A VIABLE APPROACH TO
ESTABLISH CONCLUSIVE LAND TITLE IN INDIA

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ABSTRACT:

The system of Indian land record management, largely a legacy of Moghul era, is characterized by extraordinary volumes, complex procedures and poor updatation of records. Transactional simplicity is compromised due to the co-existence of two concurrent systems of ‘Land Records’ (or ‘Record of Rights’) and land (deed) ‘Registration’. The crux of the problem is that neither of these two distinct systems, completely, comprehensively and definitively establishes the title.

The pilot experiment conducted in Gurugram district in the state of Haryana, has provided a viable model to reform the system of land records by repositioning the current system of cadastral maps (known as Musavis) through adoption of geospatial technologies on the basis of well-established real-world coordinates.

Often, imageries are incorrectly assumed as direct equivalent of maps. Migration to a unified, comprehensive, cost-effective and up-to-date system to record rights requires mapping of the cadastral maps to geo-referenced points. A methodology using the principle of Geodetic Triangulation has been evolved to correlate the legacy system to the new technology platform with a very high degree of accuracy that has been observed for individual land parcels, thereby providing a durable approach to land reforms.

KEY WORDS:

Cadastral, Geodetic Triangulation, Land reform, Land registration, Record of Rights, Geospatial technologies
THE CHALLENGE:

The land revenue management system in India is largely a legacy of Mogul era. This system with records handed down from many generations is characterized by sheer volume, complex procedures that involve processing and poor updation of record. In the Indian context, one should appreciate that it is not just a straightforward issue of registering ‘titles’ versus ‘deeds’. The crux of the problem is that neither of the two distinct systems, namely the deeds registration system and the land record management system completely, comprehensively and definitively establishes record of rights.

To further explain, the record of rights is relevant to agricultural land. It has a spatial framework that is weak and most often not updated. The deeds registration system is intended to place on public record transactions with land in all areas but does not apply to certain matters affecting land ownership such as inheritance, transfers by operation of law, court decrees, etc., although these matters can be recorded in the record of rights. This system is not map based and there are poor descriptions of property. Thus the system can be described as one that predominantly ensures the correct identification of the parties to a deed, but does little to facilitate exact identification and location of the land parcel.

The co-existence of the ‘Land Records’ and system of ‘Registration’, which is a public record, results in a sub-optimal approach that involves duplication of effort, imposes unnecessary costs and compromises on transactional simplicity. A land transaction needs to be registered under the Registration Act, 1908 and must also be recorded in the record of rights in the case of agricultural land. This is also true in case of property records of urban land for which a city survey plan exists. But certain transactions may be entered just in the Registration record but not in record of rights. Any party interested in entering into a transaction for a land parcel usually search a combination of systems and satisfy themselves of the genuineness of the pedigree which is done only with expert help.

If a reasonable target of establishing conclusive titles were to be adopted, a high resolution geo-referenced map of all land parcels becomes indispensible. Imageries have been often synonymously but wrongly used as maps. Establishing co-ordinates is central to conversion of imageries into maps. The cadastral maps prepared during Mogul era had their own reference points called sehadda (junction of two villages) and tehadda (junction of three villages). Over a period, these physical reference points (on ground) were
gradually lost and hence relegated these maps into simply pictures. Thus precise demarcation became
tougher and litigations became a routine matter.

Any attempt to reposition the present system without refining the legacy data can lead to 'garbage in -
garbage out' scenario that may not yield a durable solution to the problem. Added to this, a very small
portion of records is in public domain and a high degree of information asymmetry subsists in these
records which also need to be addressed in the transformational process.

LEGACY:

Land Records in India have evolved over centuries as land was the main source of revenue generation for
erstwhile Indian kingdoms including the British rule. The present form of preparation and maintenance of
Land Records in the northern parts of the country originated during Mughal period. "Land Records" is by
itself a very generic expression that includes records such as, the register of lands, Records of Right
(RoR), tenancy and crop inspection register, mutation register, disputed cases register, etc. It can also
include geological information regarding the shape, size, soil-type of the land and economic information
related to irrigation and crops.

Revenue record (Jamabandi) is such a register in which the detail of Village landowners and cultivators
and land revenues is given. This register is prepared afresh, every five years and contains the mutations or
changes occurring in the rights of land due to sale, mortgage, inheritance, etc. These are usually kept in
public meetings at the local level for finalization so that there is an opportunity to make representations in
the case of errors or inconsistencies.

The co-existence of the ‘Land Records’ and system of ‘Registration’ of the ‘deeds’ related to a land
transaction (which is a public record), has resulted in a sub-optimal approach that involves duplication of
effort, imposes unnecessary costs and compromises on transactional simplicity. A land transaction needs
to be registered under the Registration Act, 1908 and must also be recorded in the record of rights in the
case of agricultural land. This is also true in case of property records of urban land for which a city survey
plan exists. But certain transactions may be entered just in the Registration record but not in record of
rights.
Any party interested in entering into a transaction for a land parcel usually search a combination of systems and satisfy themselves of the genuineness of the pedigree which is done only with expert help. Consequently, it has become very difficult for a common man to understand their land rights as there is lack of transparency on the absolute nature of land records. This situation has given rise to undesirable side effects such as manipulation of records, corruption and large scale and litigations. Consequently, maintenance of land records and easy access to land information is one of the most important issues facing governance.

The basis of Land Revenue Management system established by Moguls was a set of cadastral maps (Musavis) referenced by co-ordinates called sehadda and tehadda (i.e. village bi-junctions and tri-junctions). Hardly any interventions were attempted till early 20th century when the British regime initiated the ‘Survey of India’, a pioneering effort carried out during the period 1908-1913. Even to this day, the 35 ground ‘control points’ established during this survey serve as precision coordinates for Haryana state’s land area spanning 44,212 sq. km. Subsequently, the number of cadastral maps has increased to 65,000 and drawn on a scale of 1:2,640.

If a reasonable target of establishing conclusive titles is to be adopted, a ultra-high resolution geo-referenced map of all land parcels becomes indispensable. Imageries have been often synonymously but wrongly used as maps. Establishing co-ordinates is central to conversion of imageries into maps. Over a period of time these physical bi-junction and tri-junction reference points (on ground) were gradually lost and hence relegated these maps into simply pictures, seriously impacting precise demarcation.

This transformational experiment was dovetailed to another project named ‘Udaan’ (a term in Hindi language meaning ‘flight’), that involved collection of GIS data using UAV (Unmanned Ariel Vehicles). The data collected in Udaan was done after surmounting numerous regulatory and security issues related to the use of UAVs. The GIS data collected is both comprehensive and has a very high resolution that is indispensable in the urban context.

With the eventual objective of adopting the “Torrens System”, an acknowledged international practice that guarantees conclusive land titles, the Gurugram District Administration embarked on the phased implementation of a transformational initiative for adoption of a new technology enabled system for land
records management. This aims at creating a high-resolution imagery with a resolution of five (5) centimetres and conversion of these imageries into maps. Each of the land parcels in the pilot set-up in the Tehsil (sub-district) of Manesar was geo-referenced with legacy data using the principles of Geodetic Triangulation with a high degree of accuracy.

This data can serve as a sustainable ‘base’ when a land transaction is executed. In the process it is expected that land registration system would converge with that of land records, thereby leading the emergence of a unified model, the Patwari (land records officer) makes the entry in the mutation accordingly and records the details in remarks column with red ink. After five years, when a revenue record is prepared again then the entry of the changes is made in the new revenue record at appropriate place by the Patwari who is further responsible for preparing the same after every 5 years.

