

Cadastral surveys and records of rights in land

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Based on the 1953 study by
Sir Bernard O. Binns

Revised by
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FOREWORD

This paper was first produced in 1953 as one of a group of connected studies on land tenure and related subjects undertaken as part of the programme developed in response to Resolution No. 8 of the Sixth Session of the Conference of FAO.

Some of the studies in this group were intended to clarify the issues in the very complicated and controversial subject of land reform by providing a reasonably concise and balanced presentation of the subject, both in its general features and in the special aspects revealed in particular types of land tenure and for particular development projects. Others were meant to give direct assistance to those engaged in studies or programmes of action in the field of agrarian affairs by providing guidance on methodology and the use of technical terms, etc.

The present paper belongs to the second of these groups but has, it is thought, a much broader justification than that just suggested. The importance of large-scale maps to the success of almost every activity in connection with agricultural and rural development is so great, and so commonly overlooked, that it is felt that to reissue this paper, written from the point of view of FAO, would be fully justified even if the subject were not so closely related to agrarian reform.

The original studies were based mainly on existing and readily available information and experience, and were to be regarded not as products of detailed research, but as papers on which subsequent research and action could be based. They thus made no claim to be exhaustive and no pretensions to authority other than that given by the knowledge and experience of the authors who had, in all cases, been chosen as persons or institutions possessing or having access to unusual knowledge and experience in the fields in which they dealt. The intentions of this paper remain as before which is to produce a work that can be of equal use to FAO field officers as well as to officers of member governments engaged in similar work and to ministers and other high governmental authorities responsible for framing agrarian policy.

Sir Bernard Binns, KBE, who was the original author of the paper, was for five years head of the Department of Settlements and Land Records in Burma (now Myanmar), which was responsible for the cadastral survey and land registers, and he was also for two years, as Financial Commissioner, responsible for the whole land revenue administration of which the Land Records Department was an integral part. Altogether his connection with the department covered some 14 years. He had thus long personal and practical experience of the subject and had drawn freely on this experience in writing the paper. This revised version of Sir Bernard Binns' paper has been prepared by Peter Dale, a Chartered Surveyor with considerable experience in the field. He has attempted to update the original material in the light of changing technology and contemporary views on the function of a cadastre. Much of the original material remains unchanged since it contains fundamental truths that are as valid today as they were in the 1950s. The opportunity has however been taken to refer to developments in information technology and the manner in which these impinge on modern land registration and cadastral systems.

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Introduction

The land is our most valuable resource. It is indeed much more than this: it is the means of life without which we could never have existed and on which our continued existence and progress depend. The resources of the land are neither inexhaustible nor indestructible, as many men and women have already found to their cost. Resources that had taken many millions of years to accumulate have been squandered or allowed to waste away in a few decades, and this squandering and wastage is continuing wherever definite measures to stop it are not being undertaken. Some of the resources of the land, for example, deposits of metals, coal or oil, are not in practice renewable nor can they be both preserved and used. Many other resources can be preserved and even improved in use. It is essential to the mere continued existence of human life on earth, to say nothing of our continued and increasing prosperity, that the resources of the land should be known as accurately as possible. The limitations of those resources which cannot be renewed should be understood and their unnecessary waste avoided, while renewable resources should be carefully conserved and used without waste or damage. It should be our aim to hand on the natural heritage improved, or at least unimpaired, to future generations.

Accurate knowledge of natural resources and an accurate description and record of such knowledge are the first essentials to their rational use and conservation. Measurement is a principal means of acquiring knowledge - in the pure sciences from astronomy to nuclear physics, in the applied sciences, in the arts and in the ordinary processes of daily life. It is, moreover, a most potent instrument of description and record and an essential method in almost every form of human activity. Land survey is the process of measurement and delineation of the natural and artificial features of the earth. The surveyor's observations, measurements and computations and the maps drawn from these are the record of knowledge acquired through survey. The maps are, furthermore, a description of the features measured and delineated in very precise and practical form. These measurements and delineations, when recorded in the form of maps either on paper or within a computer, are at once the best basis of accurate inventories of natural resources.

Hardcopy and digital maps are the media in which the nature, extent and position of resources can best be described and a firm foundation for their orderly and systematic conservation and development. A well-made map is an accurate scale model of the surface of the land which when presented in two dimensions at a sufficiently large scale, can be used to indicate any point on the land with accuracy. A map is, in fact, much better than a photograph for most purposes, not only because distortion can be eliminated to a much greater degree, but also because through the use of conventional signs, contour lines and other devices, the map can show all significant detail with greater simplicity and clarity than in a photograph. It is also possible in a map to show information about what is above or below the ground and to reject irrelevant detail. A series of maps can be used as an accurate record of geological formations; depth and movement of water; movements, temperatures and pressure of the air; volume and distribution of rainfall; distribution of flora and fauna; details of human population or activities; and so on. Digital maps can be combined, manipulated, analysed and displayed in different ways through the use of geographic

information systems. In the comments that follow, the term “map” includes maps in digital form.

In almost every country, a great body of public and private rights and privileges relating to the land has grown up, usually accompanied by an almost equally complex system of duties and responsibilities. An accurate large-scale map is the only sound basis for a record of such rights, privileges, duties and responsibilities. No system of registration of rights can be effective and no system of land taxation can be just and efficient without a description which enables the land affected to be identified with certainty on the ground, and no such identification can be regarded as certain without a suitable map to which the description can be referred.

As the population of the world continues to grow and the technical resources available become greater and more varied, so it becomes both more important and more easily possible to plan and organize development of natural resources. But no great work of engineering, no orderly development of agricultural, forest or mineral resources, no schemes for town or country planning can be prepared and executed without maps on large scales and of high accuracy.

In spite of the great use and value of good maps it is a lamentable fact that much of the world is still not adequately mapped for its present needs, especially in urban areas. Many maps are no longer up to date since there has been insufficient investment in map maintenance. The situation in respect of records of rights in land can be no better than that of the large-scale mapping, because a large-scale map is the only satisfactory means of identifying particular pieces of land and of defining their boundaries. The situation as to records of rights, however, may be and probably often is a good deal worse than that of the available maps. Although full information as to national records of rights in land is not readily available, enough is known to be stated definitely that there are many advanced countries in which the system of recording rights leaves much to be desired, and that many less advanced countries still have no formal record of rights in land at all.

The justification for the reissue of this paper lies in the fact that neither the unsatisfactory state of the world's land records nor the quite unnecessary handicap which this imposes on the possibility of orderly human development seems to be realized, and the argument of the paper may now be briefly stated.

The premises are:

- a. It is important - and, to a progressive economy, absolutely necessary - to have a full and accurate knowledge of the natural resources of the land.
- b. Maps are the best means of obtaining, recording and analysing such knowledge.
- c. Maps are absolutely necessary to the success of schemes for planned development of natural resources.
- d. The complexity of human relationships with the land is such that it is essential to record in detail these relationships as represented by public, communal and individual rights in land.

- e. Large-scale maps in either graphic or digital form are the only sound basis for such a record.

These premises lead irresistibly to the conclusion that no progressive country can afford to deny itself the advantages that derive from an accurate large-scale survey of its land and from a precise and up-to-date record of the rights held therein. This monograph tries to support this conclusion by examining the nature and scope of land surveys and records of rights and of the more important purposes served by cadastral and other large-scale maps and by systems of registration of rights in land. It examines these from the point of view of the land reformer, the landholder, the government, agriculture, economic development generally, and the general public.

The conclusions that it is considered can be drawn from this examination are summarized below under the relevant headings:

Land reform

1. A proper system of cadastral survey and registration of rights is the essential basis of a real understanding of the agrarian situation in a country, and thus to the planning of any measure of agrarian reform.
2. Such a system is, if possible, even more important in the execution of any plan of reform which involves any disturbance or change of existing rights in land (e.g. resettlement, expropriation of landlords, amalgamation or subdivision of holdings, consolidation of fragmented holdings, etc.).
3. Large-scale maps are essential to the proper planning and execution of schemes for the settlement of new lands.
4. Large-scale maps (and usually registers of rights) are of the greatest value in carrying out the provisions of tenancy legislation involving control of rents or security to the tenant's land and improvements.
5. Registration of rights greatly facilitates the operations of any scheme for the supply of agricultural credit, especially to small farmers.

The landholder

6. The fact that the land is properly mapped and that rights are clearly registered is of the greatest benefit to the private landholder.
 - a. It provides the fullest possible security of tenure, and minimizes the possibility of disputes and litigation.
 - b. It enables credit to be obtained more easily and probably more cheaply.
 - c. It enables transactions in land to be effected safely, quickly and cheaply and limits the need for assistance from lawyers or other expert intermediaries. This is, of course, of great importance to small proprietors.
 - d. It secures the rights of absentees and of persons with pre-emptive or reversionary rights, and of those enjoying easements or restrictive rights of any kind.

- e. It both prevents the growth of unwanted prescriptive rights in land, and assists in proving the existence of such rights where this system of acquiring rights is considered desirable.

7. Provided that the system of registration of rights is suitable, it will not facilitate the introduction of unwanted innovations in a traditional system of communal tenure, but will, on the contrary, protect and preserve the essential features of such a system.

Administration

8. The existence of accurate maps and of an unimpeachable record of rights greatly assists and renders more efficient every branch of the public service connected with the land. This is especially true of taxation, irrigation, drainage and flood control, and of the preparation of agricultural and agrarian statistics of all kinds.

Agricultural development

9. Large-scale maps are of the greatest assistance in the preparation of inventories of natural resources in land, water, and vegetation which are essential to planned agricultural development.

10. Such maps are also necessary in the carrying out of detailed geological, soil productivity, land use, erosion, farm management and other surveys and classifications in connection with agricultural development.

11. No major project of agricultural engineering (irrigation, drainage, flood control, electrification, soil conservation, etc.) is possible without very accurate large-scale maps of the area affected.

12. The orderly investigation, conservation and exploitation of forest resources demand the proper mapping of forest areas, and maps are even more important in all schemes of reforestation or afforestation.

13. The administration and development of inland and estuarine fisheries require accurate large-scale maps and the registration of existing rights in land and water.

14. All forms of public financial or material aid to farmers (subsidies, grants-in-aid, credit, seed or fertilizer distribution, pest control, plant protection, etc.) are rendered much easier and more economical by the existence of cadastral maps and records of rights.

15. Large-scale maps greatly facilitate the application of all sampling methods in statistical research connected with the land.

Other development programmes

16. Large-scale maps and records of rights are essential to the orderly investigation, classification and development of mineral resources.

17. Such maps are also absolutely necessary for all town-planning schemes, for the orderly development of industry in rural areas, and for the development of systems of communication.

18. The record of rights greatly assists in many forms of economic enquiry and sociological study, and in the development of rural welfare programmes.

19. The staff required for the maintenance of the cadastral survey is in an excellent position to collect without much additional expense many kinds of information needed in connection with development schemes which would otherwise require special staff and much additional expense.

20. The cadastral maps and the corresponding index maps can conveniently be used as base maps for the recording of any information which requires maps on these scales.

Defence

21. Large-scale maps are absolutely essential to the modern needs of national defence.

The general public

22. Besides the economic, fiscal, agrarian, scientific and administrative uses suggested above, there is a growing demand for maps and plans of all kinds for recreational purposes, for air travel, for the use of tourists, in connection with historical, archaeological or artistic studies, for commercial and industrial purposes and in educational work at all levels.

Cost

23. Though the production of large-scale maps is necessarily somewhat expensive, it is not beyond the means even of relatively poor agricultural countries. It is essential that maps and land records be kept up to date but the cost of maintenance of maps and of the preparation and maintenance of records of rights need not be expensive. All expenses incurred will rapidly be recouped in the advantages derived from the existence of the maps and records.

Land surveys and maps

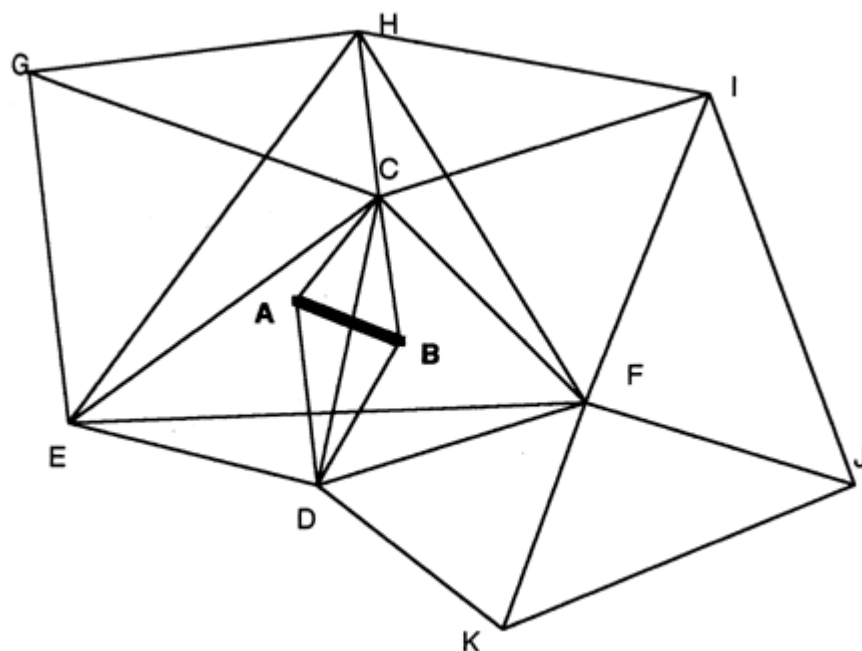
The art of making maps is a very old one. The ancient Egyptians and Babylonians made maps and plans, fragments of which have survived. The Greeks, having recognized the Earth as a sphere, applied astronomical observations to map-making: in fact in the third century BC, Eratosthenes estimated the circumference of the Earth with a degree of accuracy only surpassed in quite modern times. In the second century AD the Egyptian-born Greek Ptolomey was responsible for the production of a set of maps which remained standard works of reference for more than a thousand years. During the fourteenth, fifteenth and sixteenth centuries a series of seamen's maps, known as portolan charts, were produced covering the Mediterranean and neighbouring seas. In the sixteenth century Mercator invented the projection known by his name and still commonly used, especially in navigational charts for which it is convenient because compass bearings appear as straight lines. Mercator's maps also use the framework of latitude and longitude, which originated among the ancient Greeks.

A line of division between ancient and modern map-making may be taken as marked by three great achievements namely, the triangulation of France begun by Cassini de Thury in 1747 and finished by the French revolutionary government, the first accurate triangulation of the United Kingdom done by William Roy, and the connection by triangulation of the observatories of Greenwich and Paris carried out under the auspices of the British Royal Society. Triangulation became the basis of all modern mapping. It is only with the introduction of the Global Positioning System (GPS) and the use of artificial earth satellites to establish the positions of points on the surface of the earth that a significant alternative to triangulation has become available.

The techniques of land surveying are founded on five basic principles. The first is that of "working from the whole to the part" that is establishing an initial framework of control points that is then "broken down" into smaller networks with points closer together. The second principle is that of consistency in that once the higher order network has been established, it is possible to work to less rigorous standards in the lower orders without affecting the overall accuracy of the work. There has been no point in working to higher standards since in connecting the later work to the earlier, the higher order work is held fixed and hence the new survey cannot be better than the higher order control. The third and related principle is that of economy, namely that since higher accuracy in general costs more money the surveyor should seek no higher accuracy than is necessary and sufficient for the task in hand. The fourth principle is that of applying an independent check on the data wherever possible - for example by measuring all three angles of a triangle even though the third angle measurement is redundant. This has the effect of providing built-in quality control. Finally, as a matter of principle, since changes take place over time, mechanisms must be established to ensure that the survey is kept up to date if it is to be of continuing use. It is the latter principle that has not been adequately addressed in much of the world's mapping today.

