

CADASTRAL SURVEYS IN INDIA

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ABSTRACT

Cadastral surveys are essential for smooth running of a government. In India with its federal structure and diverse regional development - traditional methods of Cadastral surveys have so far been in use. The paper describes possibilities of use of photogrammetric methods - and that of rectified aerial photographs - and how the latter method is being introduced in a large State in India with the hope that it will not only be a better technical method but would ensure speedier development of the region and be instrumental in expediting social reform.

CADASTRAL SURVEYS - IN INDIA.

INTRODUCTION

1. Justice and fairplay in respect of ownership of land has been the cornerstone of all organised governments since time immemorial. It is one of the fundamental requirement that the government of the time must protect the property rights of its citizen. To ensure this it has to have documents which record the particulars of ownership - particulars of other rights in respect of use of property - it also has to have a system which ensures that any changes that accrue are recorded and become enforceable.

2. Historically way back even by 1st Century B.C. the institution of a village accountant known as Gopa who was answerable to the next tier of administration the district, had come into being. "He looked into the accounts and statistics of a group of villages. He recorded and numbered plots of grounds, both cultivated and uncultivated, plains, marshy lands, gardens, vegetable gardens, forests, altars, temples of gods, irrigation works, cremation grounds, feeding houses, places where water was freely supplied to travellers, places of pilgrimage, pasture grounds, and roads within his jurisdiction. He fixed the boundary of villages, of fields, of forests, and of roads, and registered gifts, sales, charities and remission of taxes regarding fields" (p.250. Ref(1))

3. During the Moghul period (15th, 16th Century A.D.) one of the major source of central revenue was land revenue. In Akbar's reign it was reformed in 1582 and put on scientific lines. It had the following principal features; Land was surveyed by measurement, it was classified and rates were fixed. "Lands were carefully surveyed, and for measurement the old units, whose length fluctuated with the change of season, were replaced by the LAHI GAZ or YARD, which was equal to 33 inches, tanab or tent rope, and jarib of bamboos joined by iron rings (Tanab-I-bans) which assured a constant measure. - - This revenue system as applied to Northern India, Gujarat and with some modifications to the Deccan, was rayatwari, that is, "the actual cultivators of the soil were the persons responsible for the annual payment of the fixed revenue." (p. 554. Ref 2)

4. As to the present, the Cadastral surveys, currently are the final result of a process that was set in motion towards the end of 18th century. The country was vast and the various regions had different evolutionary history - even the British administration developing from the three centres of Bengal, Madras and Bombay had heterogeneity. This background related to the subject under discussion resulted in the development of non-uniform practices in the conduct of cadastral surveys. To certain extent this non-uniformity was unavoidable as the cadastral surveys which are so

intimately connected with the lives of the people had to respect regional practices otherwise the results would not have been acceptable to the people. This gave rise to quite a variety in the existing cadastral practices.

5. The strong federal structure that has emerged after Independence has given impetus to processes of standardisation in many fields - the weight and measures being one of them. The introduction of metric system from 1957 onwards has necessitated corresponding changes in the cadastral surveys as well. Since this change is imperative - standardisation and improvement in the conduct of cadastral survey operations can also be considered.

REVENUE/CADASTRAL SURVEYS - HOW THEY BEGAN IN INDIA IN MODERN TIMES

6. Towards the end of 18th century, when the East India Company had found a stronghold on the Indian soil they initiated measures to ascertain the domain of their influence so that they may collect as much revenue as was possible. As such the chief object of the Revenue survey was either the formation of a new settlement with the Zamindars and other petty landlords and tenants, or where the provinces were permanently settled under Lord Cornwallis Act of 1790 as in Bihar and Bengal, the definement of every estate on the collectors' rent roll and thence to determine the revenue for each estate.

7. At the outset it was realised that the estates being generally small, scattered and intermixed, it would involve enormous expenditure to define each minute parcel of land, by means of scientific surveys. A via media had to be found. The outcome was that scientific surveys (generally referred to as revenue surveys) were confined to the survey of village boundaries only. This provided the necessary frame-work within which details of property constituting each village could be filled by cheaper means. The cheaper system was the so called "Khusrah" survey. The scientific survey was to provide the overall area check and the correct over-all layout of the villages.