The new revenue record i.e. the one prepared after every 5 years for a particular Village is to be submitted in the Tehsil office of Tehsil up to seventh of September. Prior to this, the Girdawar / Kanoongo is supposed to read out these entries in a general public meeting of the Village whose record is being prepared and then after final verification and inspection for the same is done by the area revenue officers. One copy of the new Jamabandi record remains with the Patwari and he executes his work using the same. The preparation of the new Jamabandi for a Village (i.e. the one that is prepared after 5 years) is initiated by 15th of June in the 5th year. Decision of all mutation entries till 15th June are implemented in the new Jamabandi record.

**CURRENT STATUS:**

Haryana is one of the smallest states in India with 4.4 million hectares of land forming only 1.34 per cent of the total geographical area of the country. Nearly 80 per cent of the total geographical area of the state is under cultivation of which about 84 per cent is irrigated with cropping intensity of 184 per cent.

The Haryana state is one of the leading agrarian states in India. Earlier it was part of Punjab state. Agriculture is the leading occupation for the residents of the state, the flat arable land irrigated by submersible pumps and extensive canal system. Haryana has been known as being the cradle of agriculture. Haryana is also one of the wealthier states. Haryana from being a food deficit state in 1966, at the time of its inception, has now emerged as the second largest contributor to the national pool of food grains.
Right from the time of Manu the land revenue has been a major source of income of the sovereign. A historical analysis suggests that tax on land played a pivotal role in the evolution and maintenance of the system of governance. During Moryan and Gupta period, the paid officials collected the revenue. Later during the rule of sultanates that extended for more than 300 years, jagirdars, kings, inamdars, subedars etc. were made the intermediaries who passed on the revenue to the kings.

Attempts to reform the system were first time made by Dewan Todar Mal during the regime of Sher Shah Suri whereby land was categorised, measured and a schedule of crop rates fixed. Thus, Todar Mal had gained priceless experience in the management of land and revenue. And it was continued and improved upon under the reign of the Mughal Emperor Akbar. Dewan Todar Mal was appointed as the Finance Minister and he is remembered to this day for evolving a system of revenue assessment and survey. His biggest contribution was the overhauling of the revenue system and it was the beginning of systematic efforts to manage the land. Each tract of land was divided into revenue circles. A new system of revenue known as ‘Zabt’ was introduced to take care of the crop yields and their prices estimation. On the basis of this the tax was fixed on each crop in cash. He aimed at securing to the peasant the power of enjoying his property and profiting by the fruit of his labour.

Under the various pre-British regimes, land revenue collected by the state and the state was the sole owner of the land. The land administration centred on collection of taxes/land revenue. When the British came into power in North-Western Province, a new province of Punjab was formed out of it in 1849. So the British Empire decided to assess the land revenue and to decide who shall pay the sum so assessed, so in technical language it was called settlement. Some summary settlements were held. Efforts were made to frame a record of rights for all right holders such as owner, tenant, lessee, mortgagee etc. The lists (Khewats / Khatauni) of each revenue estate were drawn up along with nature of rights and the amount of rate of revenue for which they were liable to pay to the state. The revenue management was the worst in those days. The work in those summary settlements was done in haste by some young officers who have no past experience of settlement. So these settlements were very rough. In some of the early settlements neither the fields’ survey maps were prepared nor was trustworthy record of rights (ROR) framed. No attempts were made to measure the fields and not even a rough sketch of Khewats was prepared.

For the first time some of the districts of present Haryana were put under summary settlement just before or after the first war of independence of 1857. The work of settlement was held in many districts of Haryana. Towards the close of this period statistics of ploughs, wells, irrigation and other matters which throw some light on the condition of each revenue circle were taken in consideration. The second phase of settlement started in 1863. The third phase of regular settlement roughly started in 1871 and stretched up
to 1879. Sir James Lyall was settlement commissioner and later on, he was appointed as Financial Commissioner. Sir James Fitz and James Stephen both were legal members of the council that framed the first Land Revenue Act of 1871. Some steps were taken to achieve a high degree of efficiency in this period.

Haryana cadastral map sheet has been divided into uniform grids of acres. Each acre is called a killa and it has a dimension of 40 Karam x 36 Karam and length of each karam is 5.5 feet. The lowest unit of measurement is karam and killa grid of 25 acre is called a Muraba. This system of dividing the land into uniform grids helped in eliminating any major error in measurement of killas.

Modernization of land records (including digitization of Mussavi), its linkage with Record of Rights and management of old revenue documents aimed at imparting the services related to land records and monitor revenue administration in order to improve the revenue administration.

For every village, there are cadastral maps having parcels of land (popularly known as Khasra), which form the basic record of revenue administration. After linking of the cadastral map with textual data, the citizen can be provided with the services e.g. ROR with plot map (parcel map), showing dimensions of each side, area & the adjoining plots and Textual ROR data updation in sync with spatial data updation.

Revenue record (Jamabandi) is such a register in which the detail of Village landowners and cultivators and land revenues is recorded. This registers prepared, fresh, after every five years. Whatever changes occur in the rights of land owners due to sale, mortgage, ancestral will, the land record officer (Patwari) makes the entry in the mutation accordingly and mentions the details in the remarks column with red ink. After five years, when a revenue record is prepared again then the entry of the changes is made in the new revenue record at appropriate place by the Patwari who is entrusted with the responsibility for preparing it after every 5 years and submitted to the Tehsil office.

Prior to this, the Girdawar / Kanungo is to read out these entries in a general public meeting of the Village whose record is being prepared and then after final verification and inspection for the same is done by the area revenue officers. One copy of the new Jamabandi record remains with the Patwari and he then executes his work using the same. The preparation of the new Jamabandi for a Village (i.e. the one that is prepared every 5 years) is initiated by 15th of June in the 5th year and the decisions of all mutation entries until 15th June are implemented in the new Jamabandi record.
SIGNIFICANCE OF THE STUDY:

Land records are an integral part of the Administration maintenance, all the details of the land transactions are enlisted in the revenue records, and the record is changed regularly after every change, mortgage etc. The Land Records prepared by the *Patwari*, it is often observed that the boundaries of the revenue maps do not match thus mosaicking these boundaries for creation of accurate village map, the district map and thereafter the state maps becomes challenging. Remote Sensing and Geographic Information System technologies provide a great facility to prepare seamless maps of the existing revenue maps. Thus the present study is very significant as it is an effort to rectify the existing erroneous revenue maps.

REMOTE SENSING AND GIS USE IN LAND RECORD STUDIES:

The combination of remote sensing and GIS techniques is a helpful tool for modernizing land records. Because of their synoptic viewing capability, multispectral observations, high to very high resolution imagery, receptivity and its cost effectiveness in comparison to conventional techniques, the remotely sensed data products are extensively used for detecting long-term land record changes. With technology advancements in collection and processing of remotely sensed imagery; its implementation in modernizing the land records opens significant opportunities for achieving the desired objectives with substantial degree of accuracy.