The traditional means for establishing control is triangulation, the principle behind which is that of simple trigonometry, namely that if either two angles and one side length in a triangle are known, or all three side lengths are measured,

then the precise size and shape of the triangle is known. Measurements of angles are made using a theodolite while distances which in the past had to be measured very laboriously with metal tapes are now recorded using electronic distance measuring devices. The fact that the Earth is a spheroid and not a plane surface means that no Euclidean straight lines can be measured on its surface. Lines so measured are not even arcs of a true sphere and this introduces complications in the measurements and calculations. It does not however detract from the simplicity of the principle and most modern maps have ultimately been based on a series of triangles originating from one or two base lines of known length and extended across the area covered by the map. This has formed a primary network of control points that in turn were used as the basis for determining a series of second order networks; these in turn were used to establish third order and fourth order points with local detail being fixed in relation to the overall network.



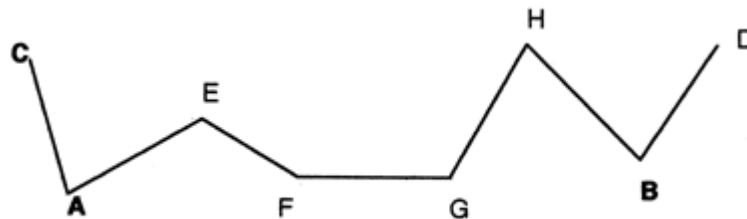
Triangulation using AB as a base line
 The distance AB is measured precisely
 Then C, D, E, F, G, H, I, J and K can be fixed by angular measurement only.

While triangulation techniques have been used to establish horizontal control, measurements of height have been obtained either by the measurement of vertical angles using a theodolite (and correcting the observed angles for the effects of curvature of the earth and refraction of the light through the atmosphere) or by levelling. The latter technique uses a spirit level and two graduated staves to obtain what can be very precise measures of the difference of height between successive points. Thus by starting at points of known height, the levels can be transferred successively until another known point is reached which can be used to check that no gross error has occurred.

Given an initial framework of horizontal control points, additional points can be established either by further triangulation, or by trilateration (that is measuring

the sides rather than the angles of triangles), or by traversing. In addition, satellite position fixing methods or photogrammetric techniques can be used.

Traversing is a method frequently used for surveying perimeters, or for defining an area for subsequent more detailed survey, or for plotting the course of a road, railway, stream or other feature. The method starts at a known point from which there is a known direction - for example a point already established by triangulation from which another known point is visible to provide the necessary orientation. Traversing then proceeds by measuring the angle and linear distance to the next point on the traverse; from there the bearings can be oriented from the previous point and a further control point established in a forward direction. The traverse proceeds in this way until either it can be closed back on to the point from which it started, or preferably on to a different previously established control point thus providing the necessary independent check against any gross error in the measurements. The angles are normally measured with a theodolite although a prismatic compass or a plane table can be used for elementary surveys. Distances should either be measured by tape with a steel band, by optical distance methods such as the subtense bar, or by electronic distance measurement. The data are either recorded in field notebooks or else electronically for subsequent computation.

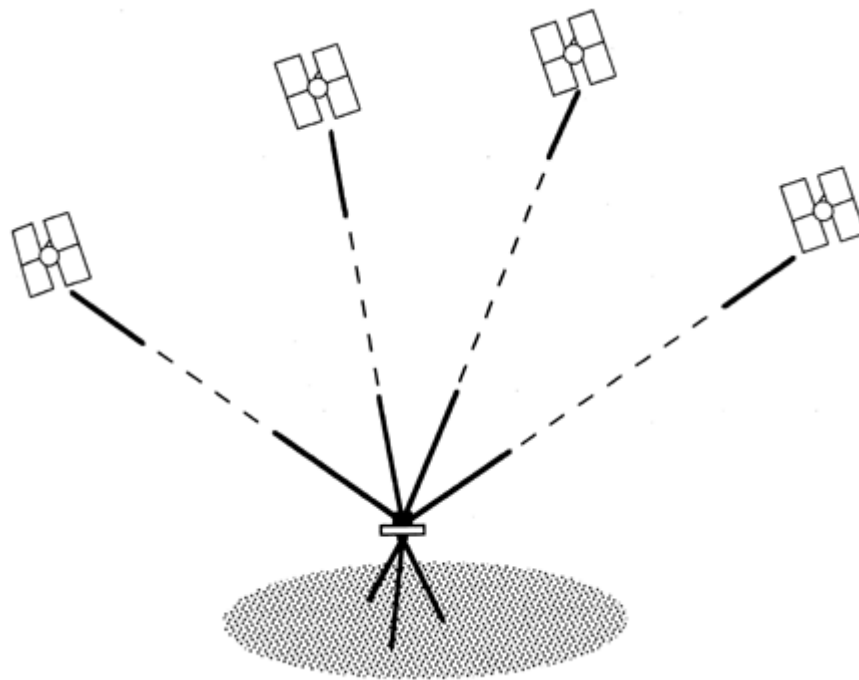


Traversing between known points A and B using known points C and D for orientation and fixing E, F, G and H by measuring angles and distances

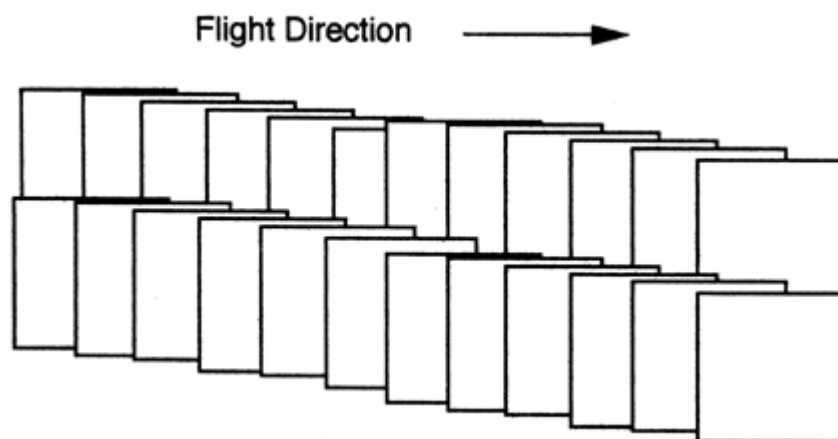
Electronic surveying techniques have become standard in the more developed world. They include measurements using a “total station” that combines both the angular qualities of a traditional theodolite with electronic distance measurement and automatic data recording. The advantages of using such equipment include the speed with which surveys can be carried out compared with traditional methods, thus giving greater levels of productivity; the lower level of risk of making gross errors in the measurements; and the lower levels of manipulative skills that are needed to obtain much higher levels of precision and accuracy. The disadvantages of electronic methods include the much higher capital investment that is needed and the much higher cost of maintenance, both elements being a drain on hard currency for developing countries. Furthermore, if the equipment breaks down it may need to be sent to a foreign country for repair and the progress of any survey can be seriously delayed.

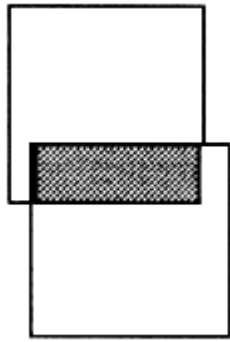
The price of much electronic equipment, especially computers, is still declining but on the other hand much information technology has a relatively short life before it is replaced by more powerful systems that are capable of even greater productivity. The prices, for example of Global Positioning System (GPS) receivers have been reduced significantly since they were first introduced,

making their use an economically viable option. With GPS it is necessary to see four satellites in the sky, the signals from which are picked up by the GPS receiver. The signals are marked with pulses at known times so that the instant at which three signals are received provides information on how far away the satellites were at that time - measurement to a fourth satellite is needed to establish the difference in time between the clock in the GPS receiver and the time being recorded by the satellite system. The system overall allows the relative positions of nearby points on the ground to be determined to within a few centimetres in latitude, longitude and height. Since a good all-round view of the sky is necessary, the technique is not suitable for forest or jungle areas or within city centres where there are many high-rise buildings. In open countryside it is, however, extremely useful and cost effective for establishing dense networks of control points.

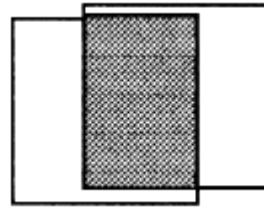


Global Positioning System (GPS) Receiver with signals from four satellites





15% Lateral Overlap



60% Fore & Aft Overlap

Strips of Aerial Photography

Photogrammetry is another method whereby large numbers of control points can be established over a restricted area - provided that suitable points on the ground can be seen clearly on the photographs. The positions of some ground points must be determined either from GPS, triangulation or traverse surveys. Measurements of the position of other points can then be made on aerial photographs and calculations performed in a process known as aerial triangulation to derive the equivalent ground positions of the points measured. Suitable overlapping aerial photography must be available to provide stereometric cover, that is, every part of the ground must appear on at least two adjoining photographs and some points must appear on three successive photographs in a strip of photography. The fore and aft overlap for photographs should be about 60 percent while the lateral overlap between strips should be around 15 percent. Having acquired such a block of photography and depending on its scale, the equipment used, the quality of the images of the coordinated points and the skill of the operators, then it is possible to measure the relative positions of points on the ground to within an accuracy of a few centimetres. Photogrammetry is essentially a mass production technique that becomes cost effective only when a sufficiently large number of points on the ground need to be fixed. The accuracy achievable with modern equipment is dependent on cost more than any other factor.

An additional benefit that comes from using photogrammetry is that the techniques can be used not only for fixing control points but also for plotting detail and contour lines. Ground survey techniques are less suited to topographic mapping other than for relatively small areas.

The trigonometrical data, however derived, refer to positions on the spheroid taken as the survey datum. A map is usually a flat sheet and to transfer the spheroidal data on to this requires a map projection. There are many kinds of projection all of which require changes to be made to the angles and distances measured on the surface of the Earth. Either the shape or the area (or both) of features mapped will inevitably to some extent be altered. Different projections give different results for different parts of the Earth's surface. Some projections have special advantages for particular purposes and the choice of projection in

each case is therefore determined by the part of the Earth's surface to which it is to be applied, and the purpose for which the map has been prepared.

The scale of the map, that is the number of units of length on the ground represented by one similar unit on the map, is of great practical importance. Scales are best described by ratios (or fractions) in which the first figure (or numerator) relates to one unit of measurement on the map and the second (or denominator) to the equivalent number of the same units on the ground. It is obvious that the larger the scale of the map the greater the detail that can be plotted on it. It is equally obvious that a scale that is convenient for one purpose may be most inconvenient for another purpose. Thus a walker may find a map on a scale of 1:10,000 convenient but the same scale would be inconvenient for a motorist who would drive beyond the limits of the map sheet in a few minutes.

The scale of the basic maps produced from topographic survey data is of considerable importance, because, while it is in general practicable and convenient to produce small-scale maps from a large-scale map by omitting detail and adjusting the position and shape of some objects, it is not practicable to produce large-scale maps from a basic map on a smaller scale without much further field work. The scale chosen for displaying a map must depend on the topography and closeness of occupation of the country mapped and on the purposes to which any maps derived from the original maps are to be put. Generally speaking the scale chosen should be the scale which will show the detail required with the necessary degree of accuracy and clarity and give sufficient space for the entry of the descriptive matter required for particular purposes.

When the basic scale has been determined, the foundation of the map is constructed on the required projection from the trigonometrical and other data recorded. The printed map is then usually taken to the field for the entry of final detail, though if it is based on air photographs much of this work may be done in the office.

A feature of most national maps is the "grid". This is a series of lines drawn parallel to and at right angles with a chosen meridian. The purpose of the grid is to enable the position of any place on the map to be located or described. This is done by numbering the squares of the original grid (and their subdivisions) in a recognized sequence. It should be observed that the only map projection on which the grid coincides with the "graticule", that is the projected positions of the network of lines of latitude and longitude on which the map is based, is the simple cylindrical projection. This is never used for topographical maps because of the way that it distorts the shape of the ground. In general the graticule and grid only coincide along selected lines such as the central meridian in the Transverse Mercator which is the most commonly used map projection for topographic mapping. In practice, the grid as a whole never coincides with the graticule.

The most convenient scales for topographic maps for general use are those between 1:25,000 and 1:250,000. Common scales are 1:50,000 and 1:100,000. Even the largest of these maps, however, contains many features indicated by "conventional signs" and not drawn to scale. If real accuracy of topographical detail is required, a larger scale has to be used. Failure to realize the limitations

of standard topographical maps has led to much confusion in the past in many countries, especially in the matter of mineral concessions.

Cadastral Maps

Cadastral is a technical term for a set of records showing the extent, value and ownership (or other basis for use or occupancy) of land. Strictly speaking, a cadastre is a record of areas and values of land and of landholders that originally was compiled for purposes of taxation. In many countries there is, however, no longer any land tax and in practice the cadastre serves two other equally important purposes. It provides a ready means of precise description and identification of particular pieces of land and it acts as a continuous record of rights in land.

A modern cadastre normally consists of a series of large-scale maps or plans, and corresponding registers. Both the plans and the registers may be stored in computers, as discussed in the chapter “computerization of maps and registers”. The present chapter deals with the essential features of cadastral maps with particular reference to the form they take when drawn on paper or displayed on a computer screen. While the survey of an individual parcel of land has in some countries resulted in a “cadastral map” for that plot of land and may have been unconnected to any adjoining land parcels, the true cadastral map covers all parcels within an area rather than isolated plots. It can act as an index for other land parcel surveys that show more detailed information or can be of sufficiently large scale for the dimensions of each plot to be obtainable from the map. In this chapter, and throughout this monograph, the term ‘cadastral map’ will be associated with any parcel of land whether defined by ownership, value or use provided that the parcel has an independent identity and is relevant to the management of land as a resource. A cadastral map will show the boundaries of such parcels but may in addition incorporate details of the resources associated with them, including the physical structures on or beneath them, their geology, soils, and vegetation and the manner in which the land is used.

The scale of cadastral maps is of great importance. Since the object of the map is to provide a precise description and identification of the land, the scale must be large enough for every separate plot of land which may be the subject of separate possession (conveniently called a “survey plot” or “land parcel”) to appear as a recognizable unit on the map. When map data are stored in a computer, they may be drawn at almost any scale and this can give an impression of greater accuracy than the quality of the survey data may warrant.

