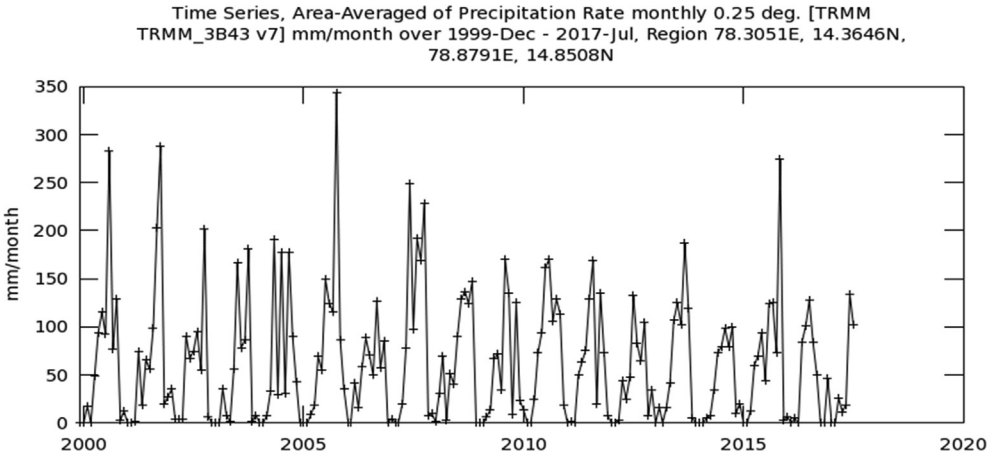

Fig. 3. Goddard Earth Sciences Data and Information Services Center 2017. NASA, TRMM satellite based time series area averaged map of the study area showing the monthly average rainfall from January 2000 to July 2017.

2.3. Sinkholes in Anantapur district

2.3.1. Yellanur mandal

The study area is lies in between Goddumarri and Lakshumpalli villages located in Yellanur Revenue mandal of Anantapur district, where sinkholes formed during 2015 and 2017 in Chitravathi river bed. River Chitravathi is the major River in the study area (Fig. 7). GPS coordinates of the Sinkhole locations are 77° 59′59.5″E and 14° 35′ 49.6″N as well as in 14° 35′ 42.8″N and 78° 0′ 15.4″E. In geological point of view this area falls in North western part of the Proterozoic Cuddapah Basin. The major rock types are Pulivendla quartzites, Tadipatri shales, Lime stones and dolomites belong to Chitravathi group. South

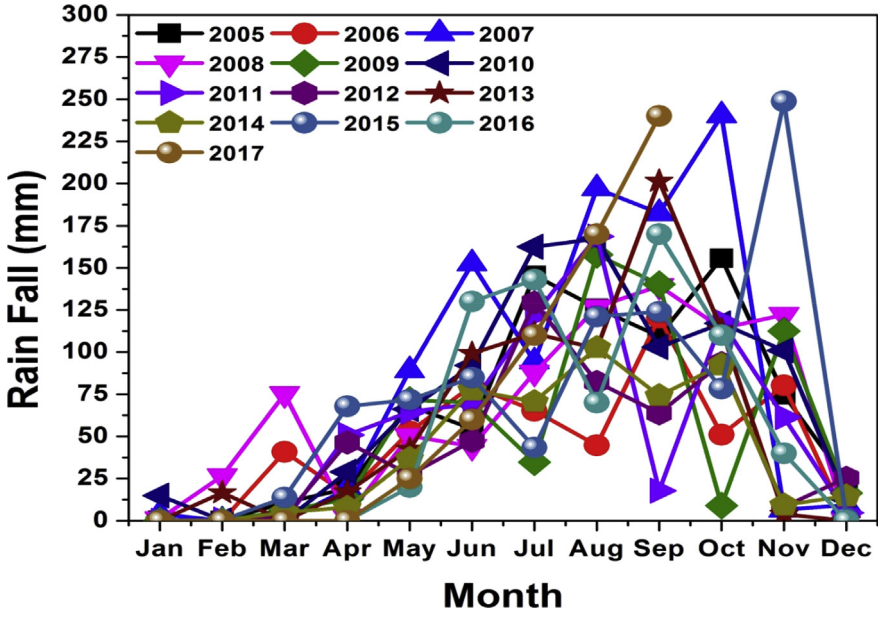

Fig. 4. Monthly average rainfall in the study area from January 2005 to September 2017.

