Midwest Universities Consortium for International Activities, Inc.

Workshop on Alternative Land Registration Policies

October 5-7, 1983
University of Wisconsin–Madison

Midwest
Universities
Consortium for
International
Activities, Inc.

Land Tenure Center

WORKSHOP ON ALTERNATIVE LAND REGISTRATION POLICIES
Wisconsin Center Guest House - Lowell Hall
610 Langdon Street - Room 118
University of Wisconsin
October 5-7, 1983

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SESSION I: OCTOBER 5, 1983

9:00 a.m.	Welcome and Outline of Workshop
9:15	John Bruce - Land Registration Systems and Customary Tenure Arrangements
9:45	Discussion
10:00	Coffee
10:15	Herman Felstehausen - The Democratic Roots of the Cadastre
10:45	Discussion
11:15	Peter Dorner - Different Dimensions of Property Rights
11:45	Discussion
12:15 p.m.	Lunch: Jim Riddell - Aerial Photography and Rural Land Boundary Demarcation: An Experience from Liberia

SESSION II: OCTOBER 5, 1983

1:30	A.P. Atkinson and Leslie Howells: The Land Registration Projects of the Directorate of Overseas Surveys, Government of Great Britain
2:15	Discussion
2:45	Coffee
3:15	Ivon Sleep - The Case of Land Registration in Antigua
4:00	Discussion
4:30	Adjourn - Reception

SESSION III: OCTOBER 6, 1983

8:30 a.m.	David Moyer - Multipurpose Cadastres
9:10	Alan Vonderohe or Dave Mezera - Spatial Framework (a linkage mechanism)
9:35	Phil Muehrcke - Mapping Techniques (Current)
10:00	Coffee
10:15	Ben Niemann - Ownership and Planning Records - ownership - land use
10:40	Nick Chrisman - Resource Records - soils - land cover
11:05	Tom Lillesand - Remote Sensing Options
11:30	Ben Niemann - Training Support Systems
12:00	Lunch

Workshop on Alternative Land Registration Policies

SESSION IV: OCTOBER 6, 1983

1:00 p.m.	Tours:
	1) Cartography Lab - David Woodward Science Hall
	2) Remote Sensing - Tom Lillesand Space-Science Building
	3) Land Information Facility - Ben Niemann Steenbock Library

SESSION V: OCTOBER 7, 1983

8:30 a.m.	Earl Epstein - Land Records and Land Tenure in North America
9:00	Discussion
9:15	Randy Stringer - et.al., Review of AID Land Titling Projects
10:00	Discussion
10:15	Coffee
10:45	Scott Witter - The CRIES Project in Jamaica
11:30	Discussion
12:15 p.m.	Lunch - Speaker: William Chatterton - The Problem of the Land Records in the US

SESSION VI: OCTOBER 7, 1983

1:30	Joe Thome - Titling Projects in Latin America
2:00	Discussion
2:30	Coffee
2:45	John Strasma - Cost Benefit Evaluation of a Land Registration Project in St. Lucia
3:30	Discussion
4:00	Closing

To attend the workshop, please register with Kathy Torok 608/262-3657.

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SESSION I

LAND AND WATER ECONOMICS AND POLICIES (No. 1 — April 1971)

ADC teaching forum

to encourage the exchange of materials useful in the teaching of courses related to agricultural development in Asia

Land Registration: Some Current Policies and Problems

H.W. WEST

Almost every program of agricultural or rural development requires good ways of recording or registering land rights. A discussion of land registration probably belongs in any course on land economics, and perhaps in some other course as well. H.W. West (Cambridge University, England) gave this brief discussion of the purpose of land records and registration at a National Seminar on Land Reform in Nepal in October, 1970. Dr. West says, "This paper is intended to provide an outline of certain important aspects only and is based, for the most part, on personal experience gained in East Africa rather than in Asia."

Systems of land record or registration may be conveniently classified according to the primary objective which led to their establishment. Historically, these purposes were either primarily fiscal or primarily proprietary.

Record for Fiscal Purposes

Here the object has been to assist in the assessment and collection of revenue; in other words the advantage has accrued primarily to the State. Virtually all ancient systems (including that employed by the Mogul Emperors) fall into this category. The most significant for present purposes are the Cadastres of continental Europe and the records compiled under the Indian Land Revenue Settlements, which today constitute by far the most extensive records of rights to land in existence.

To fulfil their function efficiently these records must supply reliable information on a whole range of variable quantities, each of which has its effect on land productivity and hence on value and the assessment of tax. In respect of each unit of land use its area and boundaries must be recorded on cadastral plans; also the soil classification and suitability for certain specified crops; the nature of the crops actually grown and their normal annual yield, the nature of any irrigation facilities etc; all this information must be recorded and kept up to date. Particulars must also be kept of both owners and occupiers, but only in so far as these are liable for the payment of land revenue to the State.

Registration for Proprietary Purposes

Here the primary function of the register has been to confirm the land holder in his proprietary interest. Under such systems the main advantage accrues first to the land holder himself, and only indirectly through him to the national economy. Because these proprietary systems may be viewed by Governments as luxury items of expenditure, they tend sometimes to suffer from governmental neglect; whereas for obvious reasons the fiscal systems have rarely been so handicapped.

In these proprietary systems the emphasis is upon establishing and securing the title of interest holders, whether this be title to absolute ownership or to derivative interests (or tenancies). Both the register of title itself and the cadastral survey which supports it are designed for this purpose and carry only such information as is necessary for the unambiguous definition of land parcels, for establishing the identity of principal interest holders and for determining the interest they hold. Other information on the physical quality of the land and on the nature of land use is omitted as irrelevant.

Through nothing more than historical accident, two systems of proprietary registration evolved simultaneously; namely the English system and the Torrens system in Australia. These two systems are closely similar, both in their objectives and in their methods, but there are important differences in detail which stem from the different geographical, economic and social conditions under which they were introduced. In England in A.D. 1862 the nature and pattern of proprietary interests in land were already long established; the physical demar-

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cation of property boundaries by hedges, fences or walls had already been carried out; accurately constructed Ordinance Survey maps on scales of 25 inches or 6 inches to one mile were already available and these showed the positions of all parcel boundaries. In 1857 when Torrens introduced his South Australian Real Property Act, Australia was still a new territory being opened up for settlement, though a great deal of land was already held under titles supported by survey. It was not in general a question of recording existing rights to land parcels whose limits had already been defined but of registering new grants of unoccupied land as these were issued and as the parcels were set out scientifically on the ground according to the acreage allocated. The absence of visible boundary features, i.e. the so-called approximate or 'general' boundaries of the English system, and the absence of easily accessible supplies of material for fences or walls meant that the survey beacon, with its so-called 'fixed' boundaries, has played a much more important part under the Torrens than under the English system.

A Current Trend in Registration Policy

When most developing countries came to adopt a system of land registration the proprietary rather than the fiscal system was in vogue. The Torrens System was seen to be more readily adaptable to their circumstances than was the English system: indeed up until 1925 the English system was labouring under many difficulties from which it has only recently emerged. So some variant of the Torrens system with its emphasis upon the guarantee of individual title and its high standards of accuracy in parcel surveys was adopted in countries as far apart as Fiji and British Honduras, or Uganda and Jamaica, or Malaysia and Trinidad.