8. The "Khusrah" was a statement of measurement of each parcel of land lying in one spot in the occupation of one cultivator and held under one title. The measurement was according to the locally accepted system known and appreciated by the inhabitants of the district. The operation was conducted by most rudimentary means like ropes, rods or chains according to local usage.

9. The "Khusrah" also involved investigation into all the details of the qualities of the soil, nature of crops and every other description of information tending to facilitate the assessment with every individual proprietor and at the same time to preserve the right of the subordinate cultivator, by recording

their separate fields and the terms on which they held them.

10. Thus in "Khusrah" the field measurements of every holding and parcel of land differing in quality or coming under the various denominations of settlement are recorded separately. The supervising officers task is difficult in as much as he is to ensure not only that the measurements are correct and the other related data are correct so that there is no loss of revenue but also that simple and often illiterate tenants are not being victimised and exploited.

11. Simultaneously with the recording of measurements and other related data in respect of each field the Ameen also prepared a rough eye-sketch of the relative position of all the fields numbered to correspond with the register or field book and which, therefore, formed a complete index to the document. This map used to be traced by the hand without scale, rule or compass. The area of each field was calculated with the help of measured data and then summed up in respect of all the fields forming a village. The area of the village thus obtained was compared against the area of the village as obtained by scientific surveys and was supposed to agree within 5%. A comment by Thuillier in 1851 is worth reproducing:

" It is a matter of astonishment how such a result is produced. Such is the nicety with

which experienced men can bring these measure -
ments, when rigorously watched and superintended,
but only when kept in check by the simultaneous
procedure of the scientific surveys, that thousands
of villages are annually completed, differing
from the true areas much less than the maximum
allowance, the average difference frequently
being reduced to 1% of the total area."

12. However, a check on the calculation of the
area, though of primary importance, was not enough. It
was essential to judiciously and minutely supervise,

".....the crops and quality of the soil in
which lies the greater chance of the Ameen defrauding
the Government by describing land as second or third
quality and yielding but one crop, when it is in
reality first class and producing two crops annually
and on this essential investigation depends the amount
of Sudder Jamma (revenue) likely to be collected where
an assessment is to follow."

13. In due course use of compass was introduced
in "Khusrah" measurement and finally in some places
'even chain survey' was introduced for recording measure-
ments of fields.

14. As to the legality of the documents for the
purpose of establishing ownership rights it is interest-
ing to note that the documents have only limited value.

It is seen that

"The principles of land revenue registry were laid down in regulations XXVI of 1802. Under it the revenue registers have been designed to show the real owners of lands so as to facilitate collection of land revenue from them. In view of this Sudder Adalah court of 1832 on a reference by the Govt. about the interpretation of Reg. XXVI of 1832 remarked that "it is sufficiently obvious that registry by the Collector cannot confer title, and the converse proposition, namely, that want of registry cannot take away title to landed property follows as a consequence "Consequently the courts have held that the "Patta does not create any interest in land, howsoever valuable it may be as an evidence of possession, and is only a memorandum showing the extent of land in the holding of a Pattadar, and the government assessment due there on." (p.23. Ref.3)

15. The picture is further complicated since there is overlapping and multiplicity of tenures and tenancy with their own traditional recognised rights but then this is not the problem of survey proper but of settlement.

16. We have discussed all the necessary ingredients of a revenue/cadastral survey. We will now see how

the availability of new techniques can help in the various operations.

ADVENT OF AERIAL PHOTOGRAPHY

17. During the First World War experiments were made to exploit the information content which could be obtained from photographs taken from air. The aerial photograph was found to be a mine of information. However, the quality of image was poor and the geometry of a photograph was not well understood - a situation which has changed considerably.

18. As in other fields definite proposals for the adoption of air survey were first made (about 1927) during the settlement of the Chittagong District in Bengal. The Air Survey company was employed to produce rough four-inch maps of an inaccessible area of dense forest. The comparison between this map (a 16-inch map) and the survey which had been carried out by ground methods satisfied the Government of Bengal.

19. A contract for the survey of about 1700 sq. miles in Malda district was awarded next. The maps on 16-inch to the mile were to show every holding. The first attempt proved abortive but subsequently in 1929 maps covering about 100 sq. miles were prepared by rectification of individual photographs. These were found satisfactory and the Government of Bengal then sanctioned survey of another 800 sq. miles of Malda district.

20. The Government of the then United Provinces also contracted for survey of about 2700 sq. miles in the districts of Sitapur, Bahraich and Faizabad.

