Creation and Harmonization of Village Boundaries using GIS Techniques

Nidhi Kundu[1], Ajeet Singh[2] and R. S. Hooda[3]

[1]Nidhi Kundu, HARSAC, CCS, HAU, Campus, Hisar
nidhi.ghanghas@gmail.com

[2]Ajeet Singh, HARSAC, CCS, HAU, Campus, Hisar
ajeetharsac@rediffmail.com

[3]R.S.Hooda, HARSAC, CCS, HAU, Campus, Hisar
hooda.rs@gmail.com

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ABSTRACT- Village boundary is the basic unit of any administrative entity. The requirement of precise village boundaries in India has long been felt for decentralized planning at Panchayat level. But no state or national organization have been able to provide the village boundaries with acceptable accuracy. Some organizations like Survey of India (SOI), Census Department and National Informatics Centre (NIC) have attempted to create village boundaries, but there are a lot of variations among the boundaries from different sources. The present paper attempts to describe the use of GIS and high resolution satellite data in the creation of digital village boundary dataset that can be extended to construct block, tehsil, sub-division, district, division and finally the state boundaries. District Jhajjar, Haryana was selected for the pilot study. The methodology involved multi-step and multi-verification approach to ensure completeness and authenticity of the boundaries. As a first step digitization of Village boundaries was attempted from Ortho-Rectified Cartosat-1 Data (2.5 Meter Resolution). As consolidation has been done in Haryana and rectangular fields (9:10) have been created, the village boundaries cutting across these rectangular fields are discernible on very high resolution satellite image at many places. These village boundaries were digitized from ortho-rectified cartosat-1 data. However, at many places these boundaries were not clear. Therefore, as a step two the village boundaries were generated using digitized cadastral data of the state. Cadastral data was corrected for topological errors such as gaps and overlaps and codes were assigned so that all boundaries could be derived by a single database. By dissolving cadastral data of the villages on New Village (NV) codes created by NIC for the Revenue Data, village boundaries were created. The village boundaries created by this method were tested for accuracy on high resolution satellite data. All the Village Boundaries of Jhajjar district were created using this method and boundaries prepared by SOI were converted To KML file and overlaid on the on Google Earth data for checking accuracy. Our boundaries perfectly followed the village boundaries on the satellite data wherever discernible, whereas the SOI boundaries were quite off. This amply proved the accuracy of our boundaries.

I. INTRODUCTION

Village boundary is a well defined line that is drawn on a plan around a village, which includes the built up area and the land belonging to that village. Village boundary is a widely utilized planning tool for guiding, controlling and identifying limits to development for an individual village. In India the village boundary also forms the basic unit of any administrative entity like block, taluka, district or state. Due to its importance in decentralized planning at Panchayat level, the requirement of creating precise village boundaries in India has long been felt. The objective of this study was to harmonize political and administrative boundaries of Jhajjar, using geo- spatial technology and public consultation in order to address the numerous disputes that exist. Specifically, the study was carried out to analyze various sets of existing administrative boundaries in the area of study by identifying all existing gaps and overlaps and rectifying various conflicts that exists in different data sets and providing a boundary that is acceptable to all. The harmonized data sets were achieved through first putting the various datasets from NIC, Census and Cadastral data on the same Spatial Reference System and comparing them

in order to identify and rectify them using various geospatial operations. The result was a single harmonized layer for village boundaries of Jhajjar for the study area which contained attributes showing the cause of differences between various data sets**.** The study worked on a hypothesis that if the village boundaries that are basic to any administrative boundary adopted by the various Government and Public organizations will be a single harmonized data set, the emerging issues on boundary disputes between Tehsils, Districts and State boundaries would not occur. For this study village boundaries derived from cadastral data was compared with already existing data sets of SOI and Census and were found to be more accurate than both data sets.