Interest at that time was centred on the need of the individual land owner for proof of title and security of tenure rather than the need of national governments for comprehensive records as a basis for tax assessment. Little or no attention, therefore, was given to the land revenue records maintained in the Indo-Pakistan sub-continent. These fiscal records were not intended to guarantee title; nevertheless, with the passage of time, they had come to serve as an effective record of presumptive title which will stand at law until evidence is brought to the contrary. It is only now being appreciated that under the conditions in many developing countries, particularly where credit for urban and rural land development is provided largely through State agencies, where the land market is not very active and land values are low, the presumption of title may be good enough and the added expense entailed by greater precision in boundary survey, greater complexity in legal provision and wider State responsibility through the guarantee of title, may not be justified.

There has been another most important dimension added since World War II. To quote the words of the late Lord Hailey, 'there is everywhere a tendency to assign to the State a wider authority and greater initiative as an agency for improving the social standards and the economic life of the community'. The term 'planning' has become a watchword of modern times. We now have economic planning, physical planning, institutional planning, land use and regional planning, and so forth. In all these the State must play a leading role, especially in developing countries, and it is self-evident that for the successful planning of any part of the economic or social life of the community, there must be comprehensive and reliable statistical data available. For planning purposes this data must be more detailed than that made available by systems of registration of title on either the English or the Torrens model, so interest appears now to be swinging back towards the cadastres of India and Pakistan and certain continental countries in Europe. The significance of these records for purely fiscal purposes is frequently declining[1], but their unparalleled value for all aspects of planning should be sufficient to ensure their efficient maintenance in the future.

The current need therefore, would seem to be rather for a system of land record which can supply the planners with a whole range of statistical data of a generally economic and social nature, whilst at the same time providing the landowners and users with a sufficient degree of security to induce satisfactory long-term development. The need for a nation-wide cadastral survey cannot be denied but it seems advisable to forego some of the refinements such as guaranteed title in the interests of more rapid expansion of the service and more efficient use of available facilities.

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[1] In the Indian State of Madhya Pradesh the land tax collected is not sufficient to meet the cost of the government administration responsible for the maintenance of the Land Records. In Holland and Belgium the authorities regard their land records as being primarily of value in land administration and not for taxation.

LAND REGISTRATION AS AN ECONOMIC AND SOCIAL SERVICE

It is proposed now to outline the theoretical benefits that should accrue from an efficient system of land registration.

It will be noticed that these groups are not mutually exclusive; moreover some of the benefits may be incompatible where the interest of the individual land holder and the interests of the State do not coincide.

Benefits Accruing to the Individual Land Holder

In any society where great importance is attached to individual rights and incentives, the benefits accruing to the landholding community will be more fully appreciated; for this reason they will not be dealt with here in any great detail

(a) **Great Confidence and Sense of Security**
It is important to note that the system should extend this benefit not only to holders of superior proprietary interests (i.e. the landlords) but also to holders of derivative interests (i.e. the tenants) where this form of landholding prevails. Tenancy boundaries should be demarcated and recorded and particulars of the tenancies should be entered as encumbrances on the titles of the superior interest holder. The registration service must support the actual land user; protection of 'mere proprietorship' is likely to be a pointless and possibly harmful exercise.

(b) **Dealings in Land May be Completed Expeditiously, Reliably and Cheaply**
To achieve this in a developing country the service must be self-sufficient in that it cannot and must not rely upon the private legal profession which may be either scarce or non-existent. If mobility of land resources is to be assured (and most economists will argue that it should) then all procedures must be readily understandable by those who hold interests in land and their conveyancing expenses must be reduced to a minimum. This indicates a policy of decentralization of registry offices so that they are as accessible as circumstances permit to avoid inconvenience to proprietors.

(c) **Less Possibility of Loss, Fraud or Mistake**
Honest mistakes and deliberate fraud cannot be entirely prevented by registration, but their perpetration is made more difficult and their detection and rectification is greatly facilitated.

(d) **Better Administration of Credit Schemes**
Here again it is the land user, whether he be owner or tenant, whose 'credit-worthiness' should be increased through registration so that he may then offer his registered interest as collateral security for a development loan. In this way outside capital may be attracted into housing development projects and also into agriculture; the risks to money-lenders are reduced and so their interest rates should come down. Because experience has shown that the improvidence of peasant proprietors may lead to dispossession on default of repayment of a loan, it is important that separate legislation be enacted to ensure that any credit advanced is directed towards production rather than consumption.[1]

(e) **Reduction in Litigation over Land Rights**
Through registration much unproductive personal expenditure can be avoided; not only the cost of legal fees and attendance at court but also the value of lost earnings and of hidden bribes. By removing most of the causes of dispute over land rights and boundaries, registration can improve both the community spirit and harmony in rural areas; but for the full benefit to be achieved it is again necessary to register the rights not only of the land owners but also of the tenants.

(f) **Absentee and Reversionary Interests are Fully Protected**
Where development depends on the grant of a lease it is essential that the lessor be confident that his reversionary interest will not be obscured, forgotten and overlooked, no matter how long the term of the lease. But this particular advantage should not be over-emphasized; in many developing societies absentee landownership is one of the factors militating against better land use and so should not be encouraged.

[1] e.g. The Kenya Land Control Act of 1967.

(g) Defects in Title May Be Finally Cured

It will frequently happen that a claim to ownership is based on faulty documents or on possession only and no other evidence can be produced. To deny registration in such circumstances would be to reduce the benefit of the service and to withold assistance from those who need it most. Whether the eventual aim is to establish guaranteed or merely presumptive title, it is better to bring such claims on to the register and to make provision whereby they can mature into titles either in consequance of the later production of additional evidence, or as the result of the passage of time or both.

Benefits Accruing to the Local Community

In developing societies where the institutions of local government are currently being established or improved, the compilation of a comprehensive land register can increase their effectiveness in a number of ways:

(i) As local authorities usually depend for their revenue on the taxation of landed property any method of improving the assessment and collection of such taxes should interest them. Reference to a reliable record of property rights and boundaries would be of great assistance. In particular the record of recent sales in the locality can be used as the basis of valuation for rating purposes.

(ii) What may be called 'segmented thinking' as between one public utility authority and another (e.g. water, electricity and drainage) may be eliminated by comprehensive records which will prevent the duplication and confusion that arise if each of several public utilities is left to keep its own records.

(iii) The authoritative and unambiguous identification of publically owned land must precede proper land administration by the local authority and is likely to lead to an improvement in revenue collection from land rents.

(iv) The responsibilities of local authorities under planning legislation can be exercised with greater confidence, expedition and public support where a comprehensive land register is available for public inspection. This is an advantage of great and increasing consequence because the present trend is to heap more and more planning duties on to the shoulders of local authorities.

Benefits Accruing to the State

Gone are the days when Government was merely a matter of foreign policy and the maintenance of public law and order. Over the last twenty-five years the tendency for Governments to take a leading role in the planning of every aspect of the national life has been further and further accentuated.

From this has stemmed the realisation that land records can play an indispensable part in many aspects of planning. It is particularly in this connection that contemporary thoughts on registration policy go beyond the objectives which Dowson and Sheppard had in mind when they compiled their work shortly after World War II. This is the growth point to which attention is especially invited in this paper; this is why any government may be well advised to take a fresh look at their registration system.