A BRIEF DESCRIPTION OF STUDY AREA:

Manesar Tehsil is located between 28°13′–28°25′ N latitude and 76°46′–77°1′ E longitude within Gurugram district in the state of Haryana, towards its south lies the National Capital Territory of Delhi, towards its southwest lies Chandigarh, the capital of Haryana. Gurugram Tehsil is situated towards its Northeast and in its West shore lays Pataudi or Farrukh Nagar Tehsil. Rewari District and Mewat District are located in South and East shore respectively.
Manesar Tehsil has a total geographical area of 165.20 Sq. km consisting of 37 villages; out of 37 villages 3 villages are unconsolidated (Bhudka, Danokri, Shikohpur) and 34 villages are consolidated (land consolidation is a planned readjustment and rearrangement of land parcels and their ownership). The details of 37 villages with name and Hadbast number are given below table-1:

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Village Name</th>
<th>Hadbast Number</th>
<th>NVCODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BADHA</td>
<td>113</td>
<td>4132</td>
</tr>
<tr>
<td>2</td>
<td>BAGHANKI</td>
<td>4</td>
<td>4387</td>
</tr>
<tr>
<td>3</td>
<td>BARGUJAR</td>
<td>156</td>
<td>4131</td>
</tr>
<tr>
<td>4</td>
<td>BHOKRKA</td>
<td>137</td>
<td>4149</td>
</tr>
<tr>
<td>5</td>
<td>BJORAKHURD</td>
<td>136</td>
<td>1198</td>
</tr>
<tr>
<td>6</td>
<td>BHUDKA(Unconsolidated)</td>
<td>142</td>
<td>4145</td>
</tr>
<tr>
<td>7</td>
<td>BILASHPUR</td>
<td>146</td>
<td>4154</td>
</tr>
<tr>
<td>8</td>
<td>BINOLA</td>
<td>147</td>
<td>4141</td>
</tr>
<tr>
<td>9</td>
<td>CHANDLADOGRAWAS</td>
<td>148</td>
<td>1195</td>
</tr>
<tr>
<td>10</td>
<td>DANOKRI(Unconsolidated)</td>
<td>141</td>
<td>4146</td>
</tr>
<tr>
<td>11</td>
<td>DARBARIPUR</td>
<td>162</td>
<td>4226</td>
</tr>
<tr>
<td></td>
<td>Village</td>
<td>Code</td>
<td>District</td>
</tr>
<tr>
<td>---</td>
<td>--------------------</td>
<td>------</td>
<td>----------</td>
</tr>
<tr>
<td>12</td>
<td>FAZALWAS</td>
<td>149</td>
<td>4139</td>
</tr>
<tr>
<td>13</td>
<td>GWALIAR</td>
<td>150</td>
<td>4140</td>
</tr>
<tr>
<td>14</td>
<td>HASANPUR</td>
<td>163</td>
<td>4224</td>
</tr>
<tr>
<td>15</td>
<td>KASAN</td>
<td>129</td>
<td>4137</td>
</tr>
<tr>
<td>16</td>
<td>KHARKIDOLA</td>
<td>161</td>
<td>4136</td>
</tr>
<tr>
<td>17</td>
<td>KHERKI</td>
<td>3</td>
<td>4385</td>
</tr>
<tr>
<td>18</td>
<td>KHOH</td>
<td>153</td>
<td>4127</td>
</tr>
<tr>
<td>19</td>
<td>KUKROLA</td>
<td>151</td>
<td>4138</td>
</tr>
<tr>
<td>20</td>
<td>LAKHNOLA</td>
<td>110</td>
<td>4130</td>
</tr>
<tr>
<td>21</td>
<td>LANGARA</td>
<td>145</td>
<td>4153</td>
</tr>
<tr>
<td>22</td>
<td>MANESAR</td>
<td>154</td>
<td>1192</td>
</tr>
<tr>
<td>23</td>
<td>NAHARPURKASAN</td>
<td>111</td>
<td>4133</td>
</tr>
<tr>
<td>24</td>
<td>NAINWAL</td>
<td>155</td>
<td>4128</td>
</tr>
<tr>
<td>25</td>
<td>NAWADAFATEHPUR</td>
<td>112</td>
<td>4134</td>
</tr>
<tr>
<td>26</td>
<td>NURANGPUR</td>
<td>157</td>
<td>1193</td>
</tr>
<tr>
<td>27</td>
<td>NURPURBAHORA</td>
<td>135</td>
<td>4147</td>
</tr>
<tr>
<td>28</td>
<td>PATHRARI</td>
<td>143</td>
<td>1200</td>
</tr>
<tr>
<td>29</td>
<td>PRASOLI</td>
<td>138</td>
<td>4148</td>
</tr>
<tr>
<td>30</td>
<td>RATHIWAS</td>
<td>140</td>
<td>1197</td>
</tr>
<tr>
<td>31</td>
<td>SAKATPUR</td>
<td>159</td>
<td>4225</td>
</tr>
<tr>
<td>32</td>
<td>SEHRAWAN</td>
<td>152</td>
<td>4129</td>
</tr>
<tr>
<td>33</td>
<td>SHIKOHOPUR(Unconsolidated)</td>
<td>160</td>
<td>1194</td>
</tr>
<tr>
<td>34</td>
<td>SIDHRAWALI</td>
<td>139</td>
<td>1202</td>
</tr>
<tr>
<td>35</td>
<td>SIHI</td>
<td>108</td>
<td>6411</td>
</tr>
<tr>
<td>36</td>
<td>SIKANDERPURBADHA</td>
<td>109</td>
<td>4135</td>
</tr>
<tr>
<td>37</td>
<td>UDEPURI</td>
<td>144</td>
<td>4152</td>
</tr>
</tbody>
</table>

Table 2.1: List of villages in Manesar tehsil
MATERIAL AND METHODOLOGY:

DATA USED:

In this study, land records of 37 villages of Manesar tehsil have been modernized from grass-root levels, in which the cadastral maps (Mussavies) were digitized and thereafter georeferenced using high accuracy survey grade ground control points (with accuracy of $\leq 5$ cm) and thereafter referencing them with orthomosaic (terrain corrected) high-resolution satellite image as well as ultra-high resolution orthomosaic.

SOFTWARE USED:

State-of-the-art latest software’s from ESRI and Hexagon (ERDAS) were used to process the raster as well as vector geospatial information which includes, cartography, map analysis, mosaicking, extraction, digitization, editing and geo-referencing , creation of various layers, catalog, data models, metadata, services, etc.

METHODOLOGY:

The following workflow depicts the methodology adopted for this study:

![Fig. 3: Methodology](image-url)
The key steps in this program, in chronological sequence, involves:

(a) creation of textual database of the record of rights (i.e. title)
(b) digitizing cadastral maps of villages
(c) collecting high resolution GIS maps from Udaan
(d) linking them to physical reference points so that there is no mismatch of recorded area and digitized area
(e) geo-referencing individual parcels of land with legacy data using 1958 as the ‘base year’
(f) validation using triangulation principles for rectification of error and geo-referencing

The merged output from the above steps are kept for public display and feedback for a defined period at a village or locality level, where the actual land owners are involved in verifying the accuracy of the experimental output thereby mitigating the asymmetry of information.

**HARYANA CADAstral SYSTEM:**

Haryana cadastral system comprises of the cadastral map (mussavi), the hardcopy of which is available with the Revenue Department; upon its digitization, the GIS and remote sensing nodal agency of the state i.e., Haryana Space Applications Centre generates the digital cadastral maps. Each cadastral map comprises of 16 murba’s and each murba is further divided into 25 killa’s. Killa is the smallest land parcel, which represented by a positive integer ranging from number 1 to 25. In case of mutation (or title change), killa is further subdivided into Bata and assigned number 1/1, 1/2, 1/3, … etc. For the villages that were consolidated in year 1957, the killa as well as murba are rectangular.

**Digitization of Cadastral Maps:** High resolution scanning of cadastral maps and thereafter raster to vector conversion was adopted to digitize the cadastral maps and feature classes with its attributes were created using GIS software’s

**Edge Matching:** Edge matching is used to align features along the edges of adjacent layers. Usually, the layer with the less accurate features is adjusted, while the other layer is used as the target layer. Edge-matching relies on displacement links to define the adjustment.
**Mosaic**: A raster dataset composed of two or more merged raster datasets for example, one image created by merging several individual images or photographs of adjacent areas.