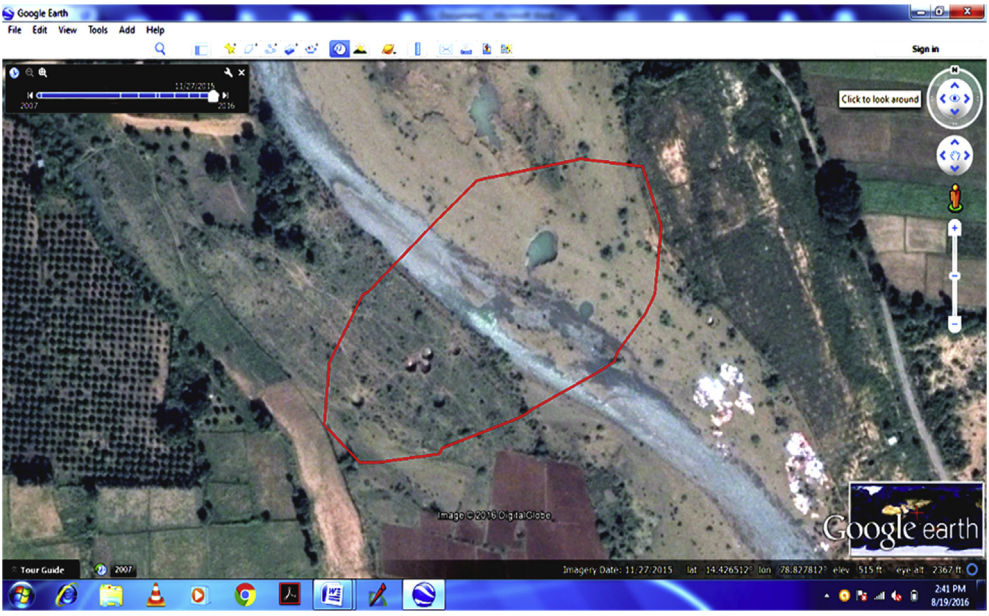

Fig. 5. Google earth historical data showing the location of sinkholes in Buggavanka River beds after the occurrence of sinkholes. (Image on 27-11-2015).

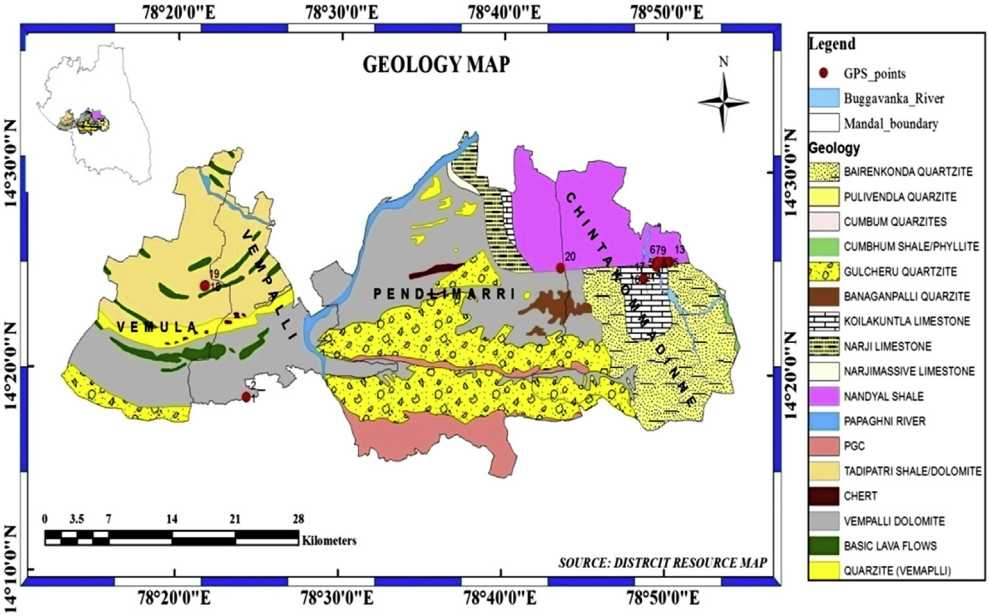

Fig. 6. Integrated geo-sinkhole map showing the various litho units and GPS locations of the sinkholes from YSR district. (red points).