It seems that land registration can fulfil three main functions at national level, particularly in developing countries, at the present time:

(a) Introduction of New Land Law

A comprehensive record of land rights provides the essential medium whereby systems of land tenure may take that difficult transitional step from custom to statute. Though customary forms of tenure have not precluded the introduction of cash cropping they have at times restricted its development. Tenurial conversion can provide a sounder basis for further agrarian development as subsistence cultivation gives way to commercial farming.

(b) Creation of a Land Resources Inventory

Because of the present unprecedented increase in population and the heavy dependence on agriculture, it is becoming daily more evident that the conservation and planned utilisation of land resources must be matters of increasing Government concern. Future land use cannot be planned satisfactorily unless the basic factual information is available both on the current situation and also on land potential or capability. Without information on irrigation facilities, soil type, degree of slope,

current valuation, actual and potential use etc., the planned development of land resources can only be a hazardous and presumptuous task with a great risk of failure.

There is a further most important consideration here. Unless all land rights are to be nationalised so as to permit the redistribution of land resources, development can take place only through the existing landowners. Landownership may therefore be a factor of critical importance, yet this is frequently overlooked by development planners. A comprehensive register will supply not only information on the area, shape and locality of each and every land parcel but also on the ownership, duration and value of virtually all rights and interests in the land.

(c) Catalyst for Modern Land Administration

In the past there has been much segmented thinking at national planning level. Each ministry has tended to compile and maintain its own statistical data service. It is time that these services were now more closely integrated and in this respect the land register should itself be seen as part only of a future national information service covering also such aspects as public health and making the fullest use of computerised techniques of data storage and retrieval.

A system of record would be of positive assistance in the really effective implementation of all Government policies relating to land:

(i) In implementing the planned adjustment of the land proprietary structure, or 'land reform' as it is more commonly called. Reliable statistical information on the level of agrarian debt, the incidence of co-ownership, on alien ownership, on various forms of tenancy, on land speculation, pluralism and subdivision, etc., could be made available through registration and by means of the register checks could be applied to ensure that public policy is being followed.

(ii) The prospects of the effective physical planning of land utilisation are also greatly improved through the compilation of data on actual and potential land use, and the incidence of sub-economic parcellation and fragmentation.

(iii) In some circumstances land registration can help to activate and to stimulate the market in property rights, whereby land can be made available to a widening sector of society. Through registration the influence of the land market may be guided and, if necessary, dealings in land may be controlled. The register provides a window on the tenurial situation and such trends as the appearance of inalienable property rights can be observed and if necessary rationalised.

(iv) The records can also provide a valuable tool in feasibility studies; in any development scheme which involves land assembly, either with or without the use of compulsory powers; in the estimation of compensation payable for land and crops; in mineral prospecting; in the selection of settlers for colonisation schemes.

In short, the existence of a comprehensive and reliable record of land rights and parcels will assist considerably in the implementation of national policies aimed at land reform and development.

FEATURES DESIRABLE IN A REGISTRATION SYSTEM

When viewed broadly, the desirable features of a system of registration may be summarized briefly as simplicity, security, completeness and cheapness.

Simplicity is essential if the system of record is to be readily understandable by landowners; otherwise it is unlikely to earn their confidence. The enabling legislation must be drafted in simple terms and if necessary translated into vernacular languages. Wherever possible, simple statutory forms should be employed for land dealings and the style of the register itself should be designed to minimize administrative complexities. In particular there must be a simple and direct connection between the land parcel and the register folio; this means that the referencing system must be based on the principle of one page of the register for one parcel of land; the cadastral plan and register must always reflect the position on the ground.

Security must depend upon a certain standard of honesty amongst both registry staff and the general public; in practice this seldom seems to present a serious problem. The procedure for the adjudication of interests in land must lay down avenues of appeal to special tribunals or to the ordinary courts of law; simple office procedures should be prescribed for the making and checking of entries on the register; the physical safety of the records should be assured by the construction of strong rooms and the microfilming of a 'disaster' copy. Experience does not seem to establish the need either for the issue of a Certificate of Title (or Land Certificate) to the interest holder or for a state insurance fund from which compensation might be paid to anyone suffering loss through mis-registration.

Completeness. Under this head must be mentioned the need for simple procedures whereby any change in either landownership or tenancy will be brought on to the register expeditiously and accurately. In this respect East African experience has emphasized the need to regulate the procedure for the administration of estates of deceased persons and to integrate this procedure closely with the maintenance of land records. Without this, the proprietary section of the registration system is bound to deteriorate and may eventually break down.

Cheapness. The cost factor is a function of the considerations set out above; and also of speed. This is where the real problem lies. It is the high cost of the service that at present provides the main difficulty whether the cost is regarded as a fair charge against Government funds or whether it is passed on, in whole or in part, to the landowner and user.

The total cost can be broken down between the cost of the registration service itself and the cost of the cadastral survey upon which the records are based.

The cost of the registration service presents the lesser problem. The cost to the individual landowner can be minimised by eliminating the need for professional assistance and by decentralising the registry service so as to reduce his overhead expenses through taking the register out to the people. Administrative costs borne by Government may be retrieved by charging reasonable fees and from the marginal increases in revenue that may be expected from more efficient assessment and collection of various forms of duty or tax.

But it is the cost of the cadastral survey that remains the heaviest single item; this is where a further technological 'break through' is urgently needed. For some years past the choice of survey technique has lain between:-

(a) Conventional ground survey methods which are effective but very time-consuming. Nevertheless these methods are relatively cheap in that instrumentation costs are low, and because much of the work can be carried out by locally trained sub-professional staff and unskilled employees. But the time taken to complete a national cadastre in this way must be measured not in years or decades but in centuries.

(b) Photogrammetrical techniques by which linemaps are produced, of sufficient accuracy, showing physical boundary features such as hedges, fences or bunds and possibly other topographical detail. But success is dependent upon the existence of 'air-visible' boundary features and also upon the possession of very expensive plotting machinery and the employment of highly skilled technicians. Provided these conditions can be met, photogrammetrical methods can lead to a very considerable saving in time; but, largely because machine-plotting is so expensive, there is little if any overall saving in cost.

(c) Methods which combine features of (a) and (b) above. These have been designed largely to circumvent the difficulty caused by lack of 'air-visible' boundary features. In general, large-scale topographical sheets are prepared by photogrammetrical methods and the topographical detail is then used to control the cadastral work which is added by elementary ground survey. These 'compromise' methods have their uses, but they offer little or no reduction in cost.

(d) At the present time there is some reason for hoping that both cheaper and more rapid methods of cadastral surveying will be developed from the use of orthophotographs, i.e. rectified aerial photographs fitted together to make an orthophoto map. An

appreciable saving in cost should be assured in this process because there is no need for the expensive plotting of line-maps. Instead, the actual orthophoto map is taken into the field and the property boundaries are identified either by direct interpretation (normally a straight-forward procedure in the case of rice-growing land) or by making additional field measurements to establish the location of boundaries in relation to topographical detail identifiable on the photography.

This method has been used in Germany and is at present on trial in Mauritius, Western Samoa and Thailand and the progress and costing of these experiments will be followed with great interest.