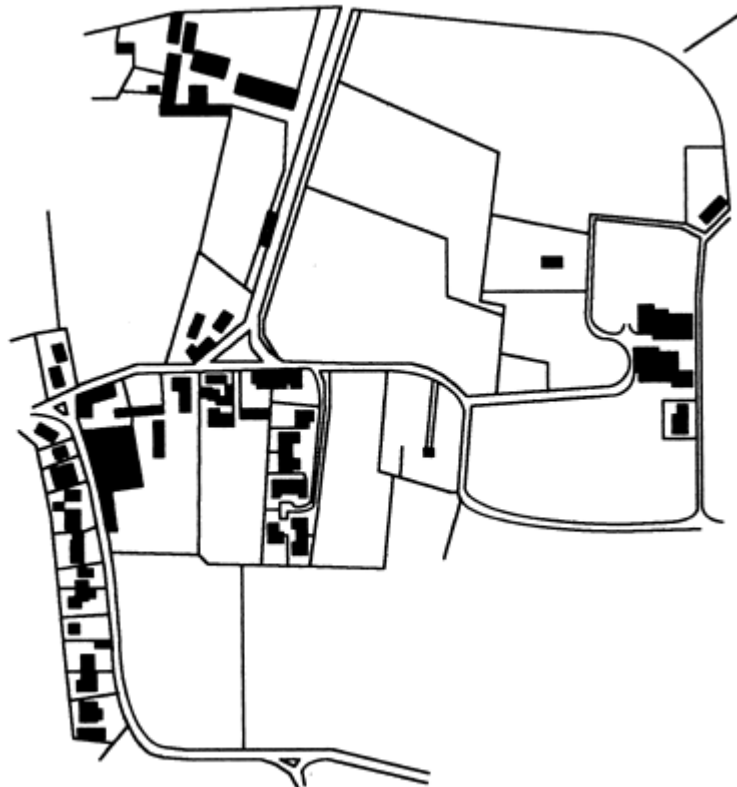
Since the map and the corresponding registers form complementary parts of the same system of description and identification, there must be some system of cross-referencing between what is shown on the map and what is recorded in the registers. This usually means that either names or numbers must be given to each separate land parcel. These references are known as property identifiers (PID) or unique parcel reference numbers (UPRN). Various reference systems have been developed including:

- a. The name of the grantor or grantee
- b. A sequential title number
- c. The volume and folio numbers on which the plot is registered
- d. The name of a farm or locality with an individual plot number
- e. The registration block and individual plot numbers

- f. A post office address
- g. A street index reference and parcel number
- h. A grid coordinate or "geocode"

The reference chosen should be easy to understand and easy to remember; easy to use for the public and by computers; permanent so that it does not change with the sale of a property, but capable of being updated when there is for example a subdivision of the land; unique; accurate; and economic to introduce.

It is essential that when these numbers or names are drawn on a map that they do not obscure the details of the map itself. The cadastral map should show the boundaries of each land parcel and in some jurisdictions may also show its area and the actual length and bearing of each boundary line. These considerations may obviously demand a scale somewhat larger than that required merely to indicate each surveyed plot.



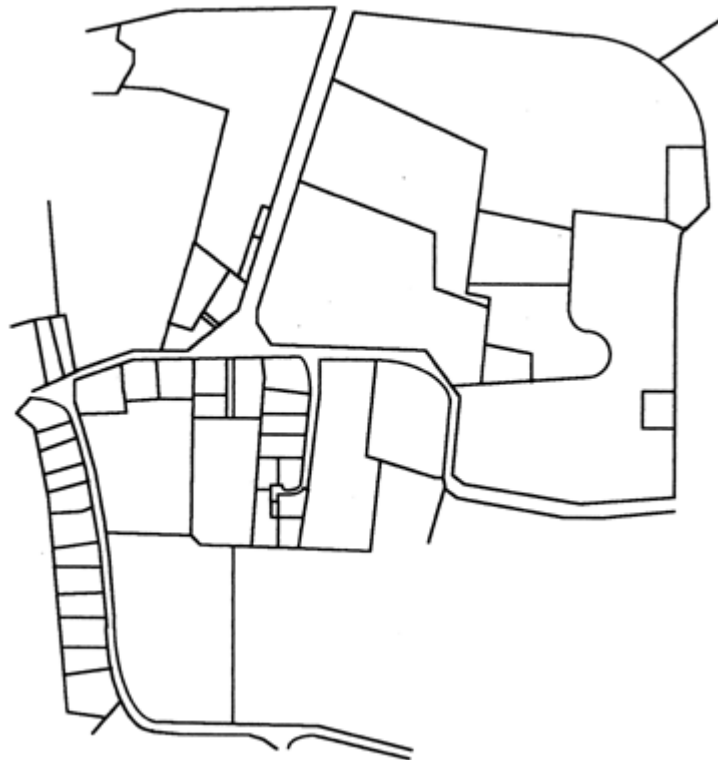
Topographic Plan showing physical detail

The smallest satisfactory scale depends primarily on the area of the smallest survey plot likely to be met with, and may thus vary greatly in different circumstances. A much larger scale will be necessary for cadastral maps of towns than for those of rural areas. Similarly a closely occupied countryside consisting of small fields and holdings will require maps on a larger scale than is necessary in areas where there are large farms with open fields.

The maps with which most people are familiar are topographic maps at scales of around 1:50,000. Such maps make it possible to show accurately (though not always to scale) the position of roads, railways, footpaths, villages, rivers, streams, bridges, important buildings, administrative boundaries and other similar features as well as the relief of the land, the depth of water and variations in tide level. These maps are however quite inadequate for cadastral purposes. A simple example will make this point clear. A carefully drawn pencil line will have a width of perhaps half a millimetre. On a map on the scale of 1:50,000 this would represent a line of 25 metres wide of the ground. There are many countries, especially hilly countries, with separate fields less than 25 metres wide. Most cadastral maps need to be at scales of between 1:500 and 1:2,500 although in densely developed areas a larger scale may be needed while in open countryside much smaller scales may be acceptable.

Large-scale plans are initially much more expensive to make per unit area than small-scale maps, but it must always be remembered that, once the large-scale survey has been completed, accurate maps on any smaller scale can be derived from them. The converse is not however true for although larger-scale maps can easily be constructed by using computers, they can never be more accurate than the original data from which they were first compiled.

Usually cadastral maps need only be “planimetric” maps, that is to say, they need not show topographical relief. There may be special reasons why altitudes should be recorded on cadastral maps, but ordinarily all that is needed is a plan of what is seen, without stereoscopy, from a point vertically above the piece of land observed. Distances recorded on such plans are the horizontal distances between points and not the surface distances actually measured on the ground. Thus the area recorded for a plot of land on a steep hillside will be the horizontal equivalent which may be significantly less than the actual surface area.



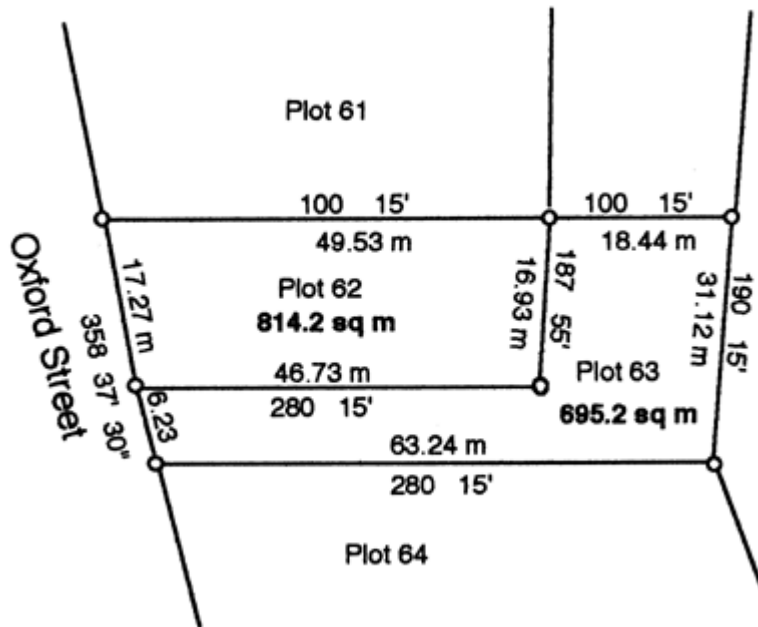
Cadastral Plan showing boundaries of land ownership

A third important requirement of cadastral maps is that they should show a sufficient number of points which can be accurately identified on the ground to enable any other point on the ground to be identified on the map (or vice versa) by eye or by simple and short measurements. Professionally this requirement is satisfied by marks recording the original triangulation stations, or the stations on supplementary theodolite traverses, but this is usually inadequate or inconvenient for practical purposes. In areas where there are permanent fences or fields surrounded by embankments, the fences and banks may provide an adequate means of detailed identification, but in unfenced open fields without any embankments, some means of indicating the land parcel boundaries on the ground will be necessary.

A good mark must be durable in itself and not easy to remove either accidentally or wilfully. In many countries it is also desirable that the material of which it is made should not be of a kind that encourages theft. Since the marks must be easily recognizable they must be fairly conspicuous on the surface but for important points, such as those used as control for surveys, there are advantages in supplementing surface marks with marks that are set in concrete and buried beneath them.

One principal method of identification used in cadastral maps is the "grid". In some countries, such as much of the public lands in the United States, a grid has been laid out on the ground creating a "rectangular system". All parcels of land are formed by straight lines, often running north to south and east to west. The problem with such a system is that it is unsympathetic to the natural topography but its advantage is its simplicity and the relative clarity of the

boundaries on the ground. More commonly however a grid is used as a referencing system so that the coordinates of all boundary turning points can be measured, calculated and recorded. The data can then be stored in a computer and used either to draw the cadastral maps or else for helping a surveyor to re-establish lost boundary marks.



Cadastral Plan showing bearings and distances of sides, areas, and plot numbers

The land parcel reference number can be used to identify the plot. It can be cross-referenced both to the files that contain more detailed survey information about the parcel such as its dimensions, and to the data on ownership, value and use. In many countries the records of survey are held in one government department (the Survey Department) while text data and details of title are held in another. The latter may, for example, be the Lands Department, the Ministry of Justice or even the Government Treasury. It is important that wherever records of land parcels are maintained, every authority adopts the same standard land parcel referencing system.

It is also essential that changes in land parcel boundaries be recorded as soon as they are agreed. All interested parties must be notified immediately of any changes that have taken place affecting land parcels, for example where there has been formal subdivision. A cadastral map must be up to date at all times.

Air surveys and cadastral maps

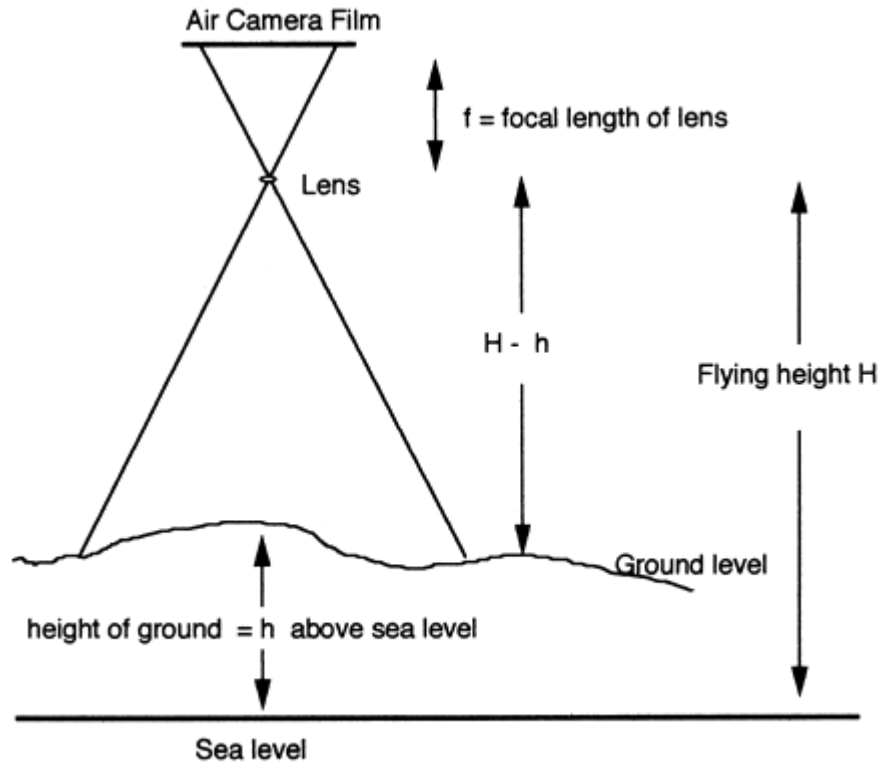
There are two ways in which maps may be produced from primary sources. One is by ground survey and the other by air survey, that is by taking measurements from aerial photographs. Points identified on overlapping aerial photographs may be transformed into positions on maps either by mechanical analogue means or through the use of mathematical techniques. The processes, known as photogrammetry, require some ground measurements to be taken in order to establish the precise scale and orientation of any map in relation to the ground data. The quality of modern instrumentation is now so good that in conjunction with computerized techniques and aerial triangulation, the ground control points that must be provided are relatively few. The actual number depends on the size and shape of the area to be mapped, the accuracy required, and the scale of the photography. The latter varies across a photograph since it is equal to the ratio between the focal length of the air survey camera (f) and the flying height of the aircraft (H) above any ground point (h); mathematically:

$$\text{the scale at any point} = f/(H-h).$$

Since the height of the terrain (h) varies across an area, then so does the scale of the photography.

Photogrammetry can be used to establish a greater density of control points from which it is then possible to compile detailed topographic maps. The outline of features as seen from the air, together with contour lines, can be identified and traced with great ease and economy. Under suitable conditions, photogrammetry can produce maps and measurements that are as accurate or even more accurate than those obtainable by standard ground methods.

While photogrammetric techniques have been extensively used for topographic mapping, they have contributed less to cadastral surveying. In favourable circumstances, for example where there are rice lands with embankments around their edge, terraced hill lands, or land enclosed with well- marked hedges or walls, the photographs may be able to supply all the field detail needed for the cadastre. In other cases this may not be so - for instance in some open field systems where cultivation of the same crops is carried out by different land holders more or less continuously over a wide area, or in some areas under tree cover. The aerial photographs may show temporary detail, for example the divisions of a single field between crops, or details within the survey plot such as minor internal drainage ditches. These should not or need not appear on the cadastral map but may be difficult to distinguish from permanent field boundaries on the photographs.



$$\text{Air Photo Scale} = 1 / (H-h)$$

In many circumstances the legal boundaries of holdings cannot be determined from the photographs without extensive checking on the ground. Generally more work will be required to supplement the photographs in the case of cadastral maps than in the case of most topographical mapping. Nevertheless the techniques can be as accurate as, and significantly cheaper than, undertaking a survey entirely by ground survey methods.

One of the great disadvantages of air survey is that, except for the ground control marks that are part of the basic geodetic framework, it does not leave permanently demarcated points on the ground. A large number of these are often required for an efficient cadastral survey in order to facilitate subdivision work and the future re-establishment of missing boundary features. In ground surveys most theodolite or other survey stations are, or can be, simply and permanently marked by buried pipes or concrete beacons as the work progresses. This system makes it possible to reconstruct any part of a minor triangulation or traverse at any time, a fact of obvious advantage when identifying by measurement any unmarked points or during revision of the survey. In the case of air surveys, the provision of additional ground marks will need to be done independently, often at considerable cost. In all cadastral surveys undertaken by photogrammetry there is a need for follow-up ground surveys to check the actual location of legal boundaries that may not be visible on the photography or may have been wrongly identified.

Survey work of all kinds tends to be expensive and the precise comparative cost of air and ground methods can usually only be determined with regard to

particular cases. Air survey methods benefit from economies of scale where a large number of boundaries or points of detail have to be recorded. The capital and running costs of aeroplanes and the equipment used in aerial surveys are high, and the personnel required are highly skilled and relatively well paid in comparison with some field surveyors. The number of days in the year on which flying can be done is normally quite small but then in many countries the number of days on which field survey work can be carried out is restricted for climatic reasons though not so much as for flying.

There may be difficulty in getting approval for air survey from the military authorities who in many countries have traditionally opposed public access to aerial photographs for supposed security reasons. Given the ready availability and quality of modern satellite imagery, this restriction makes little sense. Would-be terrorists can easily obtain from elsewhere the sort of information that opponents of public access to aerial photography seek to hide. Opposition to the use of aerial photography has increased the cost of many surveys and reduced their effectiveness with consequent but unmeasured costs that have significant impact on the national economy.