The essential steps involved were :

- (a) Photography about 1/10,000 scale;
- (b) Preparation of contact prints and enlargements on 16" = 1 mile were made; enlargements
- (c) traversing enough to provide control for each photograph.
- (d) marking up on enlargements of all details required on the map by the settlement staff in the field Detail not appearing on photograph was fixed by measuring from details recognisable on photograph and subsequent plotting;
- (e) rectification of photographs on a scale of 16" = mile;
- (f) inking up of all details on rectified print;
- (g) tracing of village sheets on celluloid;
- (h) printing by Vandyke process.

21. The maps were found satisfactory. The economy of air surveys was estimated to be about 25 to 30%.

Further accuracy and speed of Air Survey method were firmly established.

PRESENT STAGE

22. In retrospect it seems surprising as to why this method which had proved its utility and economy did not find large usage, possibly it is because of lack of an agency through which results of improved methods

could be disseminated and standardised procedures brought in use in all the states. Fortunately this lacuna is no more there. A Standing Committee has been constituted. In fact now we have many more advantages - in that we have better cameras whose resolution and coverage is more than that of previous cameras - we have techniques and instruments to extend and supplement planimetric control so that control for each photograph need not be provided by ground methods and finally we have sensitized reproduction material of very good dimensional stability on which rectified enlargements can be made. The improved equipment and techniques will give better results at comparatively less cost.

DISCUSSION ABOUT SUGGESTED METHOD OF RECTIFIED PRINTS
IN FLAT TERRAIN

23. We have seen that there were two distinct operations which served the purpose:

(a) Revenue Survey:

This was confined to the survey of village boundaries only and provided an overall check for the sum total of areas of holdings of each village as worked out by the Ameens. It also provided the frame-work within which the details of holdings as obtained by Ameens could be filled. It will be seen that tracings made from combinations of rectified prints could serve the purpose admirably. No truer boundary can be traced by ground methods as the photograph records every bend and peculiarity of the boundary. Of course, this can be done only if the boundary follows some identifiable

detail. In case, in parts it does not follow any identifiable detail it can be surveyed on the ground with the help of measurements from details which can be identified. With the help of these measurements the boundary can be plotted on the rectified print to ensure continuity.

For this method, in a number of cases, it may not be even necessary to provide dense ground control afresh as the old control points if available e.g., village trijunction etc. could be sufficient. Extension of control by aerial triangulation or slotted template could also be thought of.

The accuracy of area obtained by this method would be sufficient for all practical purposes.

(b) "Khusrah" Survey:

In the initial stages it consisted of field measurements of each individual field by means of ropes, rods or chains as locally in use and the recording of data regarding ownership, cultivation rights, tenancy, soil type, details of crop, etc. The field measurements were drawn without a compass or proper scale to form a composite index. The so called map was only to serve as an index to the layout of fields.

Subsequently more modifications were introduced. These were dictated not by the requirement of utility but because of the scope they offered for sub-

sequent check on the work. Tracings made on scaled rectified prints would meet the requirement of indexing and affording a check on the measurements taken in the field. In fact, each and every measurement of the Ameen can be subjected to a thorough check, and this would serve as a great deterrent against any favouritism or fraud.

The measurements on the ground can be confined to the measurement of field boundaries which lie below shadows or where the boundaries do not follow any recognisable feature. The boundary as measured from identifiable detail can be plotted on the rectified prints.

The other information like ownership, soil capability and crop pattern will have to be collected on the ground in any case.

24. The advantages of using the method of preparing maps with rectified prints are many and can be summarised as follows:

- a) affords a very speedy economical and faithful method of obtaining dimensional data in respect of individual plots.
- b) Provides an opportunity for 100% check if considered necessary of the work of Ameens etc, thus ensuring that the cultivators will have justice and fairplay.
- c) Makes available a set of photographs which can be used for other regional development and planning.

- d) With some experience supervising officers will be able to analyse the soil information picked up by the Ameen in a scientific manner - at least in the case of adjacent fields. There will be a possibility of subjecting the work of the field officials, to a scientific check.

25. To appreciate the information content of a tracing from the rectified print reference may be made to Annexure-I, enclosed which is a tracing made from a rectified print. It has taken:

- a) 5 days on providing control (Traverse) and 6 days for photo verification of village boundaries and plot boundaries. The latter work was done with the assistance of the Lekhpal and village headman.