SOME CONTROVERSIAL POLICY ISSUES

Controversial issues in policy-making are bound to be encountered in the establishment or extension of a registration system. Each policy decision must depend upon local circumstances so a developing country should study long-established systems and profit from experience gained and mistakes made elsewhere. Both the Torrens and the English systems of registration of title have much to offer, as also do the cadastres of India and Continental Europe. Advantageous features of all these systems should be abstracted and synthesized together or grafted on to bring an existing system nearer to the ideal.

(i) When and How Should Registration be Introduced?

In general, proprietary considerations argue for registration only in those areas which are privately owned and developed, in which land values are high enough to warrant expenditure on this service and where social conditions and facilities are sufficiently well developed to permit its efficient operation. On the other hand planning considerations demand a complete inventory of resources and so press for 100% coverage at the earliest opportunity. Simultaneous implementation over the whole country is obviously impossible; premature introduction will waste the limited resources available whilst delayed introduction may retard development; so it is vital that registration be introduced in accordance with a planned but adjustable system of priorities.

Land parcels may be brought on to the register sporadically on the initiative of the property owner, or systematically within a specified locality on the initiative of government. Arguments may be advanced in favour of sporadic introduction but it is now generally accepted that systematic introduction, locality by locality, is to be preferred providing the choice of localities is made according to the system of priorities advocated above.

(ii) What is the Unit of Record; and What Appears on the Cadastral Plan?

The unit adopted must depend upon the objectives of the system of record. Registers of title concern themselves primarily with the unit of ownership but such records are not sufficiently detailed if particulars of land values and land use are to be shown. For some purposes of economic planning and for institutional planning the unit of operation would be more suitable, i.e. the farm, whether it be owner-occupied or tenanted. But for other purposes in economic planning, and also for valuation purposes in the assessment of tax liability, both the unit of ownership and the unit of operation may be too large and data would have to be collected and recorded on the basis of the unit of use. In agricultural areas this means the individual fields which vary widely in size and in soil type, etc., and hence in productiveness and value.

Cadastral plans vary a great deal in their design and in the information they supply; the two extremes are conveniently illustrated by the Torrens and English systems of registration of title. The Torrens plan is intended solely for title purposes; separate plans are usually prepared for individual land parcels and under some Torrens jurisdictions these parcel plans are not even plotted together so as to form a continuous index diagram. The information shown on the face of Torrens plans is generally intelligible only to the professional surveyor for it is limited to such technical data as the bearings of straight-line boundaries and the linear distances between turning

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points. On the other hand the titles register in England and Wales is supported by large-scale general plans which, because of the wealth of topographical detail they carry, are useful for a whole range of other purposes. In particular all buildings are shown true to scale and all boundary features are depicted, whether these are property or merely field boundaries.

It seems indisputable that if the register is to be used for general planning purposes, then the English style rather than the Torrens style of cadastral plan is to be preferred.

(iii) What Data Should Appear on the Register? The modern register designed for titles purposes is usually divided into three sections, namely the property section which carries particulars of the land parcel; the proprietorship section which carries particulars of the registered owner and the encumbrances section in which are recorded charges, etc., with which the land is burdened. It will be noted that a diverse range of general liabilities, such as those under national planning legislation, do not appear as encumbrances, but are nevertheless effective as 'overriding interests'.

The land records maintained at village level by the patwaris of India and Pakistan are much more detailed and, through the proliferation of different registers for revenue collection, genealogical tables, water rights, soil types, mutation of property rights and so forth, would seem to have lost the merit of simplicity.

But no insurmountable difficulty should be encountered in designing a register suitable for both proprietary and planning purposes. It would be intermediate in style, formed possibly by adding a further panel to the modern titles register for the recording of data of value to the planner; e.g. soil classification, rate of tax, land capability, areas of specified cash crops, methods of irrigation if any; etc.

(iv) 'Fixed' or 'General' Boundaries? The debate over the relative merits of 'fixed' or 'general' boundaries continues at the present time. The English system depends on the existence of continuous physical boundary features and follows the general boundary rule in that no attempt is normally made to locate the actual legal boundary precisely within the thickness of these boundary features. On the other hand, the Torrens system is not dependent on physical boundary features and may sometimes ignore them where they do exist. Instead, all the turning points of boundaries are beaconed, the positions of the beacons are accurately 'fixed' by the survey process and if lost may be re-established from survey data.

In choosing one system or the other, everything will depend upon the existence or absence of physical boundary features. In an effort to reduce the time and cost of survey by photogrammetry some of the most recent Registration Acts speak of 'general' or 'approximate' boundaries and 'air-visible' hedges are being planted where these did not previously exist.

Many developing countries were obliged to adopt Torrens methods initially as there were no physical boundary features in existence. However, as development proceeds, increasing population pressure, rising land values and other factors are likely to bring about the physical demarcation of boundaries, starting with heavily capitalised properties in urban areas. In such cases it may be practicable to change over to the English system in this respect.

In areas of rice cultivation, irrigation requirements demand the construction of bunds enclosing the rice fields and these bunds form the boundaries of units of use, operation and ownership. Where such bunds are permanent and readily identifiable it would seem that precise surveys of the Torrens type are unnecessary and a general boundaries policy should be adopted.

(v) Should the Register be 'Public' or 'Private'? The English Act preserves the tradition of secrecy established under private conveyancing (without registration) and, in general, permits, only the registered proprietors and persons authorised by them in writing to inspect the register. Those jurisdictions which are based on the Torrens Acts rely upon publicity as a powerful protection against error and fraud, and any person may examine the register upon the payment of a small fee.

In most developing countries privacy of the register could operate as a brake on development. If the statistical information provided by comprehensive land records is to be used for planning purposes and for daily administration, then the authorities must have ready access to it.

THE SOCIAL AND DEMOCRATIC ROOTS OF LAND MEASUREMENT (THE CADASTRE)

by

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THE SOCIAL AND DEMOCRATIC ROOTS OF LAND MEASUREMENT (THE CADASTRE)

> "Like other great landowners, I have tenants. They are negligent about rents but very punctilious about tenures."
>
> - Aldo Leopold
> A Sand County Almanac

> "Community land use planning is a public policy matter second only to international relations. Land use planning is our response to the challenge of protecting the public interest against unrestricted use of land by its owner contrary to the public interest."
>
> - Raymond J. Penn
> Public Interest in
> Private Property (Land)

The Challenge

A cadastre is a land record. We borrowed the term from the French, but it has the same Greek roots as our word catalogue. Cadastre is a new term in American usage. We used to refer to the subject as land survey and registration.

Jacob Beuscher, the famous Wisconsin law-in-action teacher (Thomas 1972), told his students that a cadastre should be viewed as a three legged stool. One leg stands for measurement, one leg for ownership or proprietorship, and one leg for economic valuation--usually for taxation purposes. The modern cadastre has become an improved stool. It now has four legs--one added to represent the public's interest in land use controls and environmental protection. The public exercises its interest through local governmental boards and commissions which private property owners in turn try to influence.

My message is a challenge to the modern makers of cadastres. It is a challenge to build a four legged stool such that one leg is not made so much

longer, or so much shorter that the stool will not stand. Many cadastral stools have been built in this century. Many have fallen over before they could be fully used.