Broadly speaking, aerial photographs have been used in cadastral mapping in five different ways. In the simplest case, contact scale or enlarged photographs may be used as a base on which to outline the parcels. In some countries it is sufficient to produce a plan which acts as a signpost to the parcels, the boundaries of which can be determined by inspection on the ground. In such cases there is no need to record the accurate dimensions of any land parcel so long as its boundaries are clearly visible on the photographs. Thus in Kenya, photographs enlarged to 1: 2,500 scale have been used to form the base from which the boundaries of the parcels could be traced. Such an approach is expedient where large numbers of parcels need to be recorded over a short period of time. Where time and money allow, the areas can be resurveyed to higher accuracy at a later date.

More accurate mapping may be achieved by using rectified photographs that remove any distortions occurring when the photography is not done with the camera pointing exactly vertically downwards. The Land Titling Programme in Thailand made extensive use of enlarged rectified photographs, with supplementary information provided by ground survey. Cadastral photomaps at scales of 1:4,000 and larger were produced. A similar technique was used in Botswana where the photo-maps were suitably annotated to identify particular parcels. Given a vast area of savannah country with no nearby ground survey control, it is possible to identify patterns in the vegetation and to trace on to the photographs the outlines of areas of land allocated for purposes such as veterinary stations, air strips and police posts. The dimensions of the plots can then be added from measurements made by taping on the ground. A disadvantage in using rectifiers is the relatively high cost of this equipment.

For areas that are not flat, an improvement on rectification is to produce orthophotographs in which each point on the original photographic image is transformed to its correct position on a topographic map. The resulting product looks like a photograph but has the metric qualities of an accurate map since it removes the changes in scale across the original photographs that are due to variations in ground height. Although this requires more sophisticated

technology, the advantage is improved planimetric accuracy and hence the dimensions of land parcels can be measured by scaling off the plan. In parts of Australia and Canada, orthophotographs have been used successfully in the compilation of cadastral index plans. For many years in the evolution of their landscape, both countries lacked any integrated survey control network and most cadastral surveys were connected only to local features. The result was that although the size and shape of each parcel had been carefully surveyed, there was often uncertainty as to where the parcel was actually located. The orthophotomaps were used as the basis for joining together the mosaic of disparate parcel surveys, rather like fitting together the pieces of a jigsaw.

A different approach to producing cadastral maps is through the use of stereo-plotting machines. These may be used either to show the physical features which coincide or coexist with the legal boundaries or to locate points of detail that can be used as control for simple ground surveys. Cadastral maps can then be compiled from a combination of photogrammetric plotting of physical details that are visible from the air with simple graphical methods of survey to locate specific land parcel boundaries. The resulting product would then be to graphical standards of accuracy, that is to the equivalent of the thickness of a line drawn on the map.

Many countries, however, insist on numerical information for their cadastral surveys and this has resulted in separate topographic and cadastral mapping, leading to duplication of effort even within a national survey department. In urban areas, it is not uncommon to find that large scale topographic mapping has been produced photogrammetrically for the purposes of planning and general land management while cadastral plans of the same area have been compiled separately from independent ground surveys. This separation of function between cadastral and topographic surveying is symptomatic of the polarization that has taken place between advocates of ground and air surveys with a resulting lack of homogeneity in the data.

Photogrammetric techniques can be used to produce numerical coordinate data through the use of analytical stereo plotters or comparators. These produce coordinates for points on the air photographs from which the ground coordinates can be calculated. The accuracy of such coordinates depends upon the equipment used but can be similar to that achieved by ground survey - in Germany and Switzerland, for example, such techniques have been successfully used to revise cadastral maps. The great advantage of air survey over ground survey is the speed and hence the enormous amount of time that can be saved.

In setting up a cadastral system there are obvious advantages in using photogrammetric techniques where the boundaries of parcels are visible from the air or where relatively cheap and stable marks can be emplaced of sufficient size that they can be seen clearly on the photographs. In the case of small areas and when adding to or revising an existing survey, the advantage of speed is much less, and must in any event be weighed against increased costs. The latter are due not only to the higher proportion of time spent in the air in relation to the amount of photography done, but also to the expense of setting up the necessary ground controls for a small job.

There are many purposes for which large-scale air photographs are required, other than for the making of maps. Such cases are erosion surveys, forest inventory surveys, land-use surveys and many others. It may often prove economical to use aerial photography that meets the needs of the cadastral survey and to make maps on this basis, even though the cost of such photography would not be justified solely for the purposes of cadastral mapping.

The general conclusions drawn from the above observations may be stated as follows:

1. Where air surveys are part of the ordinary survey practice of a country, they may also prove suitable for large cadastral jobs, provided that the amount of supplementary ground work required is not so large as to make it more economical to use ground staff alone. In such cases it may be economical to use photography of sufficiently large scale to meet the needs of cadastral surveying even though this exceeds the requirements of other mapping projects. To carry out a dual or multiple purpose survey through one set of photographs may make economic sense. Often however the needs of different applications of the photography are incompatible and multiple sets of photography may be required.
2. Where a new cadastral survey of a large area is required to be carried out quickly, air survey is often the best practical method, unless a great deal of supplementary ground work proves necessary.
3. Unless reasonably full-time employment can be found for the staff and equipment of a national mapping agency's air survey department, it will usually be better to contract the work out to a commercial agency.
4. Cadastral surveys of small areas, extensions to existing surveys, and revision work will usually best be done by the ground staff of the national cadastral survey organization, according to a continuous programme.
5. Air survey will not supersede ground survey for cadastral purposes, but it should complement it. Where there is no great hurry to cover a large area, and especially where local ground surveyors are available or can be made available in sufficient numbers, it may be better to rely entirely on ground survey for cadastral maps, even though air survey methods may be used for some other purposes. In any event there is great merit in making the cadastral staff fully responsible for the maintenance and updating of the maps that they produce.
6. There are many purposes for which large-scale aerial photographs, as opposed to maps based on photographs, are required. If these photographs are being taken, it is possible that with some variations in method and greater care in adjustment they can be used to make maps as well as for their primary purposes. Opportunities of this kind should not be neglected. In fact when air photographs of an area are being taken for any departmental purpose, it is sound practice to examine the possible needs of all departments for photographs or maps of the area and to consider whether it is cost effective to take the photographs, once and for all, on the largest scale required for any of these purposes.

Registers of rights

Cadastral maps are essentially descriptions of the parcels of land (survey plots or holdings) with reference to which rights in land are defined and the holders of these rights identified. Cadastral maps are not in themselves a record of any right held, although it is true that they may be used to differentiate certain types of tenure, for example state and non-state land, reserved forests, and land held by public authorities or under certain tenures (for example religious or charitable foundations). In such cases, the maps may become a part of the record of rights. The formal record of rights is normally contained in one or more “registers” that in some countries are known as the “Land book”. These registers will normally be supported by cadastral maps. The converse is however not true and cadastral maps can exist without registers of rights, for example where they are the original record of a classification of land for taxation purposes.

Registers of rights must be distinguished from registers of deeds. A deed is a written instrument recording a transaction affecting, or purporting to affect, a right. Deeds may be registered for the public convenience or in the interests of private persons. A deed is only executed when there is some change in the possession of a right and a register of deeds is a record of transactions in rights and not of the rights themselves. Registration of deeds may, however, have an important part to play in the preparation or maintenance of a register of rights, as will be discussed later.

Rights in land are of many kinds, varying from full ownership to a mere conditional right of access at certain times and for certain purposes. Rights in water also exist and may be held separately or on a different basis from the rights in the land on or under which the water is found. There may also be separate rights in trees and minerals, etc. A complete register of rights should take account of all these rights but in practice few such complete registers exist, and most people when they speak of registration of rights in land are thinking only of the registration of title, that is of rights of ownership (or perhaps more broadly those of primary tenure).

This limitation probably arises from the fact that written registers of rights usually (though not invariably) come into being in countries in relatively advanced stages of social development. Such countries in general have registers based on European ideas of property in land that give protection to the landholder and are less concerned with the point of view of the public interest. In such countries land registration has tended to be seen primarily as an instrument for improving the processes of conveyancing rather than an instrument of land resource management.

An important result of this preoccupation of systems of registration with individual primary tenures has been the growth of a belief that registration is impracticable or unnecessary, and even undesirable, where private ownership is not an important feature of the tenure system. It is true that in many traditional societies what may be called the public memory, often assisted by a high degree of publicity, ceremony and even ritual, is in itself a form of record which may take the place of a written record. It may also be true that local financial or social conditions may justify a postponement of the work of survey and

registration. Experience, however, suggests that the time will inevitably come when growing pressure of population on the land and other causes will create a pressing need to define accurately the boundaries of family, village or tribal holdings and the rights enjoyed in these lands by members of the community concerned.

Once the conception of a land register as a record of individual rights in particular pieces of land is laid aside, many of the local objections to registration disappear. It is obvious that the members of a community that holds its land on a communal basis, or on the basis of what is known as the extended family, may reasonably object to any attempt to define the rights of individuals in terms of the land they actually occupy - especially when, as sometimes happens, the true ownership is believed still to vest in some long-dead ancestor. This is not, however, an essential feature of a system of registration of rights. In such cases the register might consist merely of a precise description of the lands held in common, a statement of the kinds of right enjoyed by the members of the group, and a list of members of the group regarded as possessing such rights. There need be either no reference to current occupancy, or such reference as would make it abundantly clear that occupancy carried no rights of mortgage or disposal. Such a register would initially be merely a written reflection of the public memory and its maintenance merely a record of changes duly authorised by traditional ceremonies and rituals. Its advantage as a method of avoiding disputes and unwarranted claims by individuals together with its obvious utility in cases where the traditional system finds itself unable to cope with the current situation would most likely far outweigh the objections that could be urged against it.

It should also be noted that many rights in land and water or in the produce of land and water, other than rights of individual possession of land, are in fact registered in forms other than the formal land registers. Under the better systems of forest administration, for example, it is common practice for the orders constituting new forest reserves to be set out in considerable detail (sometimes extending to actual lists of names). Such orders would define the nature and extent of rights of residence, cultivation, grazing, timber extraction and collection of wild produce by individuals or villages that subsist in the forest after reservation. Leases to work inland fisheries often contain clauses describing the rights of neighbouring cultivators in respect of use and control of the water, and place limitations, based on these rights, on the extent to which the lessee may obstruct or divert the flow of water. All these things are in effect methods of registering rights in land otherwise than in the ordinary land register. That departmentally it may be convenient to keep separate records of some of them does not detract from the fact that they are essentially part of the national record of rights in land and should be so regarded.

Some classes of rights in land cannot be disregarded such as rights of secondary occupation or use of land. Some of these, for example hereditary and life tenancies, occupancy rights, etc. derogate so importantly from the rights of the primary possessor that they must necessarily find a place in every register of rights. Others, for instance seasonal tenancies that are not renewed, are so ephemeral that the trouble of keeping the register up to date may not be justified by the advantages of having these rights registered.

Another important class of rights in land consists of liens and conditional reversions, including mortgages and pledges in security. The large class of usufructuary mortgages, which involve changes in physical possession, would probably be registered under any ordinary system of land registration. Simple mortgages not involving changes in physical possession are normally registered as documents where a system of registration of documents is in force, but may not find a place in land registers. Many pledges of land as collateral security may not be registered at all. There are, however, good reasons why all encumbrances to land should be publicly registered.

There is also a great variety of rights that do not involve possession, legal, physical or conditional, of the land itself. One of the most interesting of these arises from the fact that in some countries property in trees may be held and may pass quite separately from and independently of property in the land itself. Separate rights in minerals are a similar case. There are also many easements or servitudes, especially rights of grazing, of passage, of extraction of timber and forest produce, and of "profits à prendre" generally. These may be of great importance especially where public land is affected, or where a large estate is to be broken up. In such cases a public record of these may be of great value.

There is also a large class of public rights in land, including not only rights held by the state, but also rights held by large numbers of government departments and local authorities, village commons, and in some countries the sites of the villages themselves.

Enough has perhaps now been said to indicate the inadequacy of a register of title alone as a record of rights in land. The extent to which a national register should cover the whole field, however, is a matter for decision in each case. Before discussing the objects at which a good system of registration of rights should aim, there is one matter of fundamental importance to which reference must be made, since it arises from the main difficulty in effective registration. This is the difficulty of ascertaining in absolute terms the precise nature of the rights held by any particular person, or conversely, of ascertaining the person who holds any particular right. This subject is usually discussed in terms of title to the ownership or possession of land, and will so be discussed here. It should, however, be noted that what is said about title applies in general to all other rights.

First, it is desirable to return for a moment to the distinction between registration of deeds and registration of rights. A deed is a record of an isolated transaction and is evidence that that particular transaction took place. It is not, however, in itself evidence of the legal right of either party to carry out the transaction and consequently not evidence of the legality of the transaction itself. The defects of a register of deeds as a record of rights are therefore obvious; as Sir Robert Torrens, the great Australian authority on registration of title put it: "Title by deed can never be demonstrated as an ascertained fact: it can only be presented as an inference more or less deducible from the documentary evidence accessible at the time being."

(Torrens, R. 1859. The South Australian system of conveyancing by registration of title, Adelaide.

A register of title clearly aims at something much more definite than this. Every parcel of land is originally placed in the register as a unit of property. Once this has been done, every transaction affecting the parcel is entered in the register with reference to the land itself and registration thus serves as evidence of title and as a bar to contrary claims. The difficulty lies in the nature of the evidence on which the original entry is based. Where registration is in force from the first occupation of land, no difficulty arises since clearly there is no question of any adverse claim having previously arisen. This is, however, seldom the case, and the question at once arises of the evidence required before a first entry is made in the register. The investigation of absolute title may be, and usually will be, a long, difficult and expensive process in each case, and at the worst may never produce a definitive result. On the other hand a system of registration based on possession, which is an obvious alternative, can provide presumptive evidence of title, though from a legalistic point of view such a register is little better than a register of deeds. Every year that passes, however, makes presumptive evidence more difficult to rebut and finality can always be achieved by legislation that lays down a limit to the time within which suits claiming an interest in land may be brought. It is, of course, claimed that by the custom of many countries, especially in Africa, mere lapse of time does not extinguish a right once acquired. It is fortunate that it is in precisely these countries that the public memory referred to above will be found to be most active and accurate. Hence there are strong grounds for thinking that, provided that the inquiry on which initial registration is based is local and public and that care is taken that the purpose of the inquiry is understood by the people concerned, the claims of absentees will not go by default, even in the first instance.

It is not, of course, suggested that, even where registration is to be based on possessory rather than on absolute title, nothing more is necessary than a mere writing down of the names of persons in actual physical occupancy of the land. Many of these persons will, by their own admission or from the knowledge of their neighbours, be persons in subordinate or joint occupancy only, and what should be recorded is obviously the name of the person in primary possession or all the names of joint possessors. A careful inquiry will therefore be necessary to elicit the full facts of current possession and there will probably be other subjects for inquiry at the same time. It should be observed that the fact that quite a detailed inquiry is necessary merely to establish the full facts of current possession considerably reduces the likelihood of subsequent claims adverse to the facts thus established.

Public opposition to the initiation of a system of land registration may sometimes be strong and there is, perhaps, a larger number of cases in which expected opposition acts as a deterrent to action. It is an interesting fact that such opposition seldom comes from the landholders themselves, and this sometimes raises doubts as to the complete disinterestedness of the opposition: it is, for example, perhaps not very reasonable to expect enthusiasm for a registration system from a lawyer accustomed to high fees for conveyancing. There are, however, cases in which opposition is or seems to be justified, and in such cases great care should be exercised in adjusting the system so as to remove or mitigate public doubts and fears.

The purposes of a complete system of registration of rights in land are:

1. to provide at any time by a mere examination of the maps and registers an up-to-date and true description of all rights recognized by law or valid custom in the land at that time and a statement of the persons, classes of persons, public authorities, etc. in whom these rights vest for the time being; and
2. to provide an immediate means of identifying with certainty and accuracy both entries in the maps and registers relating to any actual piece of land and the actual piece of land to which any particular entries in maps and registers relate.

