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MAPPING OF SAND MINING AREAS USING REMOTE SENSING AND GIS: A CASE STUDY IN PARTS OF SWARNAMUKHI RIVER BED, CHITTOOR DISTRICT, ANDHRA PRADESH

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ABSTRACT

Sand is an important source engineering material and it is mainly used for construction works which is obtained from a large rock material, due to the action of different geological agents the sand is formed nearby the course of the river. In recent times there is an extensive pressure on rivers which acts as a treasure for the building sector due to rapid growth in the development activities. The main objective of the study is to investigate, recognize the areal extent of sand mining areas of Swarnamukhi River, a total of 9 major sites were identified and demarcated in parts of Srikalahasthi and Thotambedu Mandals of Chittoor District, Andhra Pradesh, by using Google earth and Arc GIS 10.4. This study is an attempt to know the utility of Google earth, Remote Sensing and GIS software tools in the field of natural resource monitoring and environmental protection. The study results areal extent concludes that there is overexploitation of sand from Thotambedu Mandal as it is near to road sites when compared to Srikalahasthi Mandal. This overexploitation of sand leads to river discharge.

INTRODUCTION

The main objective of this paper deals with sand mining and its effects on the river environment. Today sand mining is a national phenomenon because of excessive exploitation of sand from Rivers. Thus on the earth's surface natural flow of water supplied either from melting of glacier or rainfall regularly or intermittently over the crust of the earth following towards slope in a definite path channel due to gravity is generally referred to as River. Rivers always undergone a change in their shapes and alignment by continuously changing their hydrodynamic and morphodynamic processes, depending upon the slope, terrain characteristics, structural parameters, climatic variations, vegetal cover etc. with due course of time (Subrata Pan, 2013).

Sand mining is the process of removal of sand and gravel where this practice is becoming an environmental issue as the demand for a sand increase in industry and construction. In almost every mineral bearing region, soil mining and land degradation have been inseparably connected. Unscientific mining has caused degradation of land, accompanied by subsidence and consequential mine fires and disturbance of the water table leading to topographic disorder, severe ecological imbalance and damage to land use patterns in and around mining regions (Ghose *et al*., 2004; Naveen Saviour, 2012).

Advancement of information technology is contributing to top sided increase in demand for resources such as sand in River streams, which has no substitute for use as a building material in reinforced concrete cement (Hemalatha *et al*., 2005, Prasad *et al*., 2016). Mining pits, creating steeper temporary gradients, are associated with increased scour force (Mayer, 1972), which can lead to migration of the pit (Lee, 1993) and in turn, can produce scour several kilometers upstream and downstream in the area of the mining disturbance (Bull *et al*., 1974; Kondolf, 1994). Thus there is a need for regulated law bound mining activity at places where there is scope and source of this economic commodity or it may result in changes in the main channel cross-section like an increase in the width-to-depth ratio. To meet the growing demand on the way of modernization, construction materials such as sand, stone and clay are needed in large quantities (Padmalal, 2008; Leeuw *et al*., 2010). Recently the demand for construction material has increased in many parts of the world due to building complexes, private townships, flyovers, airports, metro railways, increase in highway lines and other subsequent growth in infrastructure projects (Singh *et al*., 2007; Leeuw *et al*., 2010). The construction sector across the state has been facing its worst ever sand scarcity due to supply and cost issues (Sudhir, 2016). Currently, sand extraction seriously threatened due to excessive sand mining in River channels. This calls for serious, effective and efficient regulation of sand mining (Aliyu Baba Nabegu, 2013). Illegal and excessive sand mining in the River bed of Swarnamukhi catchment area has lead to the depletion of groundwater levels and environmental degradation.

As Remote sensing is the process of acquiring information about an area from a distance without directly establishing physical contact with that area through satellite, having the ability to provide comprehensive, synoptic view of a fairly large area at regular interval with quick turn-around time integrated with Geographical Information System (GIS) techniques makes it is an appropriate and ideal for studying and monitoring River erosion and its bank line shifting. Geographic information systems (GIS) have gained increasingly widespread use in the past decade and have potential applicability to studies relating mining and floodplain land cover to channel changes (Sunitha *et al.*, 2011; Giriraj *et al.*, 2010). GIS has been referred to as an integrated package for the input, storage, analysis, and output of spatial information (Chrisman *et al.*, 1989, Sunitha *et al.*, 2014). Recently, GIS has been used in research areas where more manual techniques have traditionally dominated by environmental modeling to land use assessment (Raper *et al.*, 1991).