Recent cadastral studies in the United States have focused primarily upon the measurement leg of the stool. This is the result of rapid improvements in aerial photography, remote sensing, automated graphics and spacial computing. It is quite normal to give added attention to the sector showing the most new developments. But we should not forget what measurement is for. It is only one term in a larger vocabulary. Even as a specialized part of the cadastre, measurement represents a large, complex subject that has broader social and philosophical implications than is often assumed.

Measurement is necessary in human affairs in order for people to make sense of the world around them. Just as furniture is constantly recrafted and refitted in order to make it comfortable and familiar in the household, so are measurements constantly socialized and democratized to make them appropriate to our public purposes. We sometimes forget in an age when computers jump from generation to generation faster than human beings can grow up that our measurement tools and standards were organically derived. The only way we can understand them is to relate them to the world around us.

For this purpose, we are fortunate to have a brilliant guide to past thinking and analysis. It is the now famous Report upon Weights and Measures prepared by former President John Quincy Adams when he was Secretary of State in 1821. Adams was asked by the U.S. Senate to prepare a background statement to aid the Congress in its deliberations over whether the United States should adopt the metric system.

John Quincy Adams responded in uprecedented fashion. He undertook a thorough and detailed study of the whole history of weights and measures

reaching back in time to the oldest known documents of human civilization. He criticized the contemporary English interpretation of Article 25 of the Magna Carta which established the first departure from having weights and measures dictated by the Crown.

Adams was well equipped for this study. He had a classical education in Latin and Greek and served as secretary and clerk for the diplomatic corps in Europe, first for his father in Paris and Amsterdam, and then for the American minister to Russia. He read the recent scientific works of the French Academy that formed the basis for a precise and coherent metric system. But Adams was not so much concerned about the scientific precision of the new measurement as he was in the logic and social philosophy that underlies all measurement. He said the purpose of the report was to bring "to view certain principles believed to be essential to the subject, . . . and which it will be advisable to bear in mind" when the subject is brought up for consideration by those who must prepare the legislation (Admas p. 13). The study still stands as probably the most complete social and cultural history of measurement to be published in the United States.

With regard to the metric system, by the way, Adams recommended that the principle of diversity be followed. The United States should adopt those parts of the metric system that it could apply to essentially new undertakings (as it had done with the currency), but it should keep the English measures too where they served established purposes. He concluded that the United States probably could not succeed in introducing the full metric system to the general population until Great Britain adopted it. Now, 160 years later, we find that his conclusion still stands.

Adams set out in his report elaborate arguments to prove that to ordinary people, measurement is a social institution. People, in everyday activities,

cannot function well until they can humanize science. They will not be content until they can take the computer and convert it into an instrument of democracy and equality. It is what Ivan Illich (1973) refers to as "tools for conviviality." This is not an easy task and it is one for which scientists themselves express faint interest. Adams used these arguments to state a set of principles that apply to all measurement and which, with some slight modification of the terminology, we would recognize and use today.

Measures are Organic

Everyday measurement grew out of natural function. The cubit, for example, is one of the oldest measures of length to be documented in recorded history. It is the length from the elbow to the tip of the middle finger, about 18 to 20 inches. Such a measure came "naturally." It was organically derived, we would say, using today's terminology. Every person carries the cubit measure with him. That makes it handy or convivial in Illich's words. The Old Testament says Noah's Ark was 300 cubits long; so we have a good idea that it was a large boat of about 450 to 500 feet.

In like fashion, sailors devised their own organic measures for purpose of recording the depth of water. They used the fathom which is the height of an average man (later standardized to be six feet). Such a measure makes good sense; it is practical and personal and can be communicated easily to others. Anyone can easily understand that four fathoms is the depth of water of four sailors standing on top of each other.

So the first principle in devising measures is to relate them to life or to nature--to make them organic. Frank Lloyd Wright (1954) captured this principle in architecture and built a whole school of innovative design out of its analogies and metaphors. The metric system, of course, is also organic but its association with nature is more remote and thus less familiar.

When teaching land use planning to students, I always suggest that they visualize one acre of land. They will need some standard of space when inspecting possible new building sites. Farmers have a clear concept of land area from plowing and tilling their fields. University students have no reference to such experience. So we need to make the acre into an organic concept for them. It so happens that a football field, taking the area between the goal posts, is almost exactly an acre. Once the student has related the acre to the football field, it becomes clear and useable.

Proportion More Than Unity is a Social Measure

Adams noted that in human affairs, proportion is often more important than is continuous or unitized measure. It makes little difference in a large country whether the population is 100 million or 110 million. But if the population of women to men is 60/40 it makes a great deal of difference to a great many people. Scientists employ this same principle when measuring toxic substances. More critical than absolute quantity is the concentration in parts per million with respect to the overall amount.

In the same way, measures that can be easily reduced to simple proportions are greatly preferred by the citizen over those that must be laboriously calculated. Thus, Adams pointed out (p. 18), the cubit was eventually given up in all of Europe in favor of the inch, the foot, the yard and the fathom--all of which are even units of each other and most of which can be halved and then halved again while retaining their simple proportions.

This principle was applied in the survey of the public lands in the United States. The Ordinance of 1785 called for the division of land on the principle of sections each consisting of one square mile or 640 acres. The sections were conveniently surveyed into four quarter sections of 160 acres each. The quarter sections eventually became the famous "homesteads" as a

result of the act of 1862. The division of land into convenient blocks of such size as to allow repeated divisibility by four "socialized" land settlement and the land market (Jackson [illegible]). It was the most important action to "democratize" the landscape in the first century of this country. It made it possible for uneducated and unsophisticated farm people to settle the land, to plan its division and subsequent disposal without the aid of experts.

If people could be attached to the land, if they could go to the frontier and see the stakes in the ground, they would have reason to stay put, to invest their labor, and through their own spirit of belonging, to gain a personal sense of identity. This was to Thomas Jefferson, the author of the Ordinance of 1785, the means through which society took lost and penniless immigrants and soldiers of the revolution and converted them into citizens. The plan is attested to over and over again in the frontier literature of this country--the wrenching but eloquent accounts from Giants in the Earth (Rolvaag 1927) and Grapes of Wrath (Steinbeck 1939). The land held on to the people even when they could not hold on to it.

It is from these relationships that John Quincy Adams suggested a sociology of measurement. It is only through our transformation of the physical world into our own symbols that we can come to know it and to care for it. Man through the ages has made his tools familiar and friendly. We are forced to conclude that the computer can have no popular appeal until we can find ways to humanize it.

The Relational Principle in Measurement

There is no single standard of measure for all purposes and for all people at all points in time. While scientists lament this fact, Adams calmly pointed out that people take it in stride. In our everyday lives we have no

trouble understanding that the way one person measures and values things is different from that of another. The way we accommodate these differences and carry on happy and productive lives is through the development of continuous comparisons--the continuous restating of the relationships that my measures of value bear to your measures of value. So relation is a natural principle in measurement. We refer to these measures daily in speaking of interpersonal relations and foreign relations.

Knowing that this principle of measurement must be accommodated in our cadastre, we need to make provision for it just as we make provision for maps and registries. "Community land use planning is . . . second only to international relations," according to Raymond Penn (1961).