The achievement of these purposes may be expected to have certain effects on all relations between the land and the individuals, social groups, and public authorities interested in that land. These effects will be discussed later.

To achieve these purposes the following documents are required.

1. A cadastral map on which, with the assistance of permanent marks or features on the ground, every piece of land which has been or may be the subject of any right can be accurately identified either directly by examination or by short and simple measurement.
2. A register which acts as an index to the map, containing the area of each survey plot and which provides in tabulated form all information about the survey plot that is contained in the map.
3. A register or series of connected registers containing so much of the following information as it is intended to register:
 - a. The number, name, etc. of the corresponding map.
 - b. The basic tenure of each survey plot where different basic tenures are recognized: for example, state or non-state land; communal and private land; village and family land, etc.
 - c. The "primary holdings" by serial numbers and names (if any).
 - d. The basic tenure of each primary holding, where different basic tenures are recognized: for instance state or non-state lands, communal or private land; village or family land, etc.
 - e. The numbers or other identification of the land parcels included in each primary holding.
 - f. The area of each land parcel and the total area of the primary holding.
 - g. The name, description or other identification of the primary holder.
 - h. If the primary holder is a group of persons (other than a formal association such as a company or cooperative society), the names and other identification of each member of the group who is recognized as a joint holder and the nature of the right held. This includes groups such as joint owners, an extended family, the inhabitants of a village, a tribe, etc. The name, title etc. of the person or body recognized as representing the joint-holders for business purposes should also be included.
 - i. The tenure under which the land is held if this differs from the basic tenure, such as leases of state land.
 - j. Any permanent rights over the land not amounting to occupation held by persons other than the primary holder or joint holders, such as easements, rights of grazing, cutting or collecting of forest produce, etc.

- k. Any rights reserved against the primary holder by the government.
- l. Any primary rights, for example in trees, etc., over things on the land that do not vest in the primary landholder.
- m. Permanent subordinate rights of occupation or use.
- n. Temporary subordinate rights which have the effect of suppressing or placing in suspension the rights of the primary holder, such as usufructuary mortgages.
- o. Temporary subordinate rights of occupation or user modifying but not suppressing or suspending the rights of the primary holder, such as ordinary tenancies.
- p. Encumbrances on the land not affecting rights of occupation and user, such as simple mortgages.

Set out at length, these requirements seem very complicated. In practice, however, if separate forms are used for such obviously different types of primary right as individual and communal tenure, and if intelligent use is made of supplementary registers (especially where changes are likely to be frequent as in the case of short-term tenancies) the forms necessary will prove to be quite simple. Computerization will, of course, make such complexities even easier to handle. In some case where rights are already recorded in a separate public document, for example in the case of the newly constituted forest reserves mentioned above, all that is necessary may be a simple reference to such a document and the filing of the document referred to in a convenient place.

Many governments starting a system of registration may desire to confine themselves initially to the bare essentials of registering the basic tenures, the primary right-holders and those subordinate right-holders whose rights are either more or less permanent or may have the effect of suspending the existing rights of the primary holders. There may be sound practical reasons against attempting to register such rights as those conferred by annual tenancies. It is a sound rule to limit registration in such a way that the register can be kept accurate and up to date. An inaccurate register may well be worse than none at all.

On the other hand there may be circumstances that make it necessary to register temporary rights that may ordinarily be considered too difficult to include in the registers. One such case is where a legal right is given to a tenant to continue an annual lease indefinitely during good behaviour without formal renewal.

Land registers can, of course, be used for the recording of many other kinds of information than the simple facts of tenure. Obvious examples, often of great economic and administrative importance, are the differentiation of resident and non-resident landholders, or of agriculturist and non-agriculturist landholders.

Computerization of maps and registers

This chapter reviews the impact of computers on the surveying and mapping of land parcels, and on the recording and dissemination of land-related information. The main advantage of computerization is the speed with which data may be handled.

Computers can, *inter alia*, be used to:

- a. speed up the collection and processing of cadastral survey data;
- b. make significant reductions in the cost and space required for storing and retrieving land records;
- c. prevent unnecessary duplication of records;
- d. simplify the preparation of “back-up” copies of registers in case of disaster;
- e. accelerate the processing of data for the first registration of title;
- f. reduce the time and cost involved in transferring property rights and in processing mortgages;
- g. facilitate the monitoring and analysis of market and rental values of land and property;
- h. provide better estimates of the value of land for taxation or compulsory acquisition;
- i. improve efficiency and effectiveness in collecting land and property taxes;
- j. assist the compilation of information and reports that were impossible or very cumbersome to produce using manual systems;
- k. provide mechanisms for quality control;
- l. integrate the records of land ownership, land use and land value with socio-economic and environmental data in support of physical planning;
- m. assist in the allocation and monitoring permits to build on land;
- n. manage property assets and ensure their efficient use and maintenance;
- o. document and monitor archaeological sites and other areas of scientific or cultural interest;
- p. record tree preservation orders and conservation areas;
- q. support the management of utilities such as water, sewerage, gas, electricity, street lights, and telephones; and
- r. facilitate the automatic transmission of bills to customers, ensuring that no address is missed, hence improving revenue collection.

The list of possible applications of information technology (IT) is almost endless. It is often as valid to ask whether a country can afford to be without a good computerized land information system as it is to ask whether it can afford to install one.

Computerization speeds up the processes of field and photogrammetric survey, the storage, retrieval and analysis of data, and the preparation and production of cadastral maps and plans. Automatic data recording has two advantages - it reduces the human mistakes that occur in writing down and subsequently transcribing field survey observations, and it facilitates the transfer of data for subsequent computation and adjustment. In spite of the increased cost of modern surveying equipment, productivity can be significantly increased

through the use of computers. This then makes it possible to reduce the unit costs of survey.

While new surveys may benefit from the availability of computer systems, many records already exist only on paper, for example in written records or on paper maps. Old records must be converted into computer-readable form if the advantages of modern information technology are to be realized. The conversion of existing maps and graphic images into digital form is usually done by "digitizing". The technology for digitizing maps is readily available, though the processes are often labour intensive and remain expensive. Textual data relating to land parcels may be converted into digital form either by typing the data into a computer by long-hand methods using a keyboard or typewriter, or by scanning. In the latter case, the data may either be stored as scanned graphic images and reproduced when necessary as facsimile copies, or else they be converted into individual characters using pattern recognition software.

Without doubt the most expensive and time consuming part of setting up any computerized cadastral system lies in data conversion. The cost of entering data into the system can account for 70 percent to 80 percent of the total initial costs of getting the system operational. Fortunately the cost of data storage has decreased significantly over time while the speed of data retrieval has increased as a result of the more powerful computers that are available, especially in desktop form.

The priority in many cadastral systems is to manage textual records more efficiently rather than to produce digital cadastral maps. Text data may include the property reference number, the name and address of the proprietor, the title number and form of tenure, details of any mortgages, subleases or assignments, any caveats, and possibly details of annual rents and rental payments and their due dates. In addition there may be references to survey plans, land-use zones, planning applications, etc.

While it is often relatively straightforward to computerize textual records - for instance a deeds register - it is rarely cost effective to "computerize past mistakes". Since computers cannot tolerate the types of imperfection in the data that arise in manual, human information processing, the opportunity should be taken to improve the quality of existing data and purge the records of errors that have inevitably occurred over time. The opportunity should also be taken to overhaul the procedures that are followed. Often the benefits of computerization stem more from data and system reorganization than from the use of computers *per se*.

It is not necessary for all data to be stored within one system as long as access to the data can be gained when necessary. Connecting a series of computers together into networks covering local or wide areas is becoming more common. Through this means data can be collected, stored and updated in several different locations. Thus the Registrar of Titles may hold the definitive record of who owns the land while the Ministry of Finance may hold the land tax assessments; the municipal planning department may hold data on land use while data on sewers, water and electricity may be held by public utility companies. Each of these data bases can be linked together and data exchanged as and when needed.

Because of the high cost of data capture and maintenance, data must be shared if cadastral systems are to be cost effective. It will often be found that data sets are incompatible for one reason or another - they may for example contain different parcel referencing systems, the Registrar of Titles using a Volume and Folio system for identifying parcels while the tax assessment may have a totally different system such as a sequential number with no spatial attribute; or the data sets may relate to different definitions of areal units, the taxable unit being defined by land use while the registered title relates to land ownership. If data are to be shared, then common standards must be agreed.

Once data of appropriate quality have been entered into the system, various processes of manipulation can take place. These may take the form of geometrical transformations of the data for better graphic display; or mathematical calculations including the aggregation and generalization of data; or the extraction of particular categories of data either on the basis of attributes or combinations of attributes or in accordance with their location; or simply providing data as part of a management information system. Thus for example, the dates at which documents are passed from one section of a cadastral office to another or to an outside department can be checked, reducing the chances of documents being lost or identifying files where the processing of transfers and applications have failed to be completed by certain dates. Serious delays can then be investigated. Improved management information systems offer one way to improve cadastral systems.

Processing of the computerized records can also be undertaken using what have become known as geographic information systems or GIS. A GIS consists of a data base, graphic facilities and software for data processing. Using a GIS, different data can be retrieved from the database, or data can be taken from two or more data sets and overlaid on the graphic screen or printed out on hard copy such as paper. The computer can carry out spatial searches, such as locating all properties that fall within a specified distance of a proposed new road alignment. Estimates of the cost of acquiring any land can then be made automatically on the basis of the area affected and its estimated value per square metre.

An essential element in any cadastral system is the communication of information either in the form of reports, lists or graphic display. Computers can be used either to display data on a screen or to drive a plotter that produces maps or text in hard-copy form.

In order to make full and effective use of a computerized cadastral system, a corporate strategy should be developed so that potential users of the system, especially other government departments and parastatal bodies, can gain access to it. First, the potential users of the system need to be identified and a feasibility study undertaken to determine how much land-related information is passed between ministries, departments and other organizations and whether the installation of a computerized network is justifiable. After the feasibility study, a user requirements analysis should be undertaken, identifying in detail the resources already available and the type and quantity of data that will need to be processed. Immediate and longer-term requirements should be considered since, if successful, the system will inevitably grow.

From these studies, an implementation strategy can be worked out to determine, within the resources available, what new equipment and training are needed. The implementation strategy should lead to a technical specification that will be described in an Invitation to Tender (ITT) that will be sent out to system suppliers. The ITT document will give details of how any system is to be evaluated (known as the Benchmark Test) and the form of the acceptance test that will be required at the end of the project. Based on the responses to the invitation to tender document and the results of any benchmark tests, the best supplier will be chosen. After suitable contractual arrangements, the system can be installed and acceptance tests carried out to ensure that what has been delivered performs in accordance with the specification. Often there may be a pilot project over a limited area to ensure that the tasks have been correctly specified.

Purchasing and installing a computer system is only the start of a process of change within an organization. A computerized system will need to be maintained and this can be expensive. Technology is changing so rapidly that new equipment will need to be installed in a relatively short time. New institutional arrangements will need to be developed as the objectives as well as the practices within an organization evolve. Computerization is a dynamic rather than a static process.

A major constraint on the implementation of change within a cadastral organization is often the lack of coherent land information policies. In many developing countries there are no consistent policies for the provision of mapping, or for the supply and updating of land information. The position is often mirrored in the lack of coherent policies for the sustainability of urban or rural development. The position with regard to information resource management is little different. There is often no attempt to recover the costs of collecting, processing and distributing cadastral information nor are there plans to keep the data up to date. Frequently the investment in information technology is not supported by a business plan.

While the technology is important, the essential characteristic of a cadastre is that it is an information system, not a set of technological tools. There are of course many technical problems in data integration and in sharing data across networks. The greatest difficulties, however, lie in the human, legal, political, and economic problems that concern all potential users and which must be addressed. In providing greater access to data that are held by other people or other organizations, it is necessary to clarify the rights and obligations of both the data producers and the data users. A number of specific problems can arise, such as protection of the rights of an individual to privacy. Such protection can be achieved by:

- a. limiting the nature and extent of personal data collected;
- b. ensuring that the data that are held are relevant and accurate;
- c. limiting the amount and types of data that can be disclosed;
- d. adopting procedures for protecting the system against unauthorized use of the data; and
- e. allowing any individual the right to review, challenge or correct the data.

The confidentiality of data is more difficult to protect since a legal definition of “information” and what constitutes confidentiality are difficult to lay down.

Before investing in computerized cadastral systems the question must always be asked as to whether the organization concerned can afford to invest in high technology. This is especially so in developing countries, most of whose governments are already heavily in debt. Computerization inevitably involves the expenditure of hard-earned or borrowed foreign exchange. Furthermore there is always a fear that computer technology will reduce employment. Present evidence, however, suggests that there will be changes in the nature of employment but that in the short term at least, employment opportunities may increase. This is because the massive task of data conversion will keep many people in work for a decade or more.

An assessment of the costs and benefits is a prerequisite to computerization. The benefits in part depend on the ability to sell information. Cadastral data can be a valuable commercial asset and hence the cost of cadastral surveying can be offset by the sales of the resulting data. Increasingly, governments are requiring their ministries and departments to find ways of recovering the cost of running their services. In many less developed countries there is, however, still a view that “government should pay”. If the introduction of high technology is successful, then productivity will increase significantly. That alone may not however justify the level of investment. It may therefore be necessary to recover more of the capital costs through the sharing of data and by the sale of the information gathered. Information is a marketable resource and some of the cost can be recovered by selling data to the private sector. If full benefit is to be gained from the sale of data, then the information must be protected through copyright laws. After some initial uncertainties in many jurisdictions, it is now generally possible to protect intellectual property rights including those where the base information is stored electronically. Collections of facts such as maps, lists and pieces of text can all be treated as intellectual property.

Improving existing cadastral systems and the development of information as a corporate resource pose philosophical, technical and institutional problems. Central to their solution is better education and training. On the technical side, with many of the more complex systems, it can take months if not a year for an operator to become fully confident with the system. Although systems are becoming more “user friendly”, their complexity makes it difficult for local operators to understand the full functionality of each system. Suppliers of systems usually include the cost of basic training in their tender price. Such training needs to be sustained as the trainees become more confident and capable. Training in continuing professional development should be a major investment in any organization.

This chapter has touched on a number of issues, both technical and institutional that lie in the way of developing a computerized cadastral system. The cadastre deals with two resources - land and information. Computerization facilitates the better use of both by allowing more people to know more about the land and the problems and opportunities associated with its use. While much can be achieved through improved manual methods of data handling and by focusing the attention of administrators and the public on the integrated nature of many land-related problems, it is computerization that is the most effective catalyst for

change. Pressures on land are growing in every community both through population growth and through environmental and ecological change. To monitor, plan for and manage that change, better information is needed. Computerization of cadastral records offers vital support for such activities.

Principles to be followed in the preparation and maintenance of records of rights.

The actual details of the process of registration of rights will vary so greatly in accordance with local circumstances that no useful purpose would be served by trying to outline a suitable procedure in general terms. There are, however, a number of principles of general application which will be found greatly to assist the execution of any procedure that may be adopted.

The first is to recognize the need for adequate maps. No system of registration of rights will be successful without the support of an adequate series of cadastral maps. Even the simplest system of voluntary registration will be greatly strengthened and facilitated through the standard and accurate means of description that these maps alone can supply.

The second is to recognize that ultimately every system of registration should become compulsory. Only by compulsion can the universality on which the full advantage of registration depends be obtained. If a system of voluntary registration is introduced at the first instance, it should be regarded as part of the necessary educational process designed to prepare public opinion for compulsory registration.