An allowance in this period has to be allowed as :

- (i) The work was carried out during heavy monsoon which restricted the working hours and made movement difficult.
- (ii) The men employed were not quite conversant with the requirement and type of work.
- b) A couple of hours for rectification. The rectification was done on scale 1/4,000 on sensitised correctostat paper from negative on scale 1/10,000.
- c) One day in marking the boundaries on the rectified print. This stage could be combined with a) above thus avoiding duplication of

effort.

d) One day on tracing on astrafoil.

26. Annexure I should be compared with Annexure 2 which is an accurate photogrammetric survey. It will be seen that even in this undulating terrain the comparison is satisfactory except in a little bit of the South-east area. The distortion here is because of relief. All the same it will be seen that individual plots are accurate dimensionally as well as in shape throughout the area. This particular aspect has an important bearing in cadastral surveys and its satisfaction affords a very convincing argument for the use of this method.

The same work when carried out by normal plane-table method took about 35 working days excluding the days taken on provision of control. The time taken for provision of control was also more than as in para 25(a) as more control was required.

Thus just for details a saving of about 70% in time was effected. This by any standard is a worthwhile economy.

ACCURACY OF PHOTOGAMMETRIC SURVEY

27. Map at Annexure II has been surveyed on Wild Autograph A-7 on a scale of 1/4,000 from photo negatives on scales 1/10,000. The data for planimetric control, that is a point in each corner of the stereoscopic model, and photo-verification of the boundaries was the same as

earlier for rectification. The time taken for photogrammetric work was

- (a) Time for preparation 5 hrs.
- (b) Time for plotting 75 hrs.
- (c) Time for inking 21 hrs.
- (d) Area surveyed 186 acres

The plotting was checked by traversed partial lines and all field bunds were found to agree within plottable accuracy (0.25 mm).

This method of photogrammetric survey is beyond doubt the most accurate method but is not warranted at the present stage. Use of orthophotos has enlarged the application to even undulating terrain.

28. A comparison of time taken by different methods based on figures given above is illustrative as is apparent from the following tables

	Planetable method	Rectification	Photogrammetric plotting method
Provision of control	60 hrs.	40 hrs.	40 hrs.
Verification of plot boundaries	--	48 hrs.	48 hrs.
Plotting in the field	280 hrs.	--	95 hrs.
Rectification	--	4 hrs.	--
Transfer of boundaries on photos (Rectified)	--	6 hrs.	6 hrs.
Total time taken	340 hrs.	98 hrs.	189 hrs.
Saving in time	--	71%	44.5%

It is fairly obvious that adoption of rectification method will prove very economical aside from the fact that photo based cadastral survey will have many other advantages.

29. Another factor which has to be considered is that in cadastral surveys as currently in practice about 40% of the total cost goes towards survey - there will be significant savings in time and money spent. The relevance and validity of this line of thinking has now been accepted in one State in India - the State of Madhya Pradesh. The method was proved by undertaking an experimental survey of 4 villages in the Panna District. The results were checked against available records based on classical surveys and also by ground checks and found to be acceptable in every way. Now about 3,000,000 hectares have been taken up for surveys. Aerial photography on 1:15,000 scale taken by 152 mm focal length modern camera has been adopted to produce rectified prints on 1:4000 scale. It is expected that the cost would be about Rs.10/- per hectare.

CONCLUSION

30. Tracings made from rectified prints on non-distortable material have been advocated for revenue/ cadastral surveys in the first instance in plain areas. These would give the necessary accuracy. Emphasis on theoretical accuracy to be aimed in cadastral maps has not much meaning as :

- a) from the point of revenue assessment, area

of the property is only one of the factors amongst many like capability of soil, frequency of crop rotation, irrigation facilities etc. which are mostly a matter of judgement. A tolerance of 5% in area will meet the demands of the situation (Ref. to para 12).

- b) for cadastral purposes particularly for the purposes of exact property rights the data will have to be collected in respect of each field by visiting each field and recording the data in the presence of the concerned party. This practice is necessary to instil confidence and cut down fraud. During this process taking and recording of measurement of field could also be carried out without adding much to the process in terms of time and money. The plotting would be saved.

31. The rectified mosaic is the speediest and the most economical method. It provides means for a thorough check on the field work by the settlement officers and thus guarantees fair play and justice to every cultivator.

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TRACE FROM RECTIFIED PRINT