While it is true that the meter, adopted in Paris in 1799, is based upon a one/ten millionth fraction of the distance from the equator to the pole, it was chosen deliberately with the relational principle in mind. The scientists in Paris charged with fixing the true length of the meter sought deliberately for a fraction of the earth that would produce a meter that was close to one yard in length. That is why they settled upon the distance between the equator and the pole rather than, let us say, the circumference of the earth or the distance from pole to pole.

Even so, the poets are smiling. Nature has the last word. The earth, it turns out, is old and out of shape--fat in the middle, flat on the top and covered with bulges all around. The distance from the equator to the pole is different at every point. So the meter had to be an arbitrary stick of platinum kept at the archives in Paris for anyone who wanted to check it. There can be no final satisfaction from remeasuring the earth.

The Principle of Diversity

A widely recognized feature of nature is its diversity. With the rise of studies in ecology and environmental science many have observed that there is

strength and durability in diversity. In natural systems, diversity helps assure survivability. In social systems, diversity is valued for its enrichment of living and for its contribution to creativity. So a set of measures that are truly organic will be based on many different references, not a single standard.

Adams, therefore, recommended against discarding many of the socially derived measures that had grown out of common useage through hundreds of years of human history. He saw that there were tremendous advantages to a decimal system of measurement for all work that involved large quantities and extensive computations, as in accounting, for example. But he also noted that carpenters continued to cut lumber in units of 4, 8, 12 and 16 simply because those units allow them to match up halves and quarters without repeated calculation. Likewise, scientists invented new units of measure as they learned more about the true diversity of nature. Furthermore, the convenience and use of various measures was observed to change over time. Adams concluded in his report that America would do well to draw upon some of the best of the diversity that was available from both the English and the French systems.

Given the characteristics of nature and society, diversity in measurement is absolutely necessary. Change is a part of the process.

Relativity in Measurement

The way that both change and diversity are accommodated is through the principle of relativity. In a conceptual sense, Adams had already outlined the principle of relativity that Einstein applied later at a more theoretical level. Adams speculated that the idea of relativity comes out of the experience of bargains in the marketplace.

> "It results from the experience that the comparison of the articles of exchange, which serve for the subsistence or the enjoyment of life, by their relative extension, is not sufficient as a criterion of their value. The first use

> of the balance, and of weights, implies two substances, each of which is the test and the standard of the other" (p. 10).

Out of experience with substances of consumption and immediate value, society derives relative values for copper, silver and gold to be used as weights in the balance. One substance is transformed into another substance of value through the evolution of relational terms for representing both standards and changes. In this way the separate principles of change, diversity and relationship are integrated.

In like fashion, Einstein suggested that in measuring a thing it was arbitrary as to which was the standard and which was the product. Thus, if we take a continuous measure and convert a substance into it, we will have both a new measure and a new substance.

When Einstein's contemporaries failed to understand conceptually what he was saying, they objected to his method. Walter Kaufmann, a professor of physics, declared that Einstein's theories were incompatable with experimental findings that Kaufmann had just produced. Einstein, with a totally different view of the problem at hand, calmly replied: So much the worse for your ephemeral findings, and for the limited theoretical vision that informs them (Joravsky 1983).

Adams had already concluded nearly 100 years earlier that "Weights and measures are, in their nature, relative" (p. 12).

Advice to Reformers

Both technicians and lawmakers fail to understand the interrelational characteristics and diversity in nature, in society, and in measurement, and thus often attempt to devise new rules and regulations that only serve to complicate practice. They often increase the confusion that they are trying to remove. This can be the result of introducing technology without concern

for how it is to be socialized and humanized, or even for whether it is capable of proportional, continuous, relative and relational measure.

Diversity has been corrupted in many applied fields to mean the introduction of any additional new thing. In fact, the effect of most modern science is to foster standardization, uniformity and conformity rather than true diversity. The technology that science produces, has for the most part, never followed the Einsteinian formulation (or the John Quincy Adams formulation either). Karl Pearson, a contemporary of Einsteinian, would be more likely to speak for the mainstream today. Pearson is the father of modern statistics (the Pearsonian 'r'). In his Grammar of Science (1892), he dreamed of the day when man would eventually achieve perfect knowledge. He envisioned large computing machines.

His ideas are elegant, but they are static. Both nature and society operate by diverse rules and functions. There is no single unifying code. But that being so does not prevent us from drawing analogies from the diversity that we see around us and actually transforming nature (and ourselves) in the process. So in land measurement as in other kinds of measurement, the ability to make a new social, economic or political relationship out of the measurement system is the challenge. It is not to force the shackles of modern technology or modern economics onto the public and private interests in land so that everybody's right becomes the same.

If this is confusing to you, Adams said it was no less confusing to those who had to write new legislation regarding weights and measures. Adams (pp. 11-12) provides an insightful perspective:

> "When weights and measures present themselves to the contemplation of the legislator, and call for the interposition of law, the first and most prominent idea which occurs to him is that of uniformity: his first object is to embody them into a system, and his first wish, to reduce them to one universal common standard.

> His purposes are uniformity, permanency, universality; one standard to be the same for all persons and all purposes, and to continue the same forever. These purposes, however, require powers which no legislator has hitherto been found to possess. . . . The power of the legislator is limited over time. He is liable to change his own purposes. He is not infallible: he is liable to mistake the means of effecting his own objects. He is not immortal: his successor accedes to his power, with different views, different opinions, and perhaps different principles. The legislator has no power over the properties of matter. He cannot give a new constitution to nature. He cannot repeal her law of universal mutability. He cannot square the circle. He cannot reduce extension and gravity to one common measure. . . .
>
> In the origin of the different measures and weights, at different stages of man's individual and social existence; in the different modes by which nature has bounded the extension of matter; in the incommensurable properties of the straight and the curve line; in the different properties of matter, number, extension, and gravity, of which measures and weights are the tests, nature has planted sources of diversity, which the legislator would in vain overlook, which he would in vain attempt to control. To these sources of diversity in the nature of things, must be added all those arising from the nature and history of man. In the first use of weights and measures, neither universality nor permanency are essential to the uniformity of the standards."

A couple of brief, historical examples help to illustrate the complex, interwoven nature of cadastres and human history.

In the decades preceding the American Revolution, the William Penn family, proprietors of Pennsylvania, and the Calvert family, the Lords of Maryland, were engaged in constant litigation over the boundary between their two colonies. The two parties submitted their dispute to the English courts, and after years of bargaining, concluded that the best thing to do was to survey the south boundary of Pennsylvania (the north boundary of Maryland). Under the direction of Thomas Penn, son of William Penn, two English surveyors, Charles Mason and Jeremiah Dixon, were commissioned (Cummings 1962). Mason was 35, Dixon was 30. They had both worked for the Royal

Society and had participated in scientific projects to map the configuration of the stars and to measure the curviture of the planets.

To make a long story short, Mason and Dixon produced a straight line west of the Delaware River, starting at a point exactly 15 miles south of the city of Philadelphia after making an arc around Wilmington, Delaware. It took between 1764 and 1767 to complete and mark the line running 234 miles straight west. Attractive, engraved stone monuments were imported from England and placed every five miles along the line with mile stones put in between. Mason's journal is filled with careful accounts of how he and Dixon sometimes worked for days to set up their instruments and to find clear night weather to take readings from the stars to assure the accuracy of the line. They did an excellent job. Modern survey methods have found that they were only a few feet off after traveling over rough terrain for more than 200 miles.