The third essential is that a system of registration will only be fully successful if it is supported by Public Opinion, and public opinion must thus be educated to accept the system. Education may consist largely in the dispelling of doubts and fears, but much may be done by intelligent propaganda by the government to indicate the advantages of registration to the individual and to the local community. The institution of a voluntary system may be a valuable part of such promotion. The previous existence of a system of registration of documents, including deeds, may also be very helpful. The form of promotion will, however, necessarily be determined by the nature and reality of the doubts and fears mentioned above. Methods of increasing confidence in registration include the association of interested members of the public with all stages of the initial registration, and the holding of enquiries and examination of claims on the land or in nearby villages rather than in distant towns. There must also be procedures for appeals against the decision of registering officers at all stages of the enquiry and not merely when registration is complete. In most countries where there are small holdings it will be found that local enquiries and local facilities for making and examining claims will be absolutely essential to success.

The ultimate aim of registration should be to secure a complete and indefeasible record of all rights held. To ascertain absolute title by a single inquiry may, however, be very difficult and in practice a record based on presumptive title has been found rapidly to acquire all the essential features of one based on absolute title. The most suitable procedure may thus be to aim at the best results that can be secured by a careful local inquiry into present facts of possession. Such an inquiry should be preceded by widespread notification of the intention to hold it and should include a careful examination of all evidence produced in close consultation with local opinion.

The less “developed” a country is, the more immediately effective this inquiry will be. In most “underdeveloped” countries all the facts about individual and communal rights in land are usually well known and understood by the local people. It is merely a matter of eliciting these facts, a process which however may demand much patience and will certainly demand much local knowledge and experience. When a register has been working for a few years its essential accuracy or lack of accuracy will soon become apparent. A term can then be placed on outstanding claims, if desired, by means of a statute of limitations and the record thus made absolute. Nothing of this kind may, however, be necessary, and probably will not be necessary once the record becomes established that presumptive evidence of such weight cannot be rebutted except in most unusual circumstances.

A special difficulty in dealing with communal tenures may be the right of members of the community who have left it to resume their rights on their return. The existence of this right is a special reason for the most careful local inquiry among influential members of the society. Mere reliance on claims actually presented in person may cause serious error. This is, of course, true in other cases also.

Besides the public notification of intention to register mentioned above, personal notices should be sent, as far as possible, to all persons likely to have a claim on the land. Where land taxes are assessed, such notices may be attached to tax demand notes or despatched separately to those who have been assessed on the basis of the revenue records. Existing registers of deeds and other public records of transactions in land may also be used to assist in reaching all possible claimants.

The sites of registration offices should be chosen so that registration of mutations will cause the least possible inconvenience to members of the public. The number and distribution of these offices will depend on the size of holdings and the social and economic status of rightholders. In a country of large holdings where transactions in land are few and important, a relatively small number of offices at main centres of population may suffice. In a country of smallholdings, many small local offices will be necessary and there are great advantages in periodic tours of the lands themselves by registering officers. These small local offices and tours will certainly be necessary in any case where small tenancies fall within the scope of registration.

Many countries that have no system of registration of land have a well-established system of registration of certain classes of documents including deeds relating to transfers of rights in land. There may be good reasons for continuing the separate registration of deeds, which normally includes the making verbatim of a copy of the document registered, even after a system of registration of land has been adopted. This need not and should not mean duplication of work. In fact the double system may have considerable practical advantages. Most deeds are executed in fairly large centres of population which may be far distant from the place where the land is situated. A localized system of land registration may thus cause inconvenience to some persons concerned in a transaction, as compared with the registration of a deed which need not be localized. Every such inconvenience hinders the effectiveness of a system of registration. In many systems, whenever a deed affecting the land registers is

registered, a docket giving the essential information is forwarded as a matter of course by the registrar of deeds to the land registry concerned. In the absence of computerization, this is a most useful method of ensuring that the land registers are kept up to date. The same procedure may be applied in respect of decrees and other orders of civil courts, land courts, etc.

The success or failure of a system of registration will depend on the completeness and promptness with which mutations are reported. (By "mutation" is meant any changes that affect entries in the registers, such as changes in the land, in the conditions under which it is held or in the holder of the rights.) During the earlier stages of registration, there are likely to be many delays and omissions in reporting mutations, especially those that do not involve a formal transaction, and such delays and omissions will never entirely cease, at least in underdeveloped countries, if the duty of reporting is left entirely to the initiative of the persons affected. It must be remembered for instance that in countries where customs of inheritance prescribe absolutely the succession to landed property, there is no question of the formalities attached to the proving of a will and that in such countries land will frequently change hands without formal documents of any kind. Again many small sales, mortgages, leases, etc. may be made without written records of any kind. In these circumstances, the habit of prompt reporting may be very difficult to inculcate. Legal penalties and disabilities, though probably necessary to deal with a few cases of wilful failure to observe the law, will usually be ineffective and are certainly objectionable expedients for use in cases of mere public apathy or lack of understanding.

In general, prompt reporting of mutations will probably be best achieved by applying the following principles:

- a. That, as far as possible, mutations should be brought to the notice of the registering officer automatically or in the course of ordinary routine.
- b. That, where reports must depend on the initiative of individuals affected by the mutation, it should be made as easy as possible to make these reports by siting local registration offices conveniently for the persons who will use them and by periodic tours of registering officers within their charges.
- c. That entries in registers should be checked periodically by inquiries in the field (for instance by registering officers during their tours, by cadastral surveyors engaged in checking and revision of the maps, etc.)

Whatever system of registration is adopted it is important that the procedure should be as simple as possible. There are two strong reasons for this: first, the system should be easily comprehensible to the landholders themselves; and second, especially in underdeveloped countries, the operation of the system should not demand a staff with high educational qualifications.

Registers of Rights are quite different from Registers of Deeds in that they need not contain copies of long instruments of transfer. They can therefore be reasonably compact in form, and must be, if they are to be used for field work. The loose-leaf form is usually the most convenient. As the register is related to a particular map it has usually to be rewritten if a new survey is carried out. The old registers and maps are then placed in the archives, either in the record room

or computer archive, and continuity between old and new assured by preliminary cross-references in the new registers. Duplicate registers and back-up copies of computer files provide a safeguard against loss or damage. Copies may often conveniently be prepared on microfilm and for this purpose the loose-leaf system has great advantages. With computerized systems, regular backing up of the files must be undertaken.

The current maps and registers should be open to public inspection without charge. Inquiries involving the searching of old records can on the other hand be charged for. Holders of individual rights may also suitably be entitled to a free copy of those parts of the current map and of those entries in the current register that relate to their lands. In other cases, copies should be charged for.

Where a system of land taxation exists, the cadastral survey and record of rights are usually the basis of the tax assessment, and in fact most of the older cadastres were prepared primarily for fiscal purposes. This use of records is not essential, but the combination of the two sets of records has obvious administrative advantages since it provides both government and right holder with an incentive to keep the record accurate and up to date, and immediately justifies the expense of maintaining the records.

The use of the records for revenue purposes, however, necessarily introduces complications into the system, which need not be pursued here beyond saying that the record may have to become a record of land values, rental values, or crop yields as well as a record of rights and may also embody a system of classification of land for fiscal purposes.

Direct advantages of cadastral surveys and registration of rights

The first and most obvious advantage of a cadastral survey and record of rights is that together they give a true and exact description of the legal situation of rights in land at any moment. Only a cadastral map can provide the means of accurate identification necessary to this end and only a continuous and comprehensive record of rights can give an accurate picture of the position at any particular time.

Most of the advantages of the system of survey and record derive directly from the immediate availability of this exact information. The person legally recognized as possessing a right, the nature of the right, and the exact boundaries of the land concerned are at once clear, and any persons engaged in any transaction relating to the right knows at once how they stand. If the record is one of absolute title, the person whose name is recorded in the register, and no other, can dispose of the rights. If the register is one of possession only, there is at least a very strong presumption that the person registered as in possession is the person who can dispose of the rights and a virtual certainty that his or her interest in the transaction cannot be neglected. The possibility of fraud or of subsequent legal difficulties are thus either eliminated or greatly reduced.

Registration also provides adequate protection to all classes of rightholder, including absentees, persons with reversionary or pre-emptive rights, or those with dormant rights of any kind. It also protects any person or class of persons who have rights in easements or other restrictive rights. A public right of way is protected by registration equally with a right to restrict building or land use. Communal or private rights of grazing, extraction of timber, collection of forest produce, use of water, etc. whether on private or public lands, are publicly defined and safeguarded.

Registration also simplifies control over the acquisition of new rights. In cases where prescriptive rights accrue after a definite period, registration provides immediate evidence that the right has been established. It also prevents the acquisition of prescriptive rights where this is contrary to public policy. Generally it provides a ready means of regularizing all informal kinds of occupation or types of user. All dealings in land are greatly facilitated by registration. Boundaries are directly and accurately known, the nature and extent of existing rights are at once clear, long and costly inquiries into title are avoided, the need for the services of lawyers or other intermediaries is reduced to a minimum, and generally all transactions in land can be carried out with increased cheapness, speed and security. This applies, of course, not only to transactions involving a permanent transfer of the right, but also to temporary limitations and mortgaging. If, for example, mortgages are registered, then any persons intending to lend money on the security of land can quickly ascertain the exact position in regard to previous encumbrances. They will thus obtain a substantially greater measure of security for their money. Similarly, borrowers whose rights are registered can borrow money more easily and quickly, and probably also more cheaply, on the security of their land.

All classes benefit from the elimination of worthless documents purporting to be valid instruments establishing or conveying rights in land. This kind of document may be a real danger both to private and public interests at those stages of social and economic development where traditional systems begin to feel the impact of external influences. In the same kind of situation (and in many others) the publicity given to transfers of title by a system of compulsory registration greatly facilitates the protection designed to be given to economically weak classes of the population by legislation restricting alienation of land by or to specific classes of persons. One of the great difficulties of enforcing such legislation lies in devising a sure method of bringing apparent breaches of the law promptly to the notice of the authorities charged with the duty of enforcing it.

Generally the result of compulsory registration of rights in land is likely to be a very considerable reduction in the volume of litigation about land, with a consequent great saving of unproductive expenditure which the agricultural landholder can ill afford.

Finally there are the great advantages which the existence of an up-to-date and reliable map and record of all existing rights in land gives to every branch of the government that deals with the administration of land. Some of these advantages obviously follow directly from the existence of an unimpeachable record, for example the simplification of the work of the courts, increased ease in carrying out the acquisition of land for public purposes, improved administration of forests and other public lands, and so on. Other advantages are more indirect and perhaps less immediately obvious, but none the less very real. An attempt to summarize these will be made in the following chapter, but there is one group of advantages which, in a series of papers dealing primarily with the various aspects of land tenure and agrarian reform must be classified as "direct" and should therefore find a place in the present chapter. These advantages are those that good cadastral maps and a sound system of registration of rights bring to the appreciation of a national agrarian situation and to the elaboration of measures for its improvement and reform.

An unsatisfactory agrarian situation is usually forced on the public attention by the appearance of acute symptoms of malaise in the rural economy and especially by the depression of certain classes of the rural population and even by active agrarian unrest. These symptoms often become manifest only at a relatively late stage in the decay of the existing agrarian structure, or they may be brought to an acute stage by a sudden economic disturbance such as a worldwide slump in commodity prices or by the effects of a war which can place unusual strains on the rural work force which becomes depleted by the demands of military service. Or again the return of those who have been working in foreign countries and hence have experience of different conditions and practices may bring into prominence rural stresses and strains previously concealed.

Yet defects in land tenure systems and the agrarian structure generally do not develop like mushrooms in a night. They have been there latent but not inactive, for years or even for generations before a crisis flares up. Sometimes they have been well known and simply disregarded; sometimes they have been seen by a few officials and students of agrarian affairs and duly reported to the government, which however did nothing because the action necessary ran

counter to established public policy. More often, however, they have not come clearly to the notice of the authorities because the latter had no ready means of obtaining exact and up-to-date information on what was happening in relation to the land and its occupants. There was no close and continuous contact with rural life and consequently no means of feeling the pulse of the agricultural community. A good cadastral survey and system of registration of rights provides the material for this close and continuous contact, both by providing an up-to-date picture of the situation and by ensuring that the government has a staff which is in constant touch with the situation itself. This is especially the case where registration offices are established in the villages or small towns and the register is maintained or checked by field inspections. The cadastral maps themselves and the information contained in the land registers also provide a good, and indeed the essential, basis for the preparation and execution of a programme of land reform or for any other measures taken to remove defects in the agrarian economy. Large-scale maps are, in fact, necessary to the success of any measure of land reform that involves either the redistribution of existing holdings or the settlement of new areas. If maps do not exist they will have to be made, and once a policy of reform has been adopted there may be little time for this. The registers provide the factual basis on which the reforms must rest. If this basis does not exist, it can scarcely be improvised and the reforms will, to a large extent, be a leap into the dark which may be full of danger.

This matter is of such importance that one or two examples may suitably be given. Many schemes of land reform which involve the expropriation of large landholders contain provisions exempting from expropriation land up to a particular maximum area held by a single landholder or land of particular types or used in particular ways. This kind of provision is obviously unworkable unless the boundaries and areas of individual estates, the type of land contained in each estate and the use to which the land is put are known. This knowledge can only be provided with the exactitude required by means of a cadastral survey. Again the distribution of expropriated lands among the new holders will demand a detailed demarcation of the new holdings which, in the absence of large-scale maps, can only be undertaken painfully and inefficiently by actual measurements on the ground. Similarly no tenancy legislation that involves the determination of rents of particular holdings or the grant of improved security to tenants can be enforced effectively unless the boundaries and areas of the tenancies are accurately known from good maps. The advantages derived from the existence of a cadastral survey in the administration of agricultural credit have already been mentioned. Perhaps the most obvious example of all is that of a plan for the consolidation of fragmented holdings which will be virtually impossible to carry out unless the precise boundaries and ownership of the individual plots and fields are known.

It is no answer to these arguments to say that in some countries agrarian reforms have been attempted and even carried out without good maps or exact information as to existing rights. In these cases the immediate result of the reforms has usually been a state of uncertainty and confusion which postponed their effectiveness for years or at the best, a slowing down of the rate of their progress to a politically dangerous and economically unjustifiable degree. Good work in agrarian improvement demands exact information of the kind that only a cadastral survey can give.

The place of cadastral surveys and registration of rights in rural development

Not every country is contemplating immediate reforms in its agrarian structure but almost every country in the world has been making strenuous efforts to improve the efficiency of its agriculture and of its rural economy generally and also the conditions of life of its country people. The hard facts of modern life have shown beyond argument that the only hope (and that by no means a certain one) that the world may continue to support an expanding population lies in progressive improvement in the volume and efficiency of agricultural production. This in turn demands, as well as provides, a progressive improvement in the conditions of life of the agriculturist and of those engaged in occupations ancillary to agriculture.

In consequence, most countries have found it necessary to take stock of their existing natural resources and of the way in which these resources are being used or neglected. Many countries have also found it desirable to elaborate plans for the improvement of agriculture and for the development of the rural economy. These plans may take many forms besides the land reforms mentioned in the previous chapter. They may be based on great schemes for irrigation, drainage or flood control, for the prevention of erosion or for the conservation and extension of forests; they may involve elaborate plans for controlling agricultural production either by expanding the cultivated area or by increasing the area planted with particular crops; they may depend on the development of new or reclaimed lands by settlement, or they may include the systematic improvement of rough pasture or marginal lands. They may, on the other hand, aim at the improvement of the technical efficiency of the farmers by the introduction of new or improved methods and materials, or their economic efficiency by improved credit, communications and marketing arrangements. They may involve the provision of monetary incentives such as subsidies for the adoption of a particular crop, practice or type of farming, or payments to dissuade farmers from working certain land - the European Community for example has been paying farmers to 'set aside' land so that it is not used for agricultural production. There may be plans for the improvement and extension of agriculture by foreign immigration or by movements of local population. There may be policies for the relief of unemployment by agricultural expansion or the development of rural industries, or the replacement of inefficient farmers by more efficient ones, or the administration by the state of "problem areas".