Therefore, the main objective of this paper is to use satellite images for sand excavations and also use of Arc GIS software for demarcation of economically viable construction material occurrences in parts of Swarnamukhi River in Srikalahasthi, Thotambedu Mandals of Chittoor District, Andhra Pradesh. This method could be developed as a technology: application of Google earth temporal data for environmental monitoring and sustainable development and to be applied in similar situations that will save our time, money and tireless efforts towards the old conventional methods of locating quarries.

Study Area

The study area is located in Srikalahasthi and Thottambedu mandals, Chittoor district and forms part of the Survey of India Top sheet Nos. 57 O/9, 57 O/10 and 57 O/13 and lies between the North latitudes 13^0 43'-13^0 482 and East longitudes 79^0 41'-79^0 45' covering an area of 24.50 km^2. Location map of the study area is shown in Figure 1. The study area is drained by the Swarnamukhi River. It is Independent River and has no major tributaries. Drainage pattern seen in this area is dendritic to sub dendritic. The study area experiences a semi-arid climate and total annual rainfall is 966.4 mm. Geologically rocks of Archaean, Proterozoic, tertiary and quaternary ages are exposed in the study area. The formations chiefly composed of a complex assemblage of gneissic variants, granitic rocks with dolerite intrusive, Nagari quartzite's, isolated laterite patches, Cuddapah formations such Bairenkonda quartzites, Pullampeta shales, slates and recent alluvium deposits. A total of 9 major sites was located by using Google earth as shown in Figure 2.

MATERIALS AND METHODS

Google Earth was used as a data source for this case study, 9 major locations were identified within the selected study area. The collected information is in the form of imagery, photographs. The maps prepared from these sources are opened in GIS software and used for locating and analyzing target area, were demarked and polygons were drawn on Google earth then these polygons were exported as kml extension file (.kml) polygons converted from .kml to layer format using Arc GIS and then exported as shape files (Prasad et al., 2016). All exported shape files were merged into a new shape file containing 9 locations. There after shape files projected to WGS_84 projection, area of each polygon, and sum of total polygons were calculated (Table 1) as 1,18,027 m^2 area and the larger parts of the sand mining were identified. GIS is a computer based powerful set of tools for collecting, storing, retrieving, mapping, analyzing, transforming and displaying spatial and non spatial data from real world for a particular set of purposes the varies for each discipline and to perform many tasks such as georeferencing, subsetting, mosaicking, clipping the boundary of the study area.

River bed sand mining locations were identified by using Google Earth imagery, based on the image elements like tone, texture, shape, size, pattern and association, etc. Generally River sand appears in tones of bright white to dull white (yellow) with medium to fine texture due to the presence of silicate minerals. Whereas the sand mined areas easily identifiable with their irregular shape, uneven tone, rugged surface. The sand excavation pits appear in dark to grey tone, coarse texture with uneven topography depending on the depth and moisture content in the area.

RESULTS AND DISCUSSION

The results of sand mining sites of 2007 were compared with to 2017. The sand mining sites were demarcated by using both Google Earth and Arc GIS software in figures 3 to 8. Due to this overexploitation of sand and river flow direction is changed shown in Figure 9.

This study is an attempt to know the utility of remote sensing and GIS software tools in the field of natural resource monitoring and environmental protection. Google Earth Satellite images can be used to provide a quantifiable monitoring and most cost effective compared to intensive field-based surveys. Out of 9 sand mining sites 4 are legal and 5 are illegal sites. S3 and S4 are larger part of illegal sand mining sites were found at Dainedu Village, Thottambedu mandal which were well connected to the roads. S7, S8 and S9 are legal sand mining sites of Chukalanidigallu and Verupakhipuram villages, Srikalahasthi mandal which were less affected due to geographic settings.