II. GEO-INFORMATICS

Geo-Informatics has been described as a science which develops and uses infrastructure to address the problems of geo-sciences & related branches of engineering. Geo-informatics combines geospatial analysis and modeling for development of geospatial databases, information system design, human computer interaction and both wired & wireless networking technologies. To create village boundaries that are

Application of Geo-informatics in Harmonisation of village boundaries:

Creation of village boundaries using Cadastral maps and geo-informatics acutely rely on mathematical, technological and scientific discipline for sensing, modeling, representing, visualizing, monitoring, processing, and communicating in all fields of Cadastral mapping that are straightly related to Geo-informatics. High resolution satellite imagery and GIS maps in support of cadastral maps provides the foundation for subsequent mapping projects . accurate Geo-Informatics was used as a tool to ensure the correctness of data sets of village boundaries. Village boundaries were created using Arcmap and were compared to existing data sets of SOI and were verified finally on google earth. The first task was to overlay the various spatial datasets involved in the alignment and put them into a common Spatial Reference System. Cleaning and removal of unnecessary geometries and matching the corresponding objects in the datasets was also done in order to compare various data sets used for the study.

III. OBJECTIVE

The present study has been undertaken with the following objectives.

- To Create accurate village boundaries of Haryana using cadastral data for planning purpose.
- To create Tehsil, Block and District boundaries of Haryana from village boundaries.
- Harmonization of village boundaries with SOI and other data sets for different districts.
- Creating an output report of differences between different set of boundaries.
- Providing a methodology to resolve the issues in different boundaries.

IV. STUDY AREA

Jhajjar district is situated in the southern most part of the state Haryana bordering Rajasthan. The location of these study areas is shown in Figure 1. Carved out of Rohtak district it came into existence on July 15, 1997. It lies between 28°22’ – 28°49’ north latitudes and 76°18’ -76°59’ east longitudes. Total geographical area of the district is 1834 sq.km. It is surrounded by Rohtak district on the North, Jhajjar and Gurgaon districts in the South,

the National Capital Delhi in the East and Bhiwani district in the West. The area forms a part of Indo-Ganga alluvial plain. The climate of district Jhajjar is considered to be a local steppe climate. Jhajjar experiences extreme temperature ranges from 2° C to 47° C with severe cold in months of December & January and the months of May & June are of bitter summer. Jhajjar is a perfect study area because it addresses problems that exists with state boundaries as well as District Boundaries. Due to its proximity to Delhi, it has both rural and urban areas set up.Jhajjar has considerable number of unconsolidated villages so the correctness of boundaries was also checkedfor unconsolidated villages.