Development programmes may be almost infinite in their variety, but in every case not only the successful operation of a project but even its satisfactory formulation will inevitably demand, first, knowledge of the human and material resources actually or potentially available, and second, knowledge of the manner in which these resources are being used, misused or neglected.

Large-scale maps and exact knowledge of the way in which the land is held provide one necessary foundation for the accumulation and classification of knowledge of available resources. The other necessary foundation is an efficient census and classification of the human resources of the country, which census itself must largely depend for its utility, if not for its very possibility, on large-scale maps and other features of the cadastral survey.

When the knowledge acquired by inventory and classification comes to be applied, whether to an estimation of the current situation or to planning for the future, the need for maps becomes even more cogent. There are many factors in appreciating a situation that cannot be classified and understood at all without maps and there are few indeed that will not be made clearer if maps are available and used. Similarly many development projects depend inevitably on maps both for their inception and for their execution, and practically every scheme will be better made and better executed with maps than without them. This point is of such great importance and so often overlooked that it is worth elaborating. In doing this it seems better to discuss the question in relation to large-scale maps in general rather than in relation to cadastral maps in particular. The difference is largely formal, except to the extent that large-scale topographical maps include descriptive detail, especially relief, which may not be found on cadastral maps proper. A large-scale map for present purposes may be defined roughly as any map on a scale of 1: 25,000 or larger. For many purposes, maps on a scale of 1: 25,000 must still be regarded as smallscale maps, but as there are some types of country in which such a map will be large enough for all ordinary purposes this scale seems a useful point of division.

It happens that aerial photographs at scales of this general size may also have a value both in the preparation of inventories of resources and as guides to planning not less than or even greater than that of the maps that can be produced from them. This is particularly so in acquiring a knowledge of natural resources, especially in the preparation of forest inventories and surveys of natural vegetation, in conducting surveys of soils and soil erosion, in geological surveys, in determining general land use, and in surveys of the distribution of surface water. A map, however, is the best possible medium for recording and displaying surveys of these kinds. Not only does the map provide for subsequent identification on the ground of features brought out in the survey, but it greatly assists in describing the results of the survey by allowing the eye to help the mind in forming a comprehensible picture. Observed facts recorded in statistics or written descriptions are much more difficult to comprehend than are the same facts when set out on a map. Maps can contain a great clarity in description and an accuracy in identification that makes their use of great value in the description and evaluation of natural resources. The same characteristics give maps an equal value in demographic studies and in recording the results of agricultural censuses.

For the above purposes, maps at smaller scales may suffice but when it comes to more detailed description and identification, larger scales are likely to be required. Thus 1:15,000 may be regarded as a suitable scale for forest surveys, while 1: 8,000 may be suitable for surveys of mines, and even larger scales may be advisable for surveys of oil fields and of some types of surface mining. It is therefore in the accurate description of land use that maps on the usual cadastral scales begin to show their full value. The Ordnance Survey of the United Kingdom decided as long ago as 1840 that the scale of 1:10,560 was not large enough for many national purposes and hence most of the country has been mapped at the scale of 1: 2,500 for rural environments and 1:1,250 for urban areas. The cadastral maps of other western European countries are at comparable scales.

Before the 1:10,560 scale plans of the United Kingdom were published (they are now at a scale of 1:10,000), vast sums were spent on the production by private official agencies of large-scale maps ad hoc and many of these maps were not very reliable. While the private sector of today is able to produce maps at least to the same standards as national mapping agencies, there are advantages in working to national standards of accuracy and content that can only be maintained if governments take a lead in establishing and monitoring these standards.

The general uses to which a series of large-scale maps can be put, either directly or as base maps, are too varied for enumeration and a few examples must suffice. Obvious cases are irrigation works, flood control or protection works, the construction of railways, roads, canals and ports, pipelines and many urban purposes such as town planning and sewerage. Cadastral maps can be adapted to all these uses either as they are printed or by the addition of relief or other details that the special purpose may require. In the case of works involving the movement of water by gravitation or the control of flood water, the accuracy of the levelling required is such that no ordinary map is likely to provide it. The absence of relief lines on cadastral maps does not render them less useful than maps on smaller scales which show vertical variations in surface. The complete absence of relief may in fact be an advantage since the map can be used directly to record the levels required.

Cadastral maps which show field boundaries are especially suitable for mapping land use and in classifying land on the basis of soil capabilities or productivity. Maps of Myanmar at a scale of 1:3,960 were used to record the field-by-field classification of land on which the land revenue assessment was based, and for the production of the annual crop statistics for which the crops grown on each field or part of a field were recorded. In many countries soil maps can only be satisfactorily constructed on scales of around 1:5,000. These are countries where geological erosion, changes in elevation or other causes have produced significant field-to-field variations in surface or subsoil. Areas of this kind are much more common than is generally realized.

Maps in a cadastral series are also of great use for many administrative purposes. The assessment of any tax based on area (as the most satisfactory taxes on agricultural land usually are), requires such maps, and indeed this use is the primary purpose of cadastral maps in the technical sense. The advantage in the direction of equitable assessment is obvious. The advantages from the purely fiscal point of view, though less obvious, are no less real and the introduction of maps in new areas or the revision of out-of-date maps has in many cases produced an increase in the revenue demand which paid for the survey in two or three years. In Myanmar, in general, it was found that the introduction of a proper survey in a new area produced an immediate increase of not less than 50 percent in the demand at the old rates. In one case the revision of a badly out-of-date survey caused such a large increase in demand as to neutralize completely the effect of a remission of 40 percent granted by the Government.

Cadastral maps make possible the precise plotting of annual or seasonal variations in the area supplied with water from irrigation canals, and thus facilitate calculations of the actual amount of water supplied to any farmer or

field. They also allow the effects of changes in water supply on crops to be clearly and accurately recorded, and permit a close control over water distribution to ensure the optimum available supply.

Congested oil fields, areas used for surface mining, especially the mining of precious metals and gems where holdings are small and disputes frequent, mining operations in hilly country where the precise boundary on the surface may be of great importance, the protection of the boundaries of communal grazing grounds or of the cattle paths approaching these through farm land, the periodic distribution of land held under communal tenure, the precise delimitation and maintenance of village fuel reserves and the control of unauthorized cultivation in or along the edges of all land reserved against cultivation are other examples of administrative uses of cadastral maps.

The use of maps as a means of recording annual crop statistics has already been mentioned. Since, however, the most accurate possible estimates of crop production are of the greatest importance not only for formal agricultural planning but also in connection with the ordinary economics of agriculture, it is worthwhile reverting to this point. It has to be admitted that in many countries statistics of agricultural production, and especially crop forecasts, are far from satisfactory. The causes of this are complicated. To a large extent the defects in the statistics arise from inherent difficulties of estimation of annual variations in yield or from faulty organization. This is not the place to discuss defects of this kind. Perhaps the most important defects, however, arise from inaccurate estimates of farm areas or of sown or matured areas, and from insufficient knowledge of the normal productivity of the land. In theory it should be possible to determine production with sufficient accuracy from the measurements of the actual produce that all farmers make.

In practice, however, there are considerable difficulties in doing this, and such measurements will not in any event assist in making forecasts of production. Measurements of areas therefore assume great importance. The cadastral survey gives directly precise figures for farm areas. In many parts of the world where farming is monoculture or based on a simple rotation, these figures by themselves provide a good basis for the estimation of sown areas, and even elsewhere they provide at least a firm basis for estimation by other methods. Without going to the length of the annual marking of crops, field by field, it is possible to use the cadastral maps for such marking over a short series of years in order to provide a basis for later estimation. Alternatively, it is possible to check periodically the estimates reached by other methods, either by complete marking or by sample marking in selected areas. By this method a much firmer basis for the estimation of sown and matured areas is obtainable. Similarly the maps can be used as base maps for classification of the productivity of the land where there are considerable local variations or to facilitate direct sampling of annual yields.

The use of the cadastral maps for a classification of land according to productivity is only one instance of the many types of classification for which large-scale maps are required. The classification may be of the actual land use, or for revenue purposes, or may be a soil classification; it may be made for the recommended use of the land, of existing farm types, or for soil conservation purposes; it may relate to the carrying capacity of pasture, to tenures, or

according to water supply. All such classifications either require cadastral maps or are made much easier and more accurate by the use of such maps.

In connection with the collection of statistical data, the registers of rights, as well as the maps, have great value. The direct uses to which these registers can be put are so obvious as to require no enumeration, but it is perhaps worthwhile pointing out that simple supplementary entries in the registers that can be made with little extra trouble are capable of providing a great deal of important information that would otherwise only be collected with great difficulty. Whether the primary holders are the sole cultivators of the land, whether they are local residents or absentees, whether they belong to an agricultural class in cases of a plural economy, and many other sociological facts that may be of great importance can be recorded. A simple entry, perhaps of one letter of the alphabet in each case, can be sufficient in the register. Corresponding data can also be obtained for subordinate landholders and even labourers as can types and duration of tenancies, details of rents and many other matters connected with tenancies.

Cadastral maps and registers can also be used for the analysis and interpretation of census data. The best results in this connection will, of course, be achieved if the units on the basis of which the demographic enumeration is carried out are correlated to the units of the cadastral survey and land registers. The relative smallness of survey units will allow a close approximation of the area covered by them with that of the census units even if the latter continue to follow political boundaries. Correlation of census and cadastral data permit the accurate analysis of many features of the rural economy, and also greatly facilitate the conduct of inquiries into such economically important facts as the gross productivity per agricultural worker.

It must be admitted, however, that most systems of cadastral survey and registration of rights include one feature that limits their direct usefulness in inquiries into relations between human beings and the land. The necessity of maintaining a means of continuous identification of individual holdings in map and register, while it does not prevent the recording of the subdivisions of holdings, can place formidable difficulties in the way of combining holdings within a single map or register. If a holding is divided, it is easy to show the division on the map and make new entries in the register, the continuity of which is secured by cross-reference to previous entries. Combinations of holdings, especially the combination of a part of one holding with another, are much more difficult to effect without confusion.

This fact, together with the fact that only groups of contiguous fields can conveniently be shown as holdings on the map, suggests the desirability of providing a supplementary "index of estates" in which all the holdings of a single individual or group are entered in one place. This device can obviously be extended beyond the basic registration unit to combinations of such units and ultimately, if required, to the country as a whole. The initial compilation of this index and its maintenance for combinations of registration areas will be laborious, but its statistical value is very considerable, and it becomes a necessity wherever land legislation limits the area to be held by one person. Fortunately the problems are less acute where the records have been

computerized and data relating to an individual holding can be extracted with relative ease even though the data relate to non-adjacent land parcels.

So far in this chapter emphasis has been placed on the advantages of cadastral surveys from the point of view of the State rather than from that of the individual. It is necessary to point out that the individual has many corresponding advantages. It is an interesting fact that a very large number of private surveys of land are carried out every year in most countries, by licensed surveyors or even by the landholders themselves. The existence of official large-scale plans obviates the need for many of these surveys or at least provides base maps on which additional detail can be easily recorded. Cadastral maps, copies of which can be readily and cheaply obtained, not only lessen the cost of legal proceedings for which such maps may be required, but greatly facilitate the planning and lessen the cost of many types of farm improvement, for example drainage or irrigation schemes, the construction of farm roads, the laying of piped water supplies, the siting of new buildings, etc. It is also obviously to the advantage of the large farmer and still more to the owner of a large estate to be able to obtain without personal calculation exact data as to the area of farms, fields, roads, ponds, or other features on the estate. Estate and farm maps can also be used in many ways in connection with the planned operation of a large estate or farm, for instance as a permanent record of use, planting, dates of operations or yields, and especially in connection with silviculture, tree crops and other long-term agriculture.

Doubts and fears

The possibility of popular doubts and fears as to the effects of the introduction of a cadastre has already been mentioned. Governments also may have their doubts and fears, especially as to cost. In the present chapter it is proposed briefly to discuss these matters.

Governments depend on public acquiescence in their acts. Acquiescence may be induced by force or by persuasion, but among free peoples attempts to secure acquiescence in which force may be applied are strictly limited; the institution of a cadastre will seldom be one of these, so that governments must ordinarily rely on persuasion. In these circumstances public doubts and fears not only deserve full consideration but must receive it. Many causes may give rise to public objections to the introduction of cadastral surveys and registration of rights. Some of these will be purely imaginary and due to simple misunderstanding. Others will be factual and practical. Others again will rest on ancient and deeply rooted religious or social ideas which, though the reformer may be inclined to regard them as mere superstitions and prejudices, may well be the most important obstacles of all.

Reliance must first be placed on the assistance of the administrative and technical officers of the government, and especially on that of those officers whose work brings them in close and constant contact with the people. Many of these will be subordinates whose educational level may not be much above that of the rural people. Great attention should be given to the education of such officers, partly because people usually, though not invariably, pay more attention to what is said by those of their own kind than to the words of experts and high officials, but mainly because these subordinates have opportunities of introducing subjects into ordinary conversation with members of the public that are denied to members of the higher grades of government service. Subordinate officers often live in the villages, or stay in village houses in the course of their tours. There is always plenty of scope for talking in villages (indeed talking is usually the principal occupation of leisure hours) and casual conversation is one of the most effective methods of educating public opinion.

Every community has its natural leaders, and every effort should be made to convince these first of all, partly because, being usually more intelligent, they are easier to convince, but mainly because, when convinced, they will themselves become the most effective educators of public opinion.

It cannot be too strongly emphasized that where strong public opposition to the introduction of a system of registration of rights exists, every endeavour should be made to overcome it by sensible communication and educational measures. The objects and effects of survey and registration should be clearly explained and their advantages, especially the advantages to individuals, well stressed. On the other hand it will seldom pay to disregard or slur over any private disadvantages which may follow: to do so will merely intensify opposition.

This is not the place for an essay on methods of propaganda, and moreover the effectiveness of these methods varies so much in different conditions and states of society that to attempt any general recommendations would be a mere waste of time. The education of public opinion among a largely illiterate population,

however, presents certain special difficulties and a word on methods in this case may not come amiss. Written promotional material is usually ineffective, because such a form of communication usually reaches the illiterate in a very garbled form, and especially because in these cases the assistance of the press can seldom be satisfactorily obtained. Education must therefore proceed largely by word of mouth, except to the extent that "visual" methods can be used, and in this particular case the scope for these methods may be somewhat limited.

Education should, moreover, be a two-way process: the same means employed to explain the proposals to the public should be employed to inform the government of the exact nature and degree of public objections to the proposals. Much opposition can be overcome by minor adjustments in the proposals themselves, and explanations will be the more persuasive if the precise nature of the opposition is known.

Popular doubts and fears are thus overcome in two ways, first by explanations of precisely what is to be done and its effects on the individual and on the community, and second by adjusting the proposals as far as possible to public prejudices and sentiments.

It is perhaps worth repeating that opposition seldom comes from individual landholders, at least insofar as their own holdings are concerned. This fact is important because it suggests that, where such opposition does exist, it should be relatively easy to overcome it. There is, however, one important exception to this general statement.