From the study concluded that in 2007 there was sand along the Swaranamukhi River bed but in 2017 there was a lot of

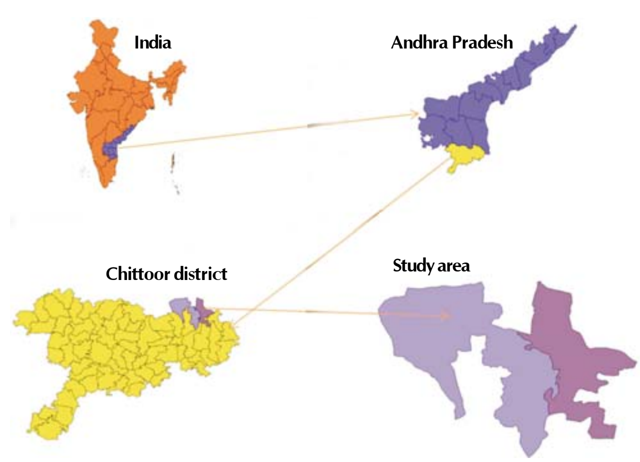

Figure 1: Location map of the study area

Table 1: Sand mining pits location information (latitude, longitude) shape area and villages

Site. No	Lattitude	Longitude	Shape area (m^2)	Village	
S1	13°48′24.90"N	79°42′12.58"E	10728	Pennala padu	Legal sites
S2	13°48′28.92"N	79°42′12.03"E	6132	Peddakanaparthi	
S3	13°50′25.44"N	79°44′10.28"E	35883	Dainedu	Illegal sites
S4	13°50′28.30"N	79°44′13.96"E	20050	Dainedu	
S5	13°50′17.28"N	79°45′19.31"E	4033	Kalavakur	Illegal sites
S6	13°50′17.56"N	79°45′25.19"E	4725	Kalavakur	
S7	13°44′11.25"N	79°41′21.26"E	10121	Chukalanidigallu	Legal sites
S8	13°43′35.92"N	79°41′35.35"E	16194	Chukalanidigallu	
S9	13°47′53.65"N	79°42′10.54"E	10161	Verupakhipuram	
Total area	118027				

Figure 2: Sand mining site (S1 to S9) locations of the study area

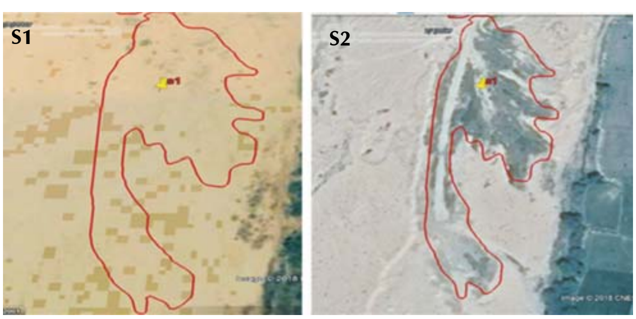

Figure 3: Sand mine pits from Site 1 showing temporal variation between 2007 (left) and 2017 (right)

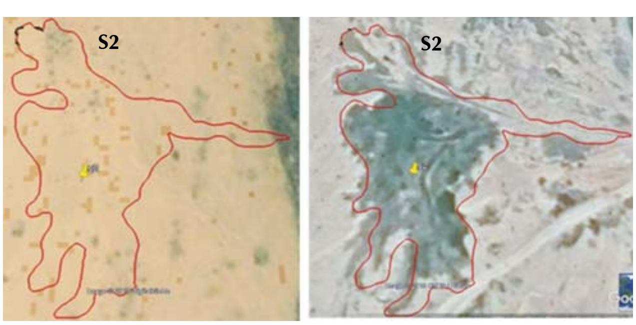

Figure 4: Sand mine pits from Site 2 showing temporal variation between 2007 (left) and 2017 (right)

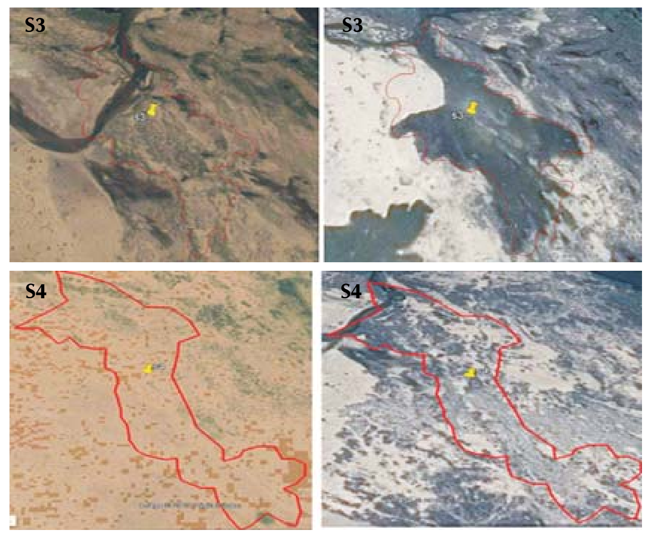

Figure 5: Sand mine pits from site 3 and 4 showing temporal variation between 2007 (left) and 2017 (right)

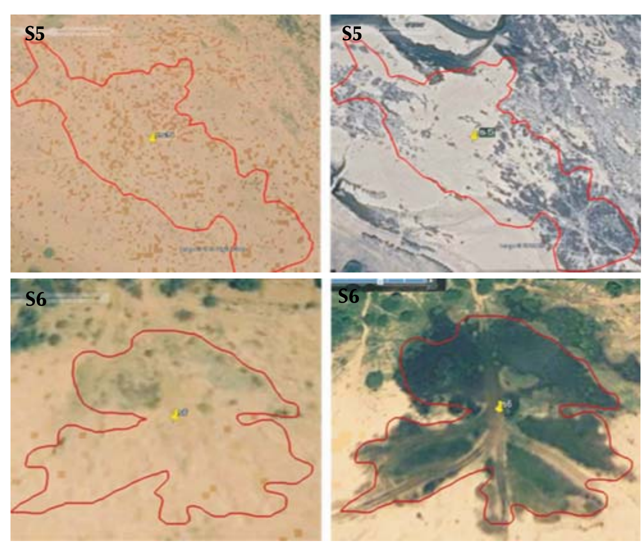

Figure 6: Sand mine pits from Site 5 to 6 showing temporal variation between 2007 (left) and 2017 (right)

changes in river bed because the sand has been excavated from the sites for the usage of various purposes and some sand might be affected due to natural effects. Rivers being common property have several tangible and non-tangible benefits to different stakeholders, monitoring thus cannot happen without taking into account these stakeholders. Awareness programs to be brought up in public domain about the value of River sand and its importance in groundwater recharge to strengthen monitoring and checking violations. This could become part of the environment management plan

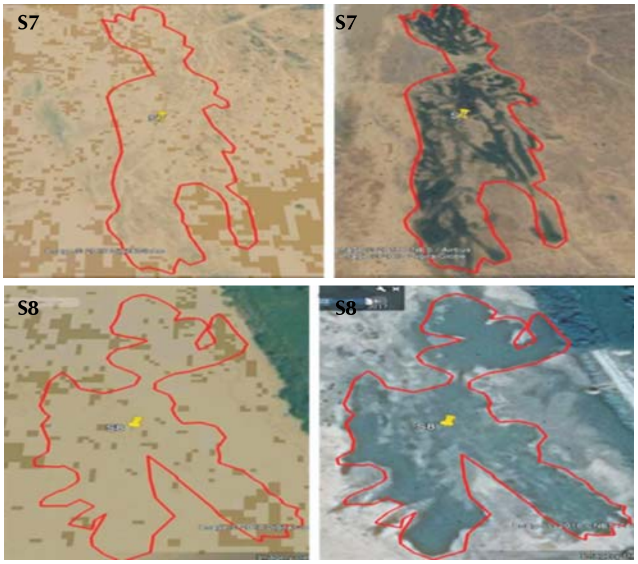

Figure 7: Sand mine pits from Site 7 to 8 showing temporal variation between 2007 (left) and 2017 (right)

Figure 8: Sand mine pits from site 9 showing temporal variation between 2007 (left) and 2017 (right)

Figure 9: Diagram of change of river flow direction

itself. Slag sand manufactured sand are good substitutes for River sand, and they will minimize the usage of River bed sand.

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