Table 1: It is showing Land Units Dimension in *Karam*

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Land Unit</th>
<th>Dimension in <em>Karam</em>&lt;sup&gt;*&lt;/sup&gt;</th>
<th>Dimension in <em>Karam</em>&lt;sup&gt;*&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>East to West</td>
<td>North to South</td>
</tr>
<tr>
<td>1</td>
<td>Mussavi</td>
<td>800</td>
<td>720</td>
</tr>
<tr>
<td>2</td>
<td>Murrba</td>
<td>200</td>
<td>180</td>
</tr>
<tr>
<td>3</td>
<td>Killa</td>
<td>40</td>
<td>36</td>
</tr>
</tbody>
</table>

<sup>*</sup> (1 *karam* = 66 inches (5.5 feet))

**Digitization of Vector Data on the Basis of Mussavi**: After mosaic the Village wise Mussavi and digitization of each feature like road, railway, habitation, river, etc. on the Mussavi in Polygons, Points, and Lines format have to be captured in different layers. The data is topologically correct for each layer. This part of my study area is provides a platform for making vector dataset from the raster data with non-spatial data provided by Haryana Space Applications Centre or HRSAC (the nodal agency for GIS & remote sensing in the state of Haryana). It is playing an important role of analysis because all area calculation, area location, area ownership change in different time, area use like road, pond, agriculture land non spatial data etc.

**Geo-Referencing of Vector & Raster Data with Reference Satellite Data and Integration of Digitized Cadastral data with RoR data**: With satellite imagery, sometimes the location information delivered with them is inadequate and the data does not align properly with other data you have. Thus, to use some raster datasets in conjunction with your other spatial data, may need to align, or georeferenced, to a map coordinate system.

A map coordinate system is defined using a map projection (a method by which the curved surface of the earth is portrayed on a flat surface). Geo-reference means to associate something with locations in physical space. The term is commonly used in the geographic information systems field to describe the process of associating a physical map or raster image with spatial locations. (https://en.wikipedia.org/wiki/Georeference). Here all images are projected under the coordinate system of Universal Transverse Mercator (UTM) and datum is WGS 84 (Zone 43) with respect to one image for reducing the error. Zone is also most important aspect in the coordinate system it will differ depending on
the location of your study area. Georeferencing is the process of assigning real-world coordinates to each-pixel of the raster Data. Both the Raster and Vector Data are Geo-Referenced with the satellite data. Each Village of Manesar Tehsil is georeferenced with the reference of satellite data.

In the present work with the help of GIS techniques, the mismatched boundaries were found out in various units like area of vector, in sq. km, in Kanal, in meters and in Hectares. The area of RoR was also found in these units, by doing so we were able to get the mismatched areas between the cadastral data and RoR images. This helped us to find out the increasing and decreasing trend of the mismatched boundaries.

**Mosaic All Mussavies of Village to create Tehsil Map:** All Villages wise Mussavies are represent together a one platform with the mosaic technique. One image created by merging several individual images or photographs of adjacent areas and this facilitates to generate single integrated map.

**Develop of seamless revenue map for AOI:** The geographical information system is a tool for managing, analysing decision-making by seamlessly both raster and vector data. To get clarity in our map we need to mosaic the various images resembling with different parts of the area.

To fulfil the objective the Village level Mussavi data were collected. While collecting the data it was found that, every Village has different number of Mussavi which is totally based on its geographical area. In the present area of study the total numbers of Mussavies found to be 285. Besides this, 37 villages are in Manesar Tehsil, out of 37 villages, 3 villages are unconsolidated and 34 villages are consolidated. All these images were analysed and mosaicked to create a single image by using Mosaic method in GIS all 37 villages individually. In the present work while joining adjacent Mussavi from different Mussavies, several area error of adjacent Village were also found as it is known that Mosaicking is not a perfectly clean process it often requires additional image processing to remove some of the 'noise' near the stitch.

Mosaicking is the process of combining multiple, individual images into a single scene. Nowadays, for the accuracy and mandatory of modern time Mussavi should be converting in digital format by using computer and recent technology. So these recent digital Mussavi can be easily usable for representation and Village information and killa details. It has considered some problems dealing with useful information of Mussavi before the time of mosaicking process.
We found joint Mussavi with the hatching areas (Red circle) have hidden information due to merging Mussavi.

**Fig. 3 : Showing the intersection area of Mussavi**

**Dubious Mussavi Data:** In this study, other issue is that some used *Mussavies* are damaged due to longstanding. Almost Mussavies at the corner are spoils and not readable properly. That’s why it is very difficult to identify some parameter of Mussavies. At the time of scanning due to the lack of better clarity we are not able to get a quality data. When we goes to further processing have to face many problems. e.g.

- At the time of merging spoils spot of *Mussavies* feel like an open space
- Sometimes it looks like a barren Land.
- Difficulties at the time of joining two or more *Mussavies*
- No better features Identification
- Single line features that present in two contiguous *Mussavies* can be distracted (roads, river etc.)
- Difficulties in the classification
- Given numbers (e.g. *killa* number, *khasra* number, *murabba* number) can be mismatched
- Scale can be differing at the time of adjoining of two or more *Mussavies*
In this Mussavi, killa line and land information has been missing due to old Mussavi data so we have faced problem of matching of adjacent Mussavi to another Mussavi shows missing of land information.

Another issue (Fig. 6) of oldest Mussavi records is that there is sub division of killa. But these killa number are not readable for land records. The image should be cleaned and de-speckled to remove noise.

Some area represents difference of scale due to dispute of Mussavi. This data are matched by manually process and does not provide exact information of killa area. These issues can be removed by Indexing and cataloging of documents/maps followed by its safe storage and damp free environment.
In this Mussavi records there is no exact representation of *killa* and *Mussavi* line in this Fig. 8. For removing this error, numbering of *Mussavi* should be started Village wise.

In this given *Mussavi*, there is no information of killa boundary and this area display by another documents which have no proper information of land records data.
Fig. 11: Showing misplace of *Mussavi* document

This *Mussavi* displays that the some part of *Mussavi* are missing due to longstanding of records and boundaries are not clear then scanning should be done at standard dpi. This factor is responsible for matching of one *Mussavi* to adjacent *Mussavi*. We cannot match properly of records.

Fig. 12 : Showing the missing of records due to longstanding of records *Mussavi* data

This identifying *Mussavi* are destroy or missing. So one or more of the available *Mussavies* in records is not as per the updated data of last consolidation year as of the remaining *Mussavies* of same Village.

Fig. 13 : Showing the some part of destroy *Mussavi*

This *Mussavi* damaged during maintenance. The reason boundary of Village, *Chhoti-burji* and length are also missing so we could not find the geographical area of Village

Fig. 14 : Showing the Village boundary are missing
This map of Mussavi is showing the error of overlap and disjoint of Mussavi, killa, chhoti-burji. This occurs due to Mussavies Village boundary is damaged and missing. Further, any new updates on Sajra maps by Patwari shall be updated in digital data only for removing this issue.

Fig. 15: Showing the missed replace in scanning

In this Fig. the physical condition, Mussavi is poor/damaged. (Not feasible to scan or read), so due to this reason some factor such as hadbast no., killa area are missing in records. For removing of this issue, the image (Mussavi records) should be stored in tiff and pdf format.