The Mason-Dixon Line, as you all know, is more than a boundary between two states. It has become the symbolic division between two cultures, two economic systems, two systems of labor, one slave and one free. For the next 100 years the line provided a clear division between north and south.

And because Jeremiah Dixon, a gentle Quaker, enjoyed the people south of the line more than those to the north, we have given his name to their culture--we still call it Dixie.

There are still other dimensions to land measurement. In 1795 the French Revolution spread throughout Western Europe. France occupied the Netherlands with a good deal of support from the Dutch Unionists who dominated the government. It was not long (1801) before Napoleon needed to raise revenues to pay for popular reforms and expand his army. The new metric system had been adopted in France in 1799 and was ordered to be used in all of the French territories.

Land acreages were measured and the first property registries were begun. But land measurement, then as now, was not motivated by a simple desire to improve the data. Property was identified in order to begin the collection of land taxes.

Small land holders were so reluctant to cooperate in the new land registry and property tax that they often gave ridiculous last names as a mockery to the authorities. Thus the rector of the Agricultural University of the Netherlands when I studied there in 1963 was named bird eyes (Ijsvogel). And the associate director of the Experiment Station at this university at that time was named mosquito brain (Muckenhirn). These were the kinds of names typically given to fool the authorities. But once entered into the property record, they became permanent family names. The people and the property were fused.

The purpose of this paper has been to show that land measurement has a way of making permanent, indelible marks upon both the face of the earth and the face of humankind. It is not a subject that can be treated solely as a study of measurement systems. Measurement is as much social and philosophical as it is numerical and unitary. And the motives for people to measure their land are different from those of their governments. The people want clarity, simplicity and harmony. The government wants revenue and control.

Those who look back upon both the French innovations in measurement and the American experiences with the Northwest Ordinance, generally agree that no major cadastral reform can succeed without a corresponding structural reform that will increase the voices of the persons whose land is measured. The challenge is to humanize the measurement system and to translate it into forms that will have meaning in theory as well as everyday life. In a real sense, every property line is in someone's life a Maxon-Dixon Line.

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CHANGING INTENSITY IN THE USE OF TROPICAL SOILS AND POSSIBLE MODIFICATION IN THE MOISTURE BALANCE OF THE FOREST-SAVANNAH LITORAL: A WEST AFRICAN CASE STUDY

by James C. Riddell*

Although a paper on tropical forest agriculturalists might seem out of place at a conference on desertification, there are two areas of potential relevance. First, and most obvious, is that as we monitor the growth of arid zones we need to monitor environmental changes in bordering areas of high rainfall. The alteration of dense vegetation zones is bound to affect the amount of light and heat reflected into the atmosphere and thereby possibly alter moisture patterns and retention (v. Thiesenhusen 1976:13), and any major changes in so large an environmental unit as the tropical forest figures in any equation of aridity and desertification of the African Sahel and Savannah.

The second area where this paper may contribute to this conference is that it is an attempt to relate the kinds of data anthropologists gather on spontaneous strategies of small-scale farmers with remote sensing data; that is, to relate what people are doing to their physical surroundings to why they are doing it.

The attempt to relate the anthropological perspective to altered natural environments is not so esoteric an exercise as it might appear at first. Anthropologists argue that culture, "... that complex whole" we learn as a member of society, is the adaptive mechanism of our species to its environment. In this view we can observe that our species-specific solutions have always had a more or less eventful impact on the natural environment, whether it be the contribution to the extinction of certain mega-fauna during the Paleolithic period, or the deforestation and desertification of today (v. Bennett 1976:4 et passim). There has been an intensification, however, of

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of the spread of a dominant cultural system (industrialization and its concomitant parts) into the earth's non-temperate and marginal environments since World War II.

This spread has produced in its wake a drastic alteration of the man/land relationship. Populations have almost universally exceeded the carrying capacity of the existing "traditional" land use and technology systems. Also, in order to meet these new needs or in response to new opportunities, large areas of land have been alienated or expropriated for the development of large-scale farming, plantations, industrial sites, and urban areas from people practicing low level but environmentally stable economics.

In response to each of these changes, the small-scale producers must alter their agricultural practices on a short-run basis in response to factors that are beyond their control and, quite possibly from their point of view, capricious and arbitrary. It is precetsely these small-scale human adaptive strategies vis-a-vis a changing pattern of world land tenure that must be monitored if we are going to be able to separate disastrous short-term practices from long-term variability in the environment. Fortunately, there may be a means at hand in the existing collection of old aerial photography. If there were some way to make this data more easily comparable and accessible by similar techniques to those currently used for Land Sat and other satellite data, we would be able to accomplish two things: on the one hand, provide a base from which to measure the changes taking place during economic development; and, on the other hand, provide a time dimension to existing anthropological data in assessing the outcome of specific policies and spontaneous social changes.

The present study is an attempt to do just this for a very small group of West African farmers in the Republic of Liberia who have drastically altered their local agricultural economy since the completion of a motor road into their area in 1948. Moreover, it is an effort to assess the environmental impact on their forest habitat during the first two decades of the Gbannah Mah farmers' incorporation into the world economy through a comparison of social data with two sets of aerial photos. The first set was taken on February 22, 1953 and the second on December 21, 1967.* Before presenting the conclusions reached from

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*In the tropical biome, the aerial photography very clearly demarcates the cropped area from forest. The amount of light reflected into the lense of the camera differes for area in crop, new fallow, old fallow and climax

comparisons of computer-enhanced photos from these two years, a brief description of the nature of the social change taking place will be necessary if an understanding of the causes behind the observed modification are to make any sense.

The Situation

The motor road brought with it momentous changes to the way of life of the Gbannah Mah. A world that had previously been seen only by wage labor migrants was now brought to their very doorsteps. In fact, the road was put through the middle of three of the towns. Administrative decisions from the nation's capital of Monrovia were now less than a day away rather than the week or more that had been the case previously. The trucks that brought in the new goods and people were also available to carry out the local farm products. The growing of cash crops now became a viable alternative to labor migration as a way of obtaining access to the money economy.

From the Gbannah point of view, the most disastrous result of the new motor road was the granting by the Liberian Government in 1948 of an economic development concession of 25,000 acres to the Pan Am Corporation for the establishment of a cocoa plantation (it has since converted to rubber production).** The area was largely unknown at this time by both the government officials and the concessionaires and the granted acreage included varying proportions of the prime farmland of three of the towns.

The inclusion of Gbannah in the national society of Liberia, and thereby into the world economy, meant that there would be inevitable changes in the utilization of land, labor and capital. Land, the basic resource of the Gbannah people, was affected in two ways. First, the land allocated to the plantation, the road and the emerging road towns, had come directly out of the agricultural resource base since none of these enterprises utilized

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*(cont'd from page 2) forest, as well as water and clouds. In Gbannah new farms are cut each spring (by May) and the crops are harvested from October to December. Therefore, the photo coverage used for this study will document the land used for the 1952 and the 1967 farming seasons.

** The plantation has never actually used more than a small percentage of its concession area.

marginal land. The second was the coming of a cash crop economy. This also increased the pressure on the land as coffee, cocoa, rubber and sugar cane competed with the existing food staple crops for prime soil resources.