Opposition frequently arises from a fear that information recorded will be used for the purposes of taxation. The objection is usually well founded; if it is not - if there is no intention of introducing land taxes - then the government can, of course, say so categorically and emphatically. Such a public declaration is not, however, to be recommended since, in a developing agricultural community, taxation of the land in one form or another is almost inevitable sooner or later. If a declaration that there is no intention to tax has been made, the government can reasonably be accused of breach of faith if it subsequently imposes a tax on land. If public opposition on this ground is considerable, it will usually be best to face the situation boldly: to point out that the development of agriculture and the improvement of rural living conditions by governmental action can only be effected if funds are available, and that the government can only obtain funds by taxation; and to explain as carefully and fully as possible that the fairness of any system of land taxation depends on the accuracy of the information on which its assessment and distribution are based. In fact the efficiency and ease of collection of a tax based on proper maps and registers will certainly permit lower rates of tax to be fixed than would otherwise be necessary to obtain the same revenue. The superiority both in fairness and in dignity of taxes on land over such primitive forms of taxation as capitation, house or poll taxes may also be stressed where these taxes exist - especially if they are already unpopular.

To a more educated public the greater fairness of land taxes as compared with export taxes or excises on produce may also be stressed. Where a system of land taxation already exists the task is much easier, because the disadvantages and unfairness which will certainly be found in a system that is not based on exact information can be used as practical arguments. A sound system of

taxation of land should be based on accurate measurements of the land and should be graduated according to a valuation of the land, or of its produce, per unit of area. Taxes based at flat rates on valuations of the gross area of a holding are invariably bad and graduated taxes based on such valuations will usually be worse. Not only are they inequitable, but they are usually incomprehensible to those who are assessed. The great merit of accurate maps is that they permit the assessment to be made in terms of values which the farmers recognize and in a form that they can understand. Full use can be made of this fact when a change in system is contemplated.

A very real and substantial objection may be the fear that registration may introduce some unwanted change in a traditional system of tenure, or may create a right where no rights previously existed. This fear is especially important in the case of traditional, communal or tribal tenures, where there is very real danger that registration of rights, especially if the system is based on European ideas of registration of individual titles, may create rights inconsistent with the existing social grouping. A means of obviating this danger has already been suggested above, which if adopted intelligently will confirm and strengthen rather than weaken the rights of the community or kinship groups and prevent rather than facilitate the growth of an unwanted individualism. In such communities, registration of rights may help to mitigate the confusion sometimes caused by the existence of two parallel sets of rights, for example rights derived from membership of a kinship group and rights based on cohabitation of the same villages. It may also help to prevent usurpation or infringement of communal rights by tribal chiefs or village headmen, and act both to safeguard prescriptive rights of occupation where these are recognized and to prevent the accrual of such rights where this is contrary to public policy.

Governments should take every precaution that accidental changes are not made in a traditional tenure system by registration and that existing undesirable tenancies are not encouraged. If this is done, and can be shown to have been done, public opposition will probably be readily overcome. Registration in these cases should not introduce new features in the tenure system, but should aim at being a crystallization of the public memory which is the traditional record of rights. Mutations also should be made in the villages and only when village opinion accepts the changes and the customary forms and ceremonies have been duly observed.

In the case of these traditional communities, registration should be carried out as speedily and widely as is practicable, because there is always a risk that the fact that rights have been registered in one area may cast doubts on the validity of the rights held in areas still unregistered. This risk is, however, minimized if registration demonstrably does no more than record an actual situation and creates no new rights.

Another very important cause of opposition to registration of rights among primitive communities may be found in religious or traditional beliefs as to the ownership of the land, as to restrictions on its use or as to ceremonies necessary before it can be used. These beliefs should be given full and sympathetic consideration. They often have valuable social and agricultural implications and must certainly never be dismissed as mere foolish superstitions. In many cases land is regarded as belonging to some long-dead

ancestor or collectively to a long line of ancestors. The rights of generations unborn may also be recognised.

Where this state of affairs exists there are obvious objections to recording the land as belonging to some living individual or group. Some satisfactory way out of this difficulty can usually be found. If the name of a dead "owner" is known or if a collective appellation for the dead and unborn right holders exists, these names can be given as a description of the land in the registers and the rights of the living thus explicitly subordinated to those of the dead and unborn. Alternatively, some other device may be adopted to make it clear where the ultimate right lies, without preventing the recording of the rights of living persons. The Polynesian "tapu" and corresponding prohibitions on the use of land by particular persons, or by anyone at all, present another set of problems, which may be very obstinate. There are obvious objections to placing on permanent record a taboo which a subsequent change in social or economic circumstances may cause to be relaxed, but so long as the taboo exists it is very real and cannot be disregarded. In the mountainous areas of southern Asia and in other parts of the world, sanction is provided for a traditional system of rotational use of land by communal religious ceremonies which are regarded as essential preliminaries to cultivation. Clearly no system of registration should give countenance to anything which disturbs this sound agricultural arrangement.

These are only examples of the kind of problem which may give rise to very real doubts and fears on the part of the people, to which the most sympathetic attention should be given. Only occasionally, as in the case of the religious objection sometimes found to measuring the land at all, will it be necessary in the public interest to disregard objections of this kind completely, and even in this case the development of air surveys may prove to be a solution.

The doubts of governments, to the extent that they do not reflect popular doubts and fears of the kinds already mentioned, are mainly based on considerations of finance and personnel. Large-scale surveys of wide areas are certainly expensive, but no modern country can afford to be without proper maps, and if these are to be made at all the extra cost of surveying each part of the country on a scale suitable to the needs of cadastral maps in that area is likely to add a fraction to the initial cost of a national survey which will be fully recouped by much greater savings at a later date when the demand for large-scale maps becomes irresistible. The cost of surveys varies so greatly in accordance with local conditions that no generalized figure will have much meaning. The principal causes of variations in cost of initial surveys are wages of the personnel employed, variations in topography, type and cost of equipment used, the limitations placed on surveying time during the year by local weather conditions and the scale of the maps to be produced.

It is not very useful to seek examples in North America or Western Europe. Both the United States of America and Canada, though so large that their surveys are still far from complete, are rich countries, whose governments can afford to spend large sums on their activities. The United Kingdom is a small, compact and still wealthy country, in which the necessity of large-scale maps has long been recognized and whose efficient survey department has long been an accepted institution. The cadastres of most of the Western European countries

date from the earlier years of the nineteenth century. Most of these countries, moreover, have the advantage that they can manufacture most of the equipment needed for both ground and air surveys and have full facilities for training technical personnel.

It is not beyond the capacity of even small and not very wealthy countries to establish and maintain satisfactory cadastral survey and records of rights. Actually the separate cost of the cadastre, as evidenced by a country such as Myanmar may be nil, because the record is required for revenue purposes. The total cost of the Land Records Department in Myanmar was treated as the cost of assessing the land revenue. It amounted to about 6 percent of the net collections, which in comparison with the cost of assessing other kinds of revenue was very reasonable, even without consideration of the fact that the same staff maintained the record of rights, prepared crop forecasts, collected crop statistics, statistics of tenancies, sales of land and mortgages and did much other miscellaneous work.

Three lessons can be learned from countries such as Myanmar. The first is the great advantage of making the register of rights into a true cadastre used for revenue purposes. The second is the great administrative advantage of having a considerable local staff in constant contact with the land and the rural people: there is practically no kind of agrarian information which cannot be collected at reasonable notice by the land records staff. The third is the great advantage of starting the geodetic survey at the earliest possible date and of completing it with all convenient speed. If the Survey of India had attempted to cover the country with maps without having the firm foundation of a rigid primary triangulation the result would now be complete confusion.

This last advantage, though of great weight with professional surveyors, should not be insisted on too dogmatically. There will often be circumstances, especially in a large country, which demand that mapping should be carried out on a regional basis, and if this is carefully done the maps made will serve their immediate and essential purpose. This happened in New Zealand where the early maps were based on regional surveys in connection with land tenure and the needs of a rapidly expanding population. Discrepancies in the boundaries of regional surveys will, however, be inevitable and the task of subsequently correcting these will be costly and difficult. A country which has an urgent need for large-scale maps but no geodetic framework may be well advised to survey the areas where the need is greatest without waiting for the completion of the primary control network.

Concluding remarks

No formal concluding summary of this paper is necessary, since the main conclusions were forecast in the introductory chapter. All that remains to be done is to tie up one or two loose ends in the argument and perhaps to suggest a moral.

Distinction between cadastral and other large-scale maps

The reader may notice that the two terms “cadastral maps” and “large-scale maps” have been used almost as though they were interchangeable. This is true of some cadastral and large-scale maps but not of others. The Myanmar revenue maps are large-scale maps containing all horizontal topographical data drawn to exact scale. These maps were made for cadastral purposes but can be used for any purpose not requiring vertical topography. Conversely the British maps on the scale 1:1,250 and 1:2,500 are large-scale topographical maps not made for cadastral purposes but usable as cadastral maps. Many of the cadastral maps of continental Europe, however, contain only a minimum of topographical detail and may indeed be mere perimeter plans of holdings which do not even show interior field details. The uses to which such maps can be put without the insertion of further detail are obviously much more limited than the uses to which the maps of Myanmar and the United Kingdom are adapted. Yet, provided that the survey is sound and that the holding boundaries are recognizable on the ground, the topographical and other additional detail can usually be easily inserted at reasonable cost and the possibilities of adapting these maps to new requirements should always be examined before a new survey is undertaken. Clearly, however, a country embarking on a new cadastral survey will do well to adopt the model of Myanmar or the United Kingdom and get a more generally useful map at very little extra expense.

Distinction between registers and records

The terms “register of rights” and “record of rights” have likewise been used as though they were synonymous. In practice they may often be so, but in theory they are not. A “register” of rights is a record of formal acts of registration of legal rights but a “record” of rights may be compiled for some other purpose than the formal registration of legally established rights, as, for example, the Myanmar record is primarily a register not of rights but of revenue assesses.

Position of registrars

A few words are necessary on the position of the registering authority, who for convenience will here be called the registrar, though in practice this may or may not be his or her title. The duties of a registrar include some administrative and some quasi-judicial functions. These may be divided between two authorities: for example the quasi-judicial functions may be exercised by the civil courts or by some persons designate among the judges. The division of responsibility usually occurs where the register purports to record absolute title. The powers and duties of the registrar vary depending on whether registration is compulsory or optional. If registration is optional the registrar may have no discretionary function except to decide whether the evidence submitted is sufficient to justify

registration, but if registration is compulsory the registrar may, and usually will have in some situations, the duty of ascertaining the true facts. This is a very important distinction and the burden placed on the registrar who has to establish absolute title under a compulsory system is a strong argument in favour of the initial registration of presumptive title only under such systems. The extent to which registrars have to exercise judicial functions has an important effect on the qualifications required in them, since they may require a legal training if they have to sift evidence of absolute title. On the other hand, under the simple Myanmar system, where the officer holding the original tenure inquiry has authority to determine once and for all the tenure status of each parcel of land, little or no legal knowledge is subsequently required.

Again under the optional system the registrar usually has the right to refuse registration if the evidence presented is not satisfactory. Under the compulsory system such general power of refusal is impossible and all that the registrar can do is to suspend registration either pending further inquiries, or to allow the consent of interested parties not represented to be obtained, refusal being confined to what are clearly illegal transactions. This again is an important distinction which greatly affects the necessary status and qualifications of the registrar. There may also be distinctions in the powers of the registrar to admit, refuse or suspend registration between initial registration and subsequent transfers.

In general, however, registrars (or their official superiors) will need the following powers:

- a. Power to accept, suspend or refuse an application for initial registration for reasons shown and recorded.
- b. Power to compel the attendance of any person or the production of any document.
- c. Power to impose on any person appearing before the registrar a legal duty to declare the truth.
- d. Power to issue caveats or inhibitions and to report apparent breaches of the law to the competent authority.
- e. Power to hold inquiries into facts and to come to findings on the facts so ascertained.
- f. In case of disputes under systems of compulsory registration, power to direct the parties to seek the orders of the court competent to determine the dispute.
- g. Power to correct errors in the registers.
- h. Power to state a case to the courts.

Persons entitled or bound to apply for registration

Under compulsory systems of registration the person claiming the possession or enjoyment of a right has usually a statutory duty to apply for registration, and sanctions against his or her failure to do so are provided by liability to prosecution or by legal disabilities. In the case of voluntary systems of registration this is of course not so and even under compulsory systems there may be persons who are entitled to apply for registration without being compelled to do so. The following list is intended to indicate the nature of the

interest in a right which may place a duty on persons or entitle them to apply for initial registration.

- a. The person (or any member of a collective group of persons) claiming the primary tenure.
- b. The guardian of an infant or the committee of the estate of a lunatic.
- c. Other persons who have the right for the time being to dispose of the primary tenure.
- d. The person having the first vested interest of inheritance in the primary tenure of an estate held in fee-tail.
- e. A duly authorized representative of the government or of a subordinate authority.
- f. A mortgagee in possession.
- g. The holder of a right of perpetual use, subject to payment of an annual rent.
- h. A person claiming a right of subordinate tenure which is registerable (e. g. a lessee).
- i. A mortgagee not in possession if non-possessory mortgages are registerable.
- j. A person claiming a private easement or servitude over the land of another in respect of such easement or servitude.
- k. Any person claiming to share in a public right or easement in respect of any land in respect of that right or easement.
- l. A person claiming separate rights over trees or water on the land.
- m. A person having pre-emptive or reversionary rights over land.

In certain cases the agreement of some individual other than the right holder in person may be required before a claim for registration of a transaction in land can be accepted, even though the consent of the right holder to the original registration is not required. Such persons include the owner or joint owners of the first vested inheritance of land held in fee-tail or under a life interest, a mortgagee, a person holding a right of pre-emption or of reversion, every joint heir or other person claiming a share in land under joint tenure, and so on. Such person may also have the right to object to the registration of a transaction and so may certain public authorities, e.g. a civil court before which the land is in suit or a public official charged with the duty of enforcing a law restricting transfers of land by or to any class of person.

Revision of cadastral maps

In a report to the United Nations (ECOSOC E/1322 of 1949), the following passage occurs:

“Cadastral surveys, unlike scientific surveys of an informative character which may be amended with changing conditions or because they are not executed according to the standards now required for accuracy, cannot be ignored, repudiated, altered or corrected, and the boundaries created or re-established cannot be changed so long as they control rights vested in the lands affected.”

While it is true that a cadastral survey cannot be ignored or repudiated, it can nevertheless be altered for good cause shown and it not only may be but should be corrected where necessary. Revision and resurvey of the cadastral maps

may indeed be essential to ensure that the “boundaries created or re-established” continue to “control rights vested in the lands affected”. Holdings and fields may be subdivided and different rights thus created. Land may be washed away by the sea or by changes in the courses of rivers. New land may be formed by the same natural forces. New roads, railways or canals may alter the boundaries of many properties. All these and many other changes will involve revision of the cadastre, and cadastral maps that take no note of them will rapidly become unusable.

What is true is not that the cadastral maps cannot be altered or corrected, but that in making such alterations due care must be exercised that the continuity of the record is not interrupted so that references from the current map (or register) to any of its predecessors can be made easily and with certainty. This continuity is, of course, of the greatest importance where reversionary rights exist or where, as in English law, riparian owners acquire rights over alluvial accretions adjoining their land or can re-establish rights over land which has reappeared after previous erosion, but it is an essential feature of all systems of registration of rights. Continuity will not however be maintained by clinging to a record which is no longer in accordance with the facts.

Brief conclusion

Successful planning and development must be based on knowledge. Orderly administration and use of the land as the necessary foundation of human life must equally be based on knowledge. Large-scale maps and the registration of rights in land, and the description of natural resources through these maps are the best basis for all such knowledge. As a record of rights the map has no substitute: it is not for nothing that ecclesiastical threats have been directed against those who move their neighbour's landmarks. The more developed countries and a few less developed countries have recognized these facts and either have adequate maps and land registers or are making them as fast as is practicable. It is not beyond the capacity even of a relatively poor government to map its territories or to register the rights recognized in its land. The money so spent will bring a rich return.

Further reading

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