Fig. 16 : Showing damaged Mussavi

Identifying Gap, Scaling and mismatching error in adjacent Mussavies: other issue in Mussavi records we found the gap between adjacent boundaries from the longstanding time Mussavies. This error occurs due to rectification without clip data. So we can remove this issue with clipping the Mussavi and after that rectify Mussavi records. In this step before mosaicking when we extract the data and join the all Mussavies together some more type’s problems has come. One of them is mismatching. When two or more Mussavies joins the boundary or killa line look mismatched clearly. Fig. 33 to 38 is showing clearly line mismatching between two Mussavies. Another issue is found the scaling of Mussavi data. Due to scaling problem, we cannot match easily two or more Mussavi boundaries known as mismatching issue. Therefore, for further remove this issue Mussavies should in proper scale.
In this Fig. 17. One or more of the available Mussavies in records are matched or updated with each other but there is some issues occurs which mismatch of killa line and road line properly.

Fig. 17: Showing the Mussavi Road Mismatch

This Fig. (18) shows gap error between two Mussavi data this occurs due to rectification without clip data. The regeneration of new Mussavies should be done only after proper approval.

Fig. 19: Showing the gap between to Mussavi

The other error in this Fig.20 of Mussavi record is that we found the overlap and gap between adjacent boundaries of each Village due to image orientation and improper rectification. So the image orientation and rectification should be upright for removing of this factor.
Fig. 20: Showing the overlapping in adjacent Mussavi

This Fig. 21 is showing a difference at ground scale of another part of Mussavi is different which is representing in rectangle box. The map should be in proper scale and rectified.

Fig. 21: Showing the difference of scaling error

Fig. 22: Showing the horizontal gap error

In this, Fig. 23 and 24 are showing horizontal and vertical gap error in rectangular box. This type of error will be depending on some parameters such as the quality and density of ground control point and configuration of ground control point.
These Fig.25 are showing Horizontal and Vertical control points must be exist and visible so removed the gap between and across adjacent Mussavi boundary.

The Fig. 26 shows the scaling issue that next adjacent Mussavi has different scale so it is not properly joining with another. For joining the both of Mussavi there had to need the correction in scale. This correction was based on rectification. After rectification some manual process has to be completed and removed the scaling error.
This Fig. 27 is showing proper joining of *Mussavi* with the exact of measured control points.

![Fig. 27: Showing the after removed scaling error](image)

Fig. 27 : Showing the after removed scaling error

Fig. 28 : Showing some gap and Skewed between adjacent boundaries of *Mussavi*

In this **Fig. 29** are showing skewed or wrapped *Mussavi* due to problem of incorrect scanning of *Mussavi* record and also have some gap and inflexible between adjacent boundary of *Mussavi*.

![Fig. 29: Showing wrapped error in Mussavi data](image)

Fig. 29 : Showing wrapped error in Mussavi data

These **Fig. 30** are showing in proper matching of adjacent *Mussavi* due to rectification of *Mussavies* with grid.
The mosaic methods are defined as part of the mosaic dataset properties, but all may not be available. After mosaicking process some other issue such as alignment of Mussavi, occurs which are shown in Fig. (32). This issue will be removed by rectification with base on fishnet.
This Fig. (33) showing proper format and forms of Mussavi by rectify of records with grid.

![Fig. 33: Showing Mussavi records after correction](image)

Finally in Fig. 34 we have prepared for example one Gwaliar Village map with corrected Mussavi records after removing all issues which are occurs in the processing.

![Fig. 34: Showing the final Gwaliar Village after mosaicking all Mussavi](image)

**Village to Village Mosaicking:**

Mosaicking is a unique process for joining the two or more raster image data. Here before mosaicking all villages Mussavi has been rectified individually and after that mosaicking all Mussavi of one Village. Finally we prepared 37 Village map of Manesar Tehsil by using same process like as mosaicking of all Mussavi of Village to Village.

This given below Fig.35 is showing the correct process of mosaicking of all Mussavi of villages in Manesar Tehsil.
Fig. 35: Showing the two adjacent Village mosaics

Fig. 96: Showing the error between adjacent boundaries of villages

Fig. 37: Showing the error on the overlap & gapping error between adjacent Village boundaries
Fig. 38 : Showing the gap error on the match adjacent Village boundary

This Fig. 39 shows all mosaicked Mussavi of 37 Village after this process we have also find the almost correct Mussavi records with some gap.

Fig. 39 : Showing the mosaicking (with error) of 37 villages (Manesar Tehsil)

Fig. 40 : Showing the after correction
To Identify Boundary Mismatch into Adjacent Villages:

Another problem that came to the mind of the researcher was that the maps created by the respective Authorities (Patwaris) were often found to be mismatched. Thus keeping this point in mind an objective was set to identify which were mismatched into the adjacent villages, for this purpose all the Patwari maps were analyzed and the mismatched location of the adjacent images were found out. There was almost 10-12 mismatched location. These mismatched locations were rectified by geo-referencing all these maps. With satellite imagery, sometimes the location information delivered with them is inadequate and the data does not align properly with other data you have. Thus, to use some raster datasets in conjunction with your other spatial data, you may need to align, or geo-reference, to a particular map coordinates system.

A map coordinate system is defined using a map projection (a method by which the curved surface of the earth is portrayed on a flat surface). Geo-reference means to associate something with locations in
physical space. The term is commonly used in the geographic information systems field to describe the process of associating a physical map or raster image with spatial locations. (https://en.wikipedia.org/wiki/Georeference). Here all images are projected under the coordinate system of Universal transverse Mercator (UTM) and datum was WGS 84 (Zone 43) with respect to one image for reducing the error. Zone is also most important aspect in the coordinate system it will differ depending on the location of your study area. Geo-referencing is the process of assigning real-world coordinates to each pixel of the raster Data. Both the Raster and Vector Data are Geo-Referenced with the satellite data. Geo-referencing is the last part of my sturdy but in GIS mostly this is first step. There is some error during Village-to-Village matching of Mussavi data such as gap occurs between boundaries and overlapping of area. These some following figures are showing problems of Mussavi data in the process of vectorization. Thus in the conclusion, each Village of Manesar Tehsil is geo-referenced with the reference of satellite data.

Mismatching and Gaps in Mussavi between adjacent villages after mosaicking:

Fig. 43 are showing Gap between the adjacent Village boundaries and overlapping of area at the time of rectification of Mussavie and mosaicking. There are some factors such as scanning, Dispute of Mussavies, scaling old revenue documents of records etc. occurring during the process that are responsible for this type error.

![Fig. 43: Showing the gap in adjacent Village](image-url)
After the rectification of *Mussavies* of all villages of Manesar Tehsil we found some error related to Gap and some are overlapped area.
The other problem is that some useful information is missing in some Mussavies due to negligence at the time of updating and this area is considered through the National Security of India. (Fig.46).

Fig. 46: Showing missing Mussavi

**Vectorization of Mussavi and Error after Mosaicking Process:**

This given below Fig.47 of vector data of Mussavi showing gap at the different areas between adjacent boundaries of Village-to-Village after final mosaicking. We have calculated total area of error.
This Fig. 48 shows geo-referenced map of Manesar Tehsil which have some error statics. Total area of error: 24,12,759.33 sqm and (2.4127 in sq. km.) There are 188 identified location of error in Manesar Tehsil.
Total area of error is 24,12,759.33 sqm and (2.4127 in sq. km.) in Manesar Tehsil. There are 188 identified location of error in Manesar Tehsil. The details of total and error area of Manesar Tehsil

**Cadastral Geodetic Network:**

- Village Tri Junction DGPS Survey
- Orthomosaic Generation (using geoprocessing and photogrammetric techniques)
- Cadastral data superimpose

District Gurgaon being part of the National Capital Region (NCR) is one of the fastest developing cities in the Country. The Land development and real estate business is one of the major areas of action in the District. The District administration has to deal with large no of land acquisition, mutation issues, Land Use Land cover change etc on a regular basis. In absence for proper reference and day to day change in the land cover it becomes difficult the measure the land accurately and thereby take forward the administrative work relating to acquisition, mutation, compensation etc, District administration decided to conduct Village Tri-Junction survey shall be required for referring with the administrative revenue records for day to day work which shall then be referenced with the available state references and records like Revenue maps, satellite imagery etc.