The traditional land holding unit in Gbannah is the gbein (sib), a patrilineal kinship unit based on stipulated descent. A farmer has usufructory rights to all the land he needs and usually makes a new upland rice farm (intercropped with maize, cassava and sometimes sorghum) for each wife every year. The rental of land is unknown in traditional terms, but one could "borrow" a farm site on a season by season basis from affinal kin, usually one's mother's brother (v. Fortes 1945; 1949).

Farmers desiring more land for cash cropping than is available in their own sib's area began making regular appeals for land in the early 1950's. While this situation was readily accepted then, by the 1968 farming season it was causing considerable debate (Riddell 1969). This is probably as clear an indication as any of the growing anxiety over land.

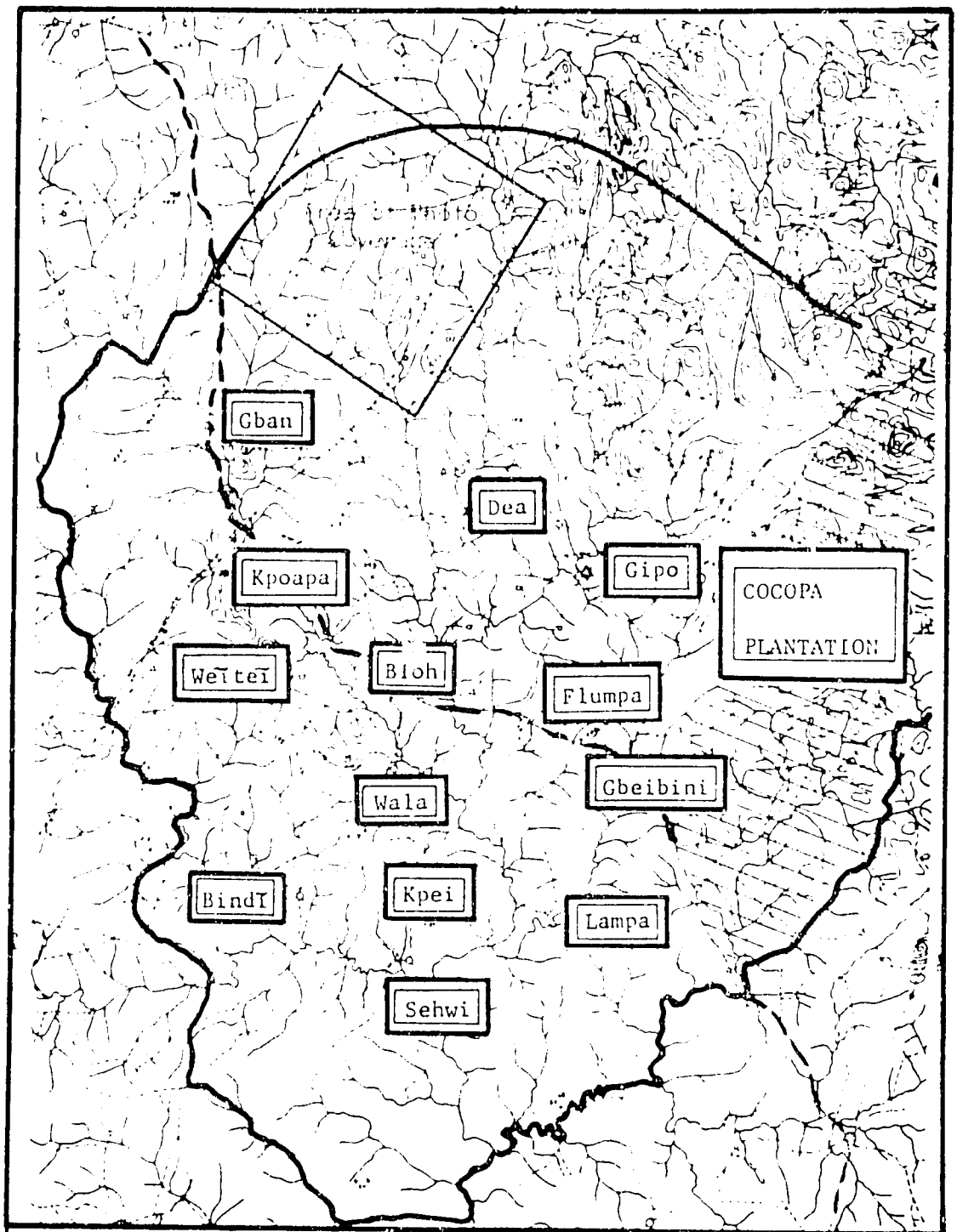
A population growth rate of between two and three percent, and the addition of an active cash crop sector has resulted in a more intensive use of fixed land resources. Gbannah is located in gradually rising uplands

TABLE 1

Percentage of Domestic Groups Cash-cropping in Four Sample Gbannah Towns, 1968

TOWN	DOMESTIC GROUPS	DOMESTIC GROUPS CASH-CROPPING	PERCENTAGE
Gipo	49	43	88
Dea	23	16	69
Gbeibini	57	49	85
Sehwi	44	36	84

that eventuall reach the Nimba mountains (6069 feet) 45 miles to the north. Increased agricultural activity would have two kinds of marginal soil resources upon which to expand: hillsides and the swamps found in the low-lying areas.



MAP TOPOGRAPHIC AND DRAINAGE FEATURES OF GBANNAH

Rice cultivation in the swamps is a traditional activity, but is confined exclusively to women. There have been efforts by FAO, USAID and others in Liberia to involve males in this activity and thereby ease the transition from upland rice to paddy. One of the things I was interested in was seeing how much utilization was made of the swamps in 1967 as compared to 1953.

The hillside soils are a more problematical area from an ecological point of view. In 1968 the farmers of Gbannah felt that the most fertile soil lay under high forest on steep hillsides. There may be some basis in fact to this belief as these areas would be subject to less soil nutrient loss caused by perculation and leaching due to the angle they present to the sun and rainfall. Once the forest cover is removed, however, the problems multiply (v. Eckholm 1976:27). Again, we need to monitor the degree to which this ecological zone is being altered in the first two decades of adjustment.

The growing pressure on the land is but one facet of a process general to Gbannah. Another facet is the changing labor needs. Although labor migration goes back to the period just prior to the founding of the Firestone Rubber Plantation at Harbel near the coast in 1925-6, it did not involve any appreciable proportion of the male labor force. The ease of communication made possible by the motor road also made wage employment both relatively easy and attractive. By 1968, 40% of the adult males were gone at some time during the farming season.

Two distinctions characterize the Gbannah labor migration pattern. First, the women that stayed home have formed reciprocal labor groups to clear farmland and have assumed other managerial and work roles said to formerly have been the sole province of males.* The second distinctive feature is the rate of labor migration in relation to the farming cycle. It is commonly anticipated in Liberia that labor availability at the plantations will decrease during the period when traditional farms are being prepared, March through April. While this is generally the case, it is not

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* In other parts of West Africa (v.Swindell 1978) this need for labor has been met by employment of outsiders as laborers or by allowing strangers to farm in exchange for labor. In Gbannah these ideas have not taken hold, probably due to the perceived shortage of land.

true for migrants from Gbannah as the bar graph below indicates. These migrants return home during the traditional slack period, August and September. Subsequent interviews reveal that their return on labor expended in growing cash crops is greater once a certain level is reached than is possible through wage labor.