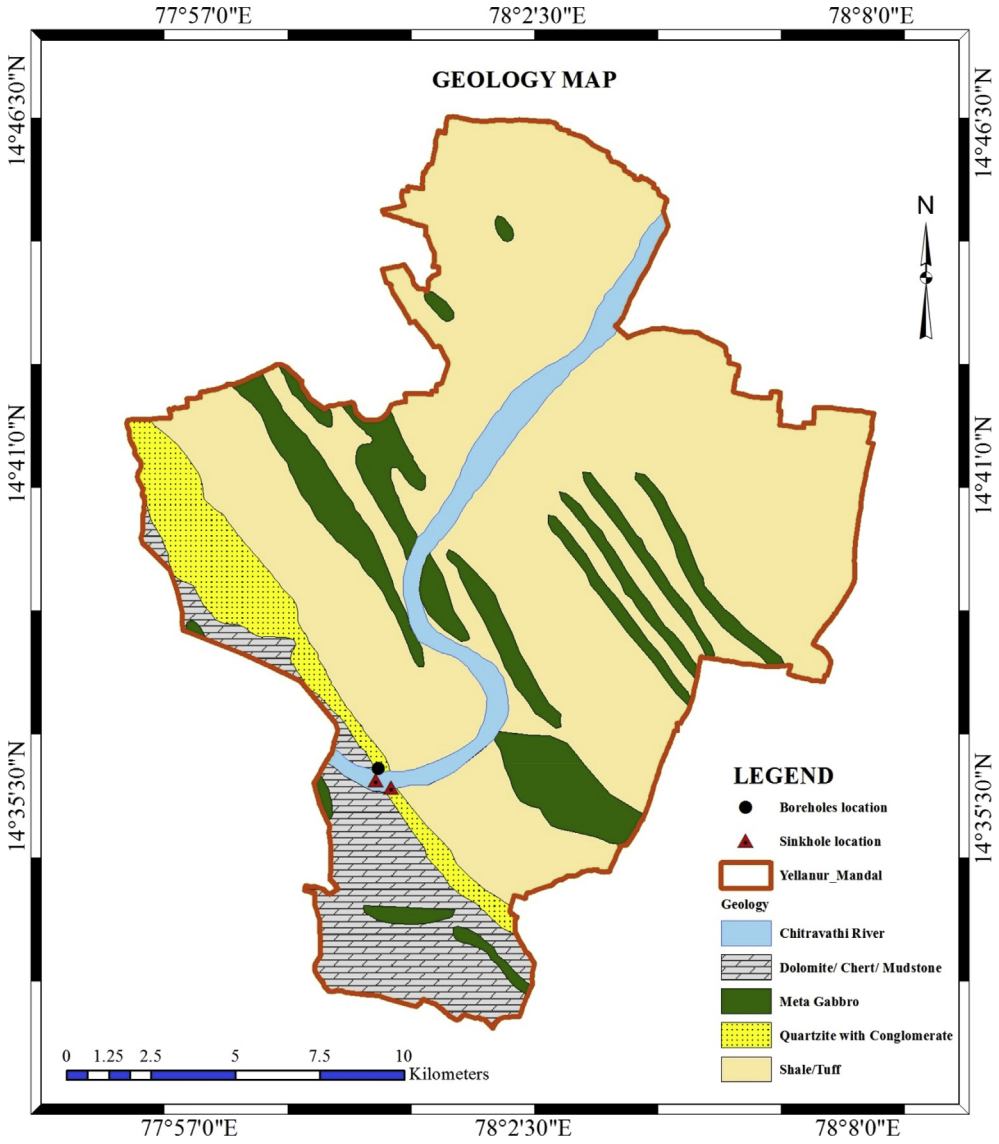

Fig. 7. Integrated geo-sinkhole map showing the various litho units and GPS locations of the sinkholes (red triangles) and Cluster of bore wells near the sinkholes (black circle) from Anantapur district.

and south western part of the study area subjected to great deformations (fractures, and joints) which resulted denudation hills and structural hills belong to dolomites and quartzite formations of Chitravathi group respectively.

2.4. Methodology

From the Review of literature it is clear that, there is a remarkable raise in investigations on sinkhole and associated damages on a global scale during the last two decades [5,6]. A comprehensive sinkhole

inventory is the primary aspect in Sinkhole hazard analysis and risk assessment. The accuracy and the consistency of sinkhole vulnerability and risk maps greatly rely on the comprehensive and truthfulness of the sinkhole inventory [7]. Hence sinkhole database shall contain the following aspects viz., exact location, magnitude and frequency relationships of sinkholes, Genetic type, Chronology, Activity, including subsidence rates, kinematical behavior (gradual, episodic or mixed) relationship with conditioning and triggering factors [8–14]. Sinkhole inventory with chronological data showed a good correlation with drought periods [15]. In this point of view, a systematic approach has been made to generate the present inventory data. Detailed field surveys carried out in the areas where the sinkholes are distributed and all the location information are collected using hand held Global Positioning System (GPS) and SOI Toposheets No: 57F/14, 57J/11 and 57J/15 on 1:50000 scale along with field information regarding geomorphology, lithology structures and groundwater availability. The collected GPS points imported to ArcGIS to prepare a sinkhole location map. These locations are compared with historic temporal data imagery prior to formation and after the formation of sinkholes in the same area as shown in the Fig. 5. These depressions are absent in the images captured before the sinkhole occurrence. Hence it is clear that these depressions resulted by the formation of sinkholes. Identified depressions are field-checked, and the thematic layers of information viz., Geology map and sinkhole location data allowed the systematic interpretation and preparation of sinkhole inventory data.

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Transparency document

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