**SCOPE OF THE WORK:**

A. **Village Tri-junction monumentation** - Monument of 60 cm Steel rod with Poly rock head. Each monument shall be uniquely number as per project specification to be given by the client/HARSAC.

B. **Village Tri Junction DGPS Survey** –Established of geodetic coordinate using DGPS survey. The DGPS survey shall be carried out in reference to state network reference shall provided by Client/HARSAC. The DGPS survey for each point shall be for duration of 1 hours, as discussed.

C. **Satellite Data Processing & Village Cadastral map Dereferencing** – Post processing of DGPS Survey data, Geo-referencing of Satellite Image, DEM and Ortho Generation, Overlaying of revenue village map and analysis.
The Monumentation and DGPS work has been carried out Tehsil wise and cover approximately 512 village tri-junctions covering 5200 *musavi* spread over 292 villages in 05 tehsils. All inputs have been provided by client and it is decided that the above work shall be co-ordinate and monitor by Haryana Space Research Application Centre (HRSAC).

**CADAstral Geodetic Network Methodology:**

**Identification of Survey of India (SOI) Master Control Point:** There are 35 SOI Master Control points of National Geodetic Network falls in Haryana State. With the help of this National Geodetic Network, Haryana state Primary (121) and secondary (589) control points were established.

The distribution of the control points in the whole state is shown in the following figures:

![SOI Control Points](image1)
![Primary Control Points](image2)
![Secondary Control Points](image3)

Collection of Primary Control Point and ground validation: The 04 No’s State Primary control point falls out of Total 121 Primary Control Point in Gurgaon district have been collected to prolong the National and State Geodetic Network. The input of primary control point received from HARSAC have been validated in ground and used for creation of geodetic network and establishment of Tertiary control point.
Collection of Secondary Control Point and ground Validation: The 18 No’s Secondary control falls out of 589 point have been collected to prolong the National, State Geodetic Network and State primary Control point. The input of 18 No’s Secondary control point received from HARSAC have been validated in ground and used for creation of Geodetic network and establishment of Tertiary control point.

**Site Selection for Establishment of Tertiary Control Point:** The above available primary and secondary control point have been used to fix the value of 555 tertiary control point of the Gurgaon District. The mosaicked vector layer of all revenue village provided by HARSAC was used to geo-
reference to the image for identification of the Village Tri-Junction (*Sehda*) and desktop planning of ground movement.

**Fig 49: Planning of Village Tri Junction Monumentation Establishment**
Preparation of Unique Identification Hatching plate: A unique Hatching (steel) plate designed to keep the unique identification of each monumentation established at Village Tri-Junction. The Hatching (Steel) plate material used for Tri-Junction is indestructible and water resistant.
Execution (Monumentation and DGPS Survey): After doing the preplanning of site movement and preparation, collection of input the monumentation and DGPS Survey work have been carried out. There are mainly two cases, one is where old rock at Burji is found and other is where old rock is not found. In the later case the poly rock marker is installed. The below figures shows the both cases.

Data Download: RINEX is the universal format for the GPS data and different GPS receivers store the data in their own format. Receiver Independent Exchange Format (RINEX) is data interchange format for raw satellite navigation system data and different GPS receivers store the data in their own format. This allows the user to post-process the received data to produce a more accurate solution — usually with other data unknown to the original receiver, such as better models of the atmospheric conditions at time of measurement.
Most geodetic processing software for GPS data use a well-defined set of observables:

The carrier-phase measurement at one or both carriers (actually being a measurement on the beat frequency between the received carrier of the satellite signal and a receiver-generated reference frequency). The pseudo range (code) measurement, equivalent to the difference of the time of reception (expressed in the time frame of the receiver) and the time of transmission (expressed in the time frame of the satellite) of a distinct satellite signal. The observation time being the reading of the receiver clock at the instant of validity of the carrier phase and/or the code measurements. Usually the software assumes that the observation time is valid for both the phase and the code measurements, and for all satellites observed.

Consequently all these programs do not need most of the information that is usually stored by the receivers: They need phase, code, and time in the above mentioned definitions, and some station-related information like station name, antenna height, etc.

We get two files in RINEX, one is .RXO and other is .RXN. Trimble Business Centre which is used for the processing accepts these two files.

Figure: Processing of Baselines
Baseline generated:

Processing baselines:

Viewing baseline processing settings

When processing is complete, view the results before you save the processed vectors:

Ensure that all the baselines have a fixed solution. To do this, click the Solution Type column header. Baselines are fixed, and some have a Float solution. All the attributes of processing (e.g. cut off angle, acceptance criteria, data beat) are set and whole baselines of the project are processed. Baselines those have high error or there solution is “Float Solution” are deleted and the healthy baselines are used to create the network. Points which have no connection or the points which are connected to the network with weak baselines are rejected or their values are checked with the values calculated by resurvey of that point. When you are finished reviewing the results, click save to save the processed vectors to the project database. Once the processed vectors for each baseline are saved, the baselines change color from teal to blue. The Point Derivations Report lists all observations (vectors) that flow into the selected Point. In the following example, the report compares the coordinates derived from the first observation at that point with the coordinates from subsequent observations. To review the processing results and edit the survey network once all baselines in the control network have been processed and reviewed. The network is edited by fixing the known coordinates of the points in the network depending on the network geometry. Then the residual of the other known points are calculated. For the MSL height, EGM96 model is applied.

Figure: Adjusting the network
Orthophoto Generation:

Ortho-rectification is a process of making the geometry of an image plannimetric, or map accurate, by modeling the nature and magnitude of geometric distortions in the imagery. These distortions are caused by topography, camera geometry, and sensor-related errors. Ortho-rectification is a logical step when precise positional accuracy and uniform scale are required throughout an image. After Ortho-rectifying an image, you can measure or precisely locate features in the image, collect information for a GIS, or combine the image with other Ortho-rectified images for sophisticated analyses.
Establishing Ground Control Points and DGPS survey:

Ground control point is important input in the process of Ortho-rectification of satellite images or photographs, so for this requirement we developed a network of ground control point for Gurgaon district. Total number of ground control point as 17 are proposed according to satellite image overlap area and 550 points are tri junction of villages. DGPS survey is carried out for observed actual ground coordinate. The selection of the site for DGPS observation will be done considering the some limitations such as

- Locations near strong radio transmissions should be avoided as these may disturb satellite signal reception.
- Stations should be situated in locations relatively free from horizon obstructions. As satellite signals do not penetrate metal, buildings, or trees and are susceptible to signal delay errors when passing through leaves, glass, plastic and other materials.
- Avoid locating stations near large flat surfaces such as buildings, large signs, fences, to avoid multipath errors.