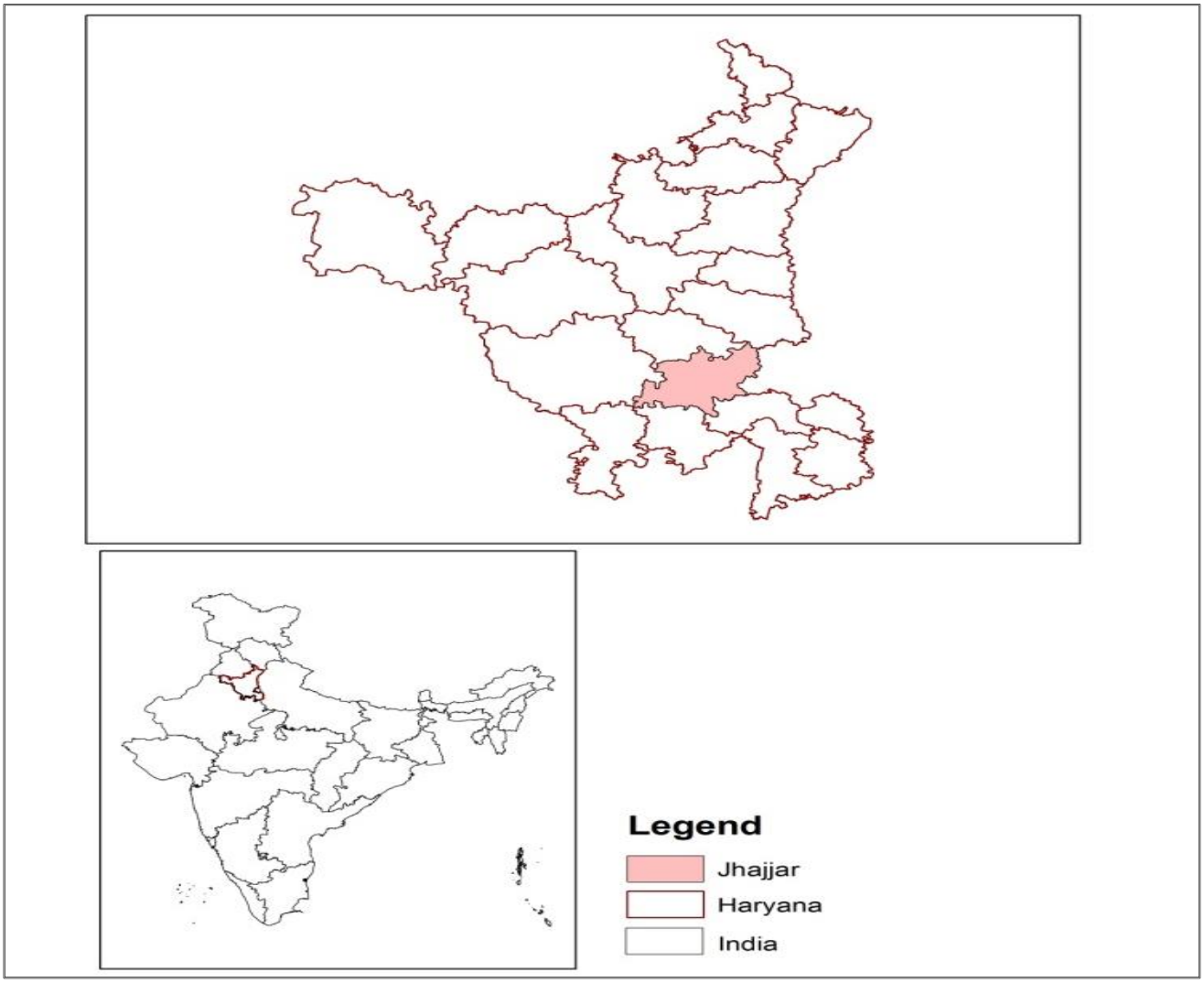

Figure 1: Location of Study Area

Conventional inputs used for the project:

Spatial data used

- Existing maps SOI, Census, Cadastral maps
- Cadastral Map: The Mussavies of the study areas were collected from District Revenue Office and used to generate cadastral plan metric vector data. These maps were georeferenced and overlaid on the satellite imagery for further analysis.
- ArcGIS online satellite imagery
- Google earth satellite imagery
- Village cadastral maps in hard copy with survey numbers.

- SOI layers for village boundaries
- SIS DP Vector for District Jhajjar
- Ortho-Rectified Cartosat-1 Data (2.5 Meter Resolution) satellite image.

Non Spatial data used

- Statistical data from the Census
- List of villages from Revenue Department
- List of villages from LGD Directory

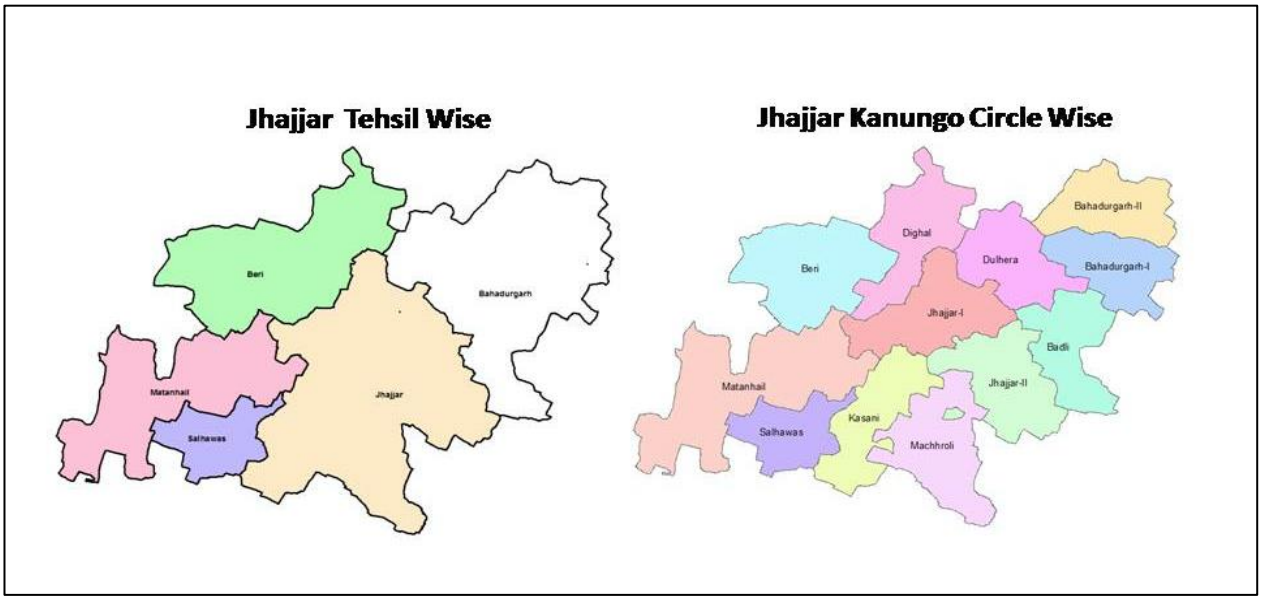

Figure 2 : Tehsil and Kanungo Circle(Jhajjar)

V. Methods and Materials

For the study the following major steps were adopted.

- Collection of High Resolution Satellite imagery Cartosat I and Survey of India data was done to start the study.
- Mosaicing of satellite data in ERDAS 9.1 software was done as a second step.
- The village maps procured from Land Records Department (LRD) for each tehsil of Jhajjar were traced.
- Digitization Of village boundaries from Ortho-Rectified Cartosat-1 Data (2.5 Meter Resolution).
- However, problem occurred because at many places village boundaries were not clear. In order to overcome this issue village boundaries were shaped using cadastral data. The village boundaries created by this method were tested for accuracy on satellite data.
- Digitization of cadastral maps started under SISDP in the state and village boundaries were also generated using cadastral data.
- After creation of village boundaries from cadastral data it was corrected for topological errors and seamless data is generated.
- A standard template is used to have uniformity in layers; all the fields were defined in advance. All the villages were digitized and layers were created by dissolving the data on NV codes.

- HARSAC and SOI boundaries were overlaid with satellite images.
- Common reference system was set for both boundaries.
- HARSAC and SOI village boundaries were lastly tested on satellite data.
- List of villages from revenue department is utilized for verification.
- Major gaps and overlaps were identified and these required to be aligned. These gaps were resolved one by one manually in the appropriate manner
- The result of all these was a harmonized boundary for the study area.

VI. VILLAGE BOUNDARY ASSESSMENT

Village boundary assessment is carried out following a sequence where inherent difference of SOI old / new data with Cadastral data was done.For district boundary SOI new data is correct for Rohtak and Sonipat side of Jhajjar and Old data is correct for Rewari side of Jhajjar. Although both the data sets of SOI has major difference with cadastral boundaries. Figure 3 shows the three boundaries that have been utilized in the study. The difference between various data sets was studied and issues were checked for accuracy from various agencies.

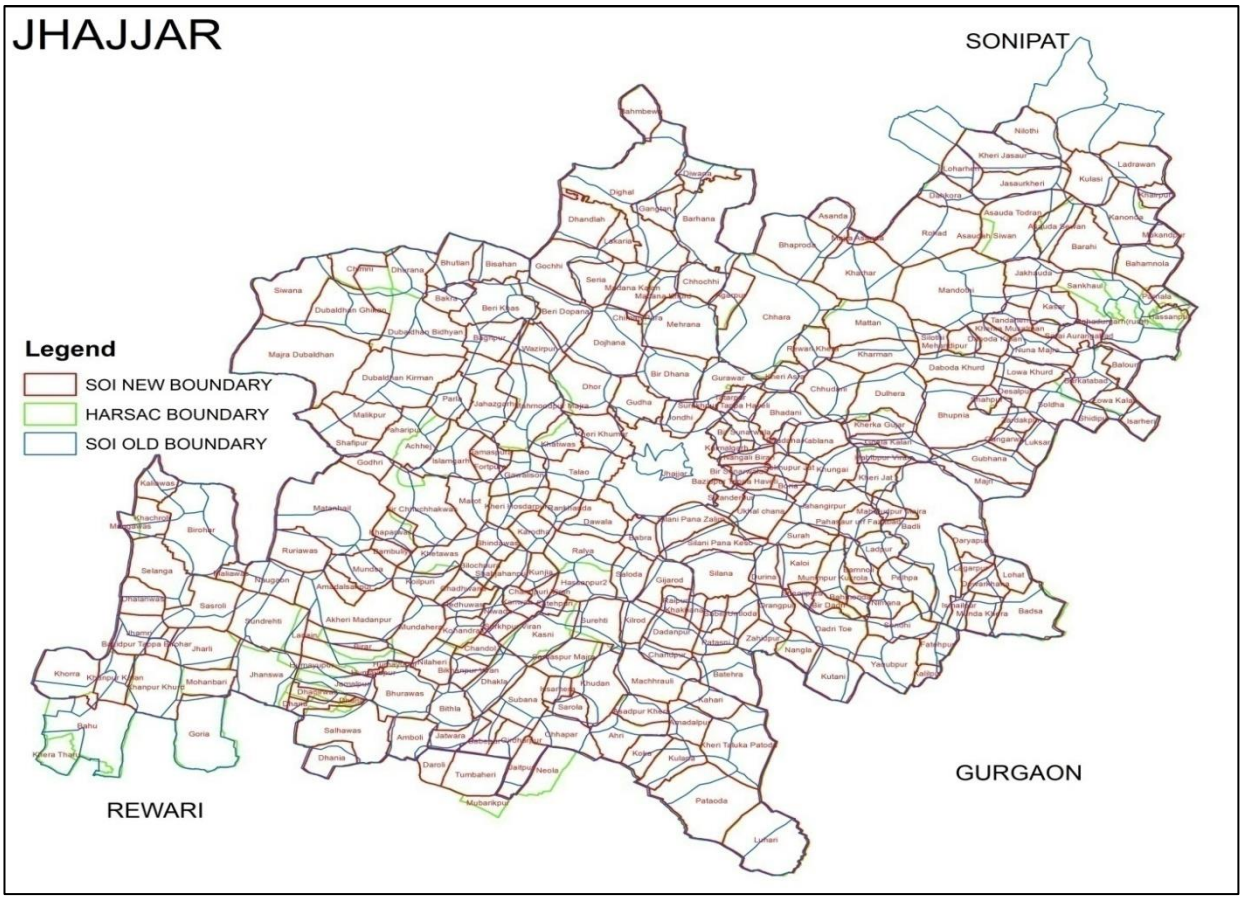

Figure 3: SOI Datasets with HARSAC Datasets

The major differences were catalogued are as follows.

- Mismatch in boundaries of Districts in two boundaries.
- Mismatch in no of Tehsils in both data sets.
- Mismatch in village boundaries in both data sets.
- Mismatch in total no of villages in both data sets.
- Mismatch in names of villages in both data sets.
- Mismatch in area of villages in both data sets.

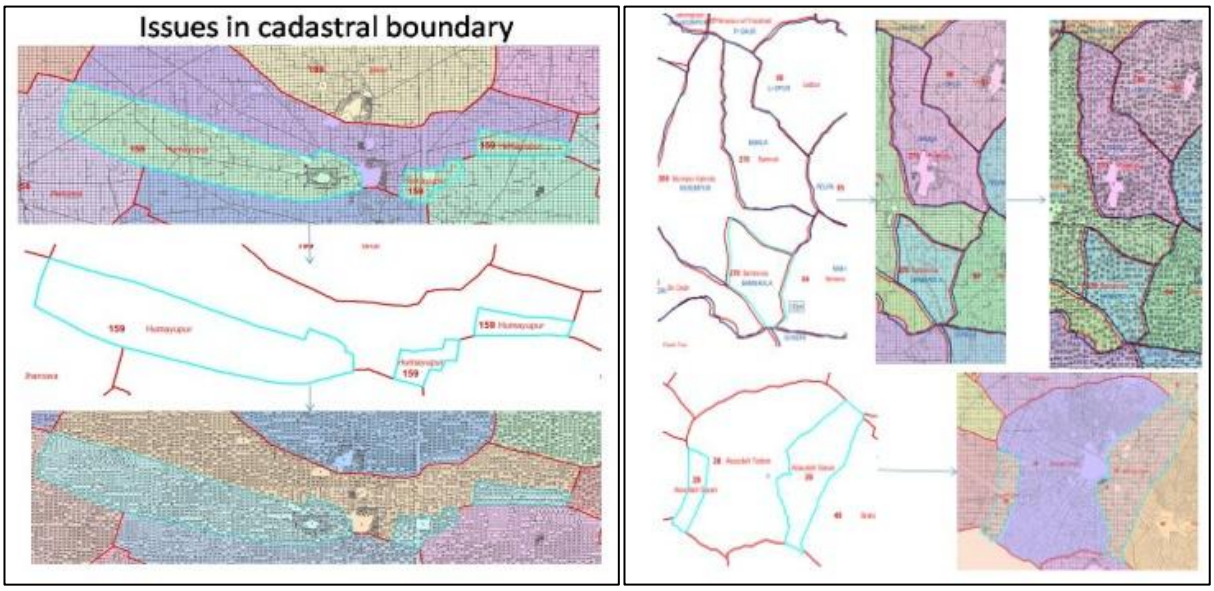

Figure 4: Conflicts in Cadastral Data

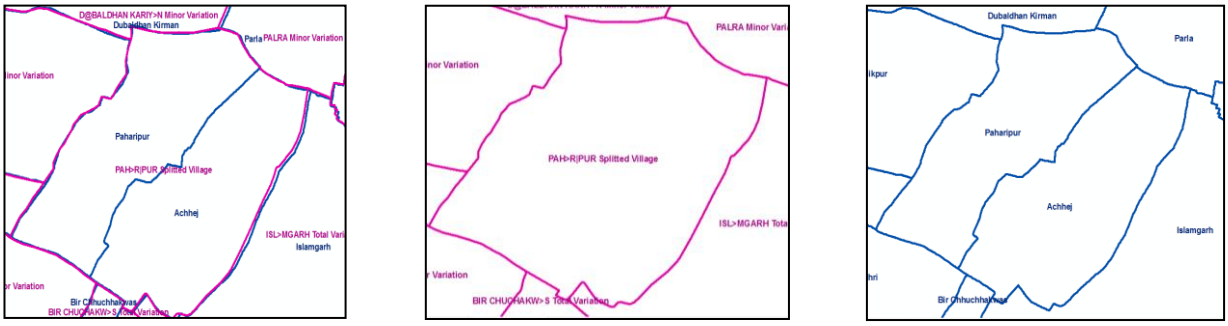

Figure 5: Conflicts in SOI data

All the conflicts were taken in account to create a harmonized village boundary that was acceptable to all. The final decision was taken that boundaries derived from cadastral data will be considered as final as their accuracy was the maximum.

VII. Result and Statistics

This study introduces an integrated approach of harmonizing village boundaries from a variety of data sets. All data sets had different kind of conflicts. Major difference between different datasets was the no of villages. Number of villages in the SOI boundary was 254 in new data. As per tehsildar there were 264 cadastral villages in Jhajjar.NIC jamabandi website was showing 266 villages in Jhajjar and as per LG directory (DD) that was updated on April 3, 2017 there were 271 villages. Revenue department list was considered final and SOI data was compared with that list. It was noticed that Bahu, Goria, Khera Tharu, Mubarikpur, Neola are not in SOI village boundary for Jhajjar.Second variation was in name of spellings of various villages. When SOI village names were compared with LG directory/Cadastral data it was deduced SOI 127 village names had special characters for eg. N@N>M>JRA, KH>T|W>S .104 major differences were in spellings, Untloda in LG directory was Untlodha in HARSAC Boundary.

Village boundaries were compared in terms of spelling in village name, spatial location of villages, area mismatch, splitted villages(village that has two parts).Figure

Conflicts	Conflict description	No of villages	Conflicts	Conflict description	No of villages
Name-128	Spelling mistake	102	Shape-55	Splitted villages	9
	Name differs	22		Major variation	17
	Location differs	2		Total variation in shape	29
Area-41	Area difference 5%-15%	13	Area-41	Area difference 55%-65%	2
	Area difference 15%-25%	12		Area difference 65%-75%	1
	Area difference 25%-35%	5		Area difference 75%-85%	2
	Area difference 35%-45%	1		Area difference 85%-95%	1
	Area difference 45%-55%	2		Area difference >95%	2
Missing villages-14	Splitted villages	9		Out of district Boundary in SOI data	5

Figure 6: Jhajjar Statistics

Figure 7 shows conflicts between two sets of boundaries of Jhajjar district.All the villages were categorized in Minor variation, Major variation, Splitted villages,Total variation and village missing in SOI boundary. Minor variation was used for the villages where there two boundaries matched with acceptable level of accuracy. Where the village boundaries have differences more than acceptable level of accuracy the villages were categorized as Major Difference. Boundaries that were totally different were categorized as Total variation. Some villages in SOI data set has more than one cadastral villages. Those villages were categorized as Splitted villages. Some villages were outside the district boundary for Jhajjar in SOI data sets. Cadastral boundaries when checked for accuracy on google earth were found more accurate than SOI boundaries.

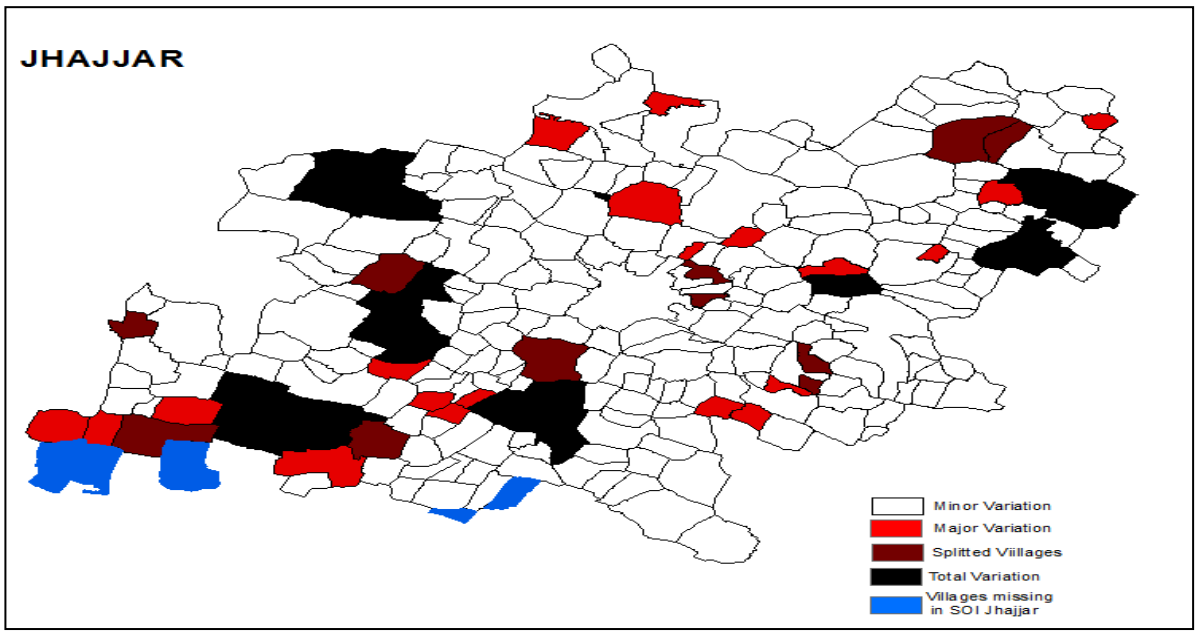

Figure 7: Jhajjar Conflicts

VIII. CONCLUSION

- Village boundaries are a well utilized planning tool for guiding, controlling and identifying limits to development for an individual village. Village boundaries also need to be contiguous. In this study harmonization of village boundaries is carried out using high resolution satellite data and available cadastral data. Slight changes in boundaries from different sources were deduced. Cadastral based boundaries match signatures on satellite data more accurately and appear to be more accurate.
- Village names in cadastral data matches LG directory more than any other list.
- Cadastral data is digitized on 2640 scale and geo-referenced on 10,000 while SOI data is on 22,000 scale. Hence cadastral based boundaries appear to be more accurate.
- Splitted villages are in both layers but in cadastral murraba no are in continuation of other part whereas no such continuation exists in SOI. That clearly shows cadastral boundaries are more accurate.

IX. LIMITATIONS

- Unavailability of data, Cadastral data of some area is not at all available. Panchkula District in Haryana where cadastral maps are not available for almost the entire district.
- Creating village boundaries of unconsolidated villages has some accuracy issues.
- Places where signature of village's boundaries is not available may have less accuracy.

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