High Resolution Stereo Satellite Image Acquisition:

Digital Stereo Data of World View-II was acquired through National Remote Sensing Centre, Hyderabad, Department of Space, and Govt. of India having spatial resolution of 0.5 m for this study with off nadir angle less than 10 degree. Satellite data is acquired after date of monument establishment. After acquiring satellite data it is check the clouds, haze, restricted area, and gaps in area of interest. Digital Globe offers two types of stereo products; Basic Stereo products delivered as full scenes that are uncorrected and Ortho-Ready Stereo Products that are area-based and geo-referenced to a map projection and constant base elevation. The stereo imagery is collected in-track, e.g. on the same satellite pass and supplied with a full set of metadata. These products are ideal for DEM generation, 3D visualization and feature extraction applications.

Image Processing and Block triangulation of Images:

After acquire satellite data it is mosaic according strip or scene because only first tile has RPC file (Rational Polynomial Coefficient) which is a sensor model commonly used by the remote sensing industry to determine the ground coordinates of pixels in high resolution satellite imagery. Then tie point creation at every image pair with overlapped area is completed. A tie point is a point whose ground coordinates are not known, but is visually recognizable in the overlap area between two or more images. The corresponding image positions of tie points appearing on the overlap areas of multiple images is
identified and measured. Ground coordinates for tie points are computed during block triangulation. Tie points are measured manually. Tie points should be visually defined in all images. Ideally, they should show good contrast in two directions, like the corner of a building or a road intersection. Tie points should also be distributed over the area of the block. Typically, nine tie points in each image are adequate for block triangulation. After Tie point generation and obtained control, LPS has all the information it needs to perform aerial triangulation. This step in the process establishes the mathematical relationship between the images that make up the block file. Aerial Triangulation (AT) is the process of optimally piecing together a block of overlapping aerial images such that you can make a map. The objective is to determine the position and orientation of each image in a mapping frame. These are called the exterior orientation (EO) parameters.

Measurement of the TIE Point

Block triangulation was carried out by refinement of image geometry model (RPC) supplied with the imagery, with the help of GPS control points. Minimum numbers of control points provided for a stereo-pair of imagery are nine. GCP is falling in overlap zones. The GCPs was well distributed in a matrix of 3X3. Absolute Orientation is RMSE on GCPs from Block Adjustment imagery. Relative Block Accuracy is 0.5 X input pixel size. Minimum 100 tie points was be generated manually to ensure internal
consistency. Size of block was made larger if overlap is available between 2 or more pairs of stereo imagery.

**DEM Extraction & Editing:**

A digital elevation model (DEM) is a 3-D representation of the terrain’s surface, created from elevation data. There are two types of digital elevation models, digital terrain model (DTM) and digital surface model (DSM). DTMs represent the bare ground surface excluding any man-made features while DSMs represent the earth’s surface including all objects on it. Raster DEM data files contain elevation values of the terrain over a specified area at a fixed grid interval or post spacing. The intervals between each of the grid points are referenced to a geographical coordinate system. This is usually either latitude-longitude or UTM (Universal Transverse Mercator) coordinate systems. The closer together the grid points are located, the more detailed the terrain information. DEMs are an integral part of any Geospatial Analysis. They are required both for the description of the three dimensional surface and to Ortho-rectify imagery used in mapping applications or for modeling purposes. There is a variety of DEM source data available, the suitability of which depends on the project specifications. DEM was produced by automatic DEM extraction from stereoscopic satellite images collected by Digital Globe’s WorldView-2. Digital Globe offers two types of stereo products; Basic Stereo products delivered as full scenes that are uncorrected and Ortho-Ready Stereo Products that are area-based and geo-referenced to a map projection and constant base elevation. The stereo imagery is collected in-track, e.g. on the same satellite pass and supplied with a full set of metadata. These products are ideal for DEM generation, 3D visualization and feature extraction applications. In this work the DEM is extract after block triangulation with the help of software and the DEM editing is completed for each scene manually with the help of 3D setup.
ORTHOPHOTO GENERATION:

After DEM extraction and DEM editing the process of Ortho-generation was carried out for every scene of study area with the software LPS. Then seam line editing was carried out. The seam line was generated along roads, rivers, canal and other linear features on the overlapped area of the adjoining images. After seam line editing the process of mosaic and automatic global tone balancing was carried out.
OVERLAYING REVENUE VILLAGE MAP ON ORTHO-IMAGE IN REFERENCE WITH PROCESSED TERTIARY POINTS:

The vector provided has four layers, *khasra* polygon, *khasra* line, point layer and text layer. All of the four layers are georeferenced to the image with the tertiary points. In the below figure the *Burji* of the vector are linked to the tertiary points. In this way all the *burjis* are linked to their respective tertiary points. After adjusting the vector, the respective *burjis* and vector are clipped to their geographical position as shown in the figure below.

As the result of geo-referencing all the villages in the same manner, a seamless vector of the all villages is produced.

Figure: linking the *burjis* of vector data to tertiary points
Figure: Georeferenced vector on ortho-image
OUTCOME:

The work was started with the objective to prepare a seamless revenue map of Manesar Tehsil and to find out the disputed data or error in Patwari maps and rectify the error through mosaicking and in that way finding out the applicability of RS and GIS in day-to-day administrative works.

To fulfil these objectives the study was divided into three part, in the first part mosaicking of all Mussavies has been done, and in the second part the mismatched boundaries of adjacent villages were found and in the third part accurate data were extracted through the process of the Geo-referencing technique. The detail of above all three categories is described in brief given below one by one.

MOSAIC:

The first motive of this study is collecting Village wise Mussavi data. GIS software gives us a view of large area in a single image. This image can again be used for analysis as per our research methodology. But as we know it is not possible to get a single image of a large area. Thus to get a high resolution image of an area we have to need the join to all parts of image in a seamless manner. In the present area of study the total 285 numbers of Mussavies were found. Beside these 37 villages fallen in Manesar Tehsil, out of 37 villages 3 villages are unconsolidated and 34 villages are consolidated. All these images were analysed and mosaicked to create a single image by using Mosaic method in Arc GIS of every 37 Village individually. The Mosaicking was done based on Saheda Stone of every Village With the help of the mosaic technique in Arc GIS platform we were able to prepare our required revenue map.
### Table 2: It presents the numbers of Mussavies in each Village

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Village Name</th>
<th>Hadbast Number</th>
<th>NVCODE</th>
<th>Number of cadastral Mussavies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Badha</td>
<td>113</td>
<td>04132</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>Baghanki</td>
<td>4</td>
<td>04387</td>
<td>11</td>
</tr>
<tr>
<td>3</td>
<td>Bargujar</td>
<td>156</td>
<td>04131</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>Bhokrka</td>
<td>137</td>
<td>04149</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>Bhorakhurd</td>
<td>136</td>
<td>01198</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>Bhudka <em>(Unconsolidated)</em></td>
<td>142</td>
<td>04145</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>Bilashpur</td>
<td>146</td>
<td>04154</td>
<td>11</td>
</tr>
<tr>
<td>8</td>
<td>Binola</td>
<td>147</td>
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<td>9</td>
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<td>Gwaliar</td>
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<td>Kharkidola</td>
<td>161</td>
<td>04136</td>
<td>10</td>
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OUTCOME OF MISMATCHED AREAS (ADJACENT VILLAGE):

The maps taken from the Patwaris were found to be mismatched for this purpose all the Patwari maps were analysed and the mismatched locations of the adjacent images were found out. There were highly 20 mismatched locations but little bit mismatching in all 37 villages. The various mismatched as per identified by the researcher is below in the table below 42:

These mismatched locations were identified by Geo-referencing all the vectorized images which were collected from HARSAC. The vectorization process started from digitization (Point, Line and Polygon) which is based on Village Mussavi. Firstly every single Village was digitized. The Digitization is done at a comfortable zoom level to ensure that the vertices to avoid undershoot and overshoot. There is not any overshoots, undershoots and duplicate features. Polygons, Points, and Lines are captured in different layers. Logical connectivity of the features have to be followed i.e. a river will not join a road. The digitized line is followed as per the dimension specified for each segment of killa boundary on the map. The data is topologically correct for each of the layers. The required attribute information such as parcel/Khasra numbers available on the Mussavi is assigned to the vector polygons. This is helpful in the seamless digital data generation of entire Village. The single file *.shp is generated for each Village. The nomenclature of the file (digital vector data) is done considering numeric code. The final code is comprised of the following code:

1. District code: DD
2. Tehsil code: TTT
3 Village code: VVVVV (NV code)
After complete digitization this study finds out that the total number of parcel in Manesar Tehsil is 65745 and Village wise parcel details is given below by table:-

**Table 3: Total number of parcels in each Village& existed Mussavi**

<table>
<thead>
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<th>Sr. No.</th>
<th>Village Name</th>
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<th>NVCODE</th>
<th>Number of cadastral Mussavies</th>
<th>Number of Parcels</th>
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With the help of the GIS techniques the difference of geographical Village area between ROR and Vector Data. The various villages area were also found out in various units of measurements like area of vector in Kanal-Marla and Acres. In the same way area of RoR were found in kanal-Marla and Acers. All these different units of measurements were used to accurately analyse the increasing and decreasing of the difference of geographical area of villages. The details of the geographical area of villages in the different records were found out which are given in the below table 44:

To get more accuracy of the geographical area were also found in some Village with measurement unit. The results of both of these are given in the tables below in acres:
<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Village Name</th>
<th>Total Area of ROR as per Misal Hakiyat</th>
<th>Total Area of RoR as per Patwari Recorded</th>
<th>Total Rakba of ROR as per HALRIS.HRIS</th>
<th>Area as per Vector Data</th>
<th>Area in % Difference in between RoR(MisalHakiyat) and Vector(3 - 6)</th>
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<td>616.15</td>
<td>616.80</td>
<td>615.27</td>
<td>-0.03</td>
</tr>
<tr>
<td>36</td>
<td>Bhaghanki</td>
<td>1033.71</td>
<td>1034.73</td>
<td>1035.02</td>
<td>1038.14</td>
<td>0.43</td>
</tr>
<tr>
<td>37</td>
<td>Sihi</td>
<td>1168.77</td>
<td>1167.77</td>
<td>1167.64</td>
<td>1171.60</td>
<td>0.24</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>40818.92</td>
<td>40801.85</td>
<td>40805.27</td>
<td>40822.91</td>
<td>0.01</td>
</tr>
</tbody>
</table>

*Red is unconsolidated Village

While analyzing the tables we have found out more area difference with ROR and Vector between some villages such as Naurangpur, Shikohpur, Chandla Dungarwas, Bohara Khurd, Bar Gujar, Badha, Naharpur Kasan, Sikanderpur Badha, Hassanpur due to these adjacent boundary of villages are attached with another Gurugram Tehsil or unconsolidated villages. Thus from the above work we can conclude that we can never get an accurate result unless and until we study through different perspectives, like in this work we calculated the value of difference geographical area in different units and every different unit told a different story.
FINDINGS:

Maps are a powerful medium for planning, analysis and monitoring. It integrates non-spatial and spatial datasets for query and optimal display. Cadastral Maps can be used on a day-to-day basis by decision-makers at grass root level creating different governance spin-offs. The data of cadastral survey forms the basis for generation of any accurate high-level map. Since last decade, it has been realized that the existing Village maps are not geo-referred. On the other hand, policy makers, planners, land administrators and individual citizens all have a dire need for right information. Today’s needs are using GIS technology, which is having capability of capturing, storing, analysing, and displaying geographically referenced information. As today every peoples are using computer and its minutes click to get the any information regarding their subject. In GIS map of Village is mapped and Attribute data is entered in data sheet that will helpful to policy makers, planners, land administrators and individual citizens to find out Land Records within in minute. This study will bring out the importance of land records and management system in India. And benefit the land owners, Planners, Decision makers and land administrators by improving the effectiveness and efficiency of land records management. It is desirable to have properly geo referenced land records data and its integration with other land parameters for planning and decision-making. It is important that cadastral survey using latest technology may be done for the entire country. Disputed cases in land titles should also be decided at the earliest. Computerization process should integrate registration of land titles. Land laws/mutation process should be simplified for easy and fast implement.

- This study considered 285 cadastral maps in Manesar Tehsil. Beside and 37 villages fall in Manesar Tehsil, out of 37 villages 3 villages are unconsolidated and 34 villages are consolidated. All revenue maps are extracted and matched with its Village boundary to remove any overlapping to get error free image.
- The boundary mismatching was another reason for various errors. The study determines that total mismatched area is 2.41 sq. km. (1.46 %). Such mismatches were found at 188 spots in 37 villages and 20 villages this type of error was acute.
- Three villages are unconsolidated out of all 37 Village. According to Land Record department of Haryana government, these three villages are unconsolidated, as landowners did not co-operate for land consolidation.
- Manesar Tehsil has 65,775 number of parcels and Manesar Village has maximum number of parcels (6932 and 20 cadastral maps) but Bargujar has the least (379 and 7 revenue maps).
• When we discuss about the area differentiation in between two or other sources then it is not exactly matching with each. In some sources are very high differences but in some cases, it is coming almost same. According to Misal Hakiyat (balance sheet carry forward) have total area 326,555 kanal and 8 marla but according to Patwari record it is 326,422 kanal and 19 marla, as per HALRIS & HARIS this area is 3,26,451 kanal and 18 marla, these all 3 organizations or department come under the Land Record department. But there is no satisfying matching of data with each other. There are many differences in hundreds of kanal. When we talk about the digitized vector data it comes 3,26,598 kanal and 8 marla. The vector data have some matching with the Missal Hakiyat with 43 kanal difference. This difference is 0.01 percentage only. The average difference comes down to 0.01% between vector data and area indicated in revenue maps. The original error was more pronounced in villages of Naurangpur, Shikohpur, Chandla Dungarwas, Bohara Khurd, Bar Gujar, Badha, Naharpur Kasan, Sikanderpur Badha and Hassanpur.

• In a brown field, exercise like the present one error minimisation is the objective. Nevertheless, there are inherent limitations. Therefore, data from more datasets should be procured and assessed. Collection of data from various sources is the key. As more and more data gets processed from various historical records and physical parameters like contours, toposheets etc the error minimisation is achieved.

In the present work it has been found that GIS is an effectively used to match records available in revenue maps and digital imageries created using UAVs. Further, geo-referencing added to the authenticity.

CONCLUSION

High-resolution aerial remote sensing image data using unmanned aerial vehicles show a high level of detail and provide many opportunities to be used as base for cadastral map generation. Precision orthomosaic generated having 5 cm spatial resolution are ideally suited for accurate deriving cadastral maps. The obscured areas need ground survey intervention by DGPS & ETS. The habitation area vectors of existing cadastral maps can be integrated to image vector maps to finalize the new cadastral maps of the villages. The image derived cadastral maps can be directly used by revenue official for tenant interaction, settlement activities and revenue administration. One of the significant observations of the study is matching of Total village area in Cadastral map area (after digitization). It is also observed that the plot area of digitized cadastral map and the image map are matching but in case of certain plots the RoR area shows wide variation. The variation is more in case of Government lands, Temple/Trust lands, Common Property Resources and plots near to Village boundary etc. The adopted technology can be
successfully used for modernizing the land records and be upscaled for online land transactions, thereby improving the transparency. The proposed design almost approaches the Torren’s system.

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<end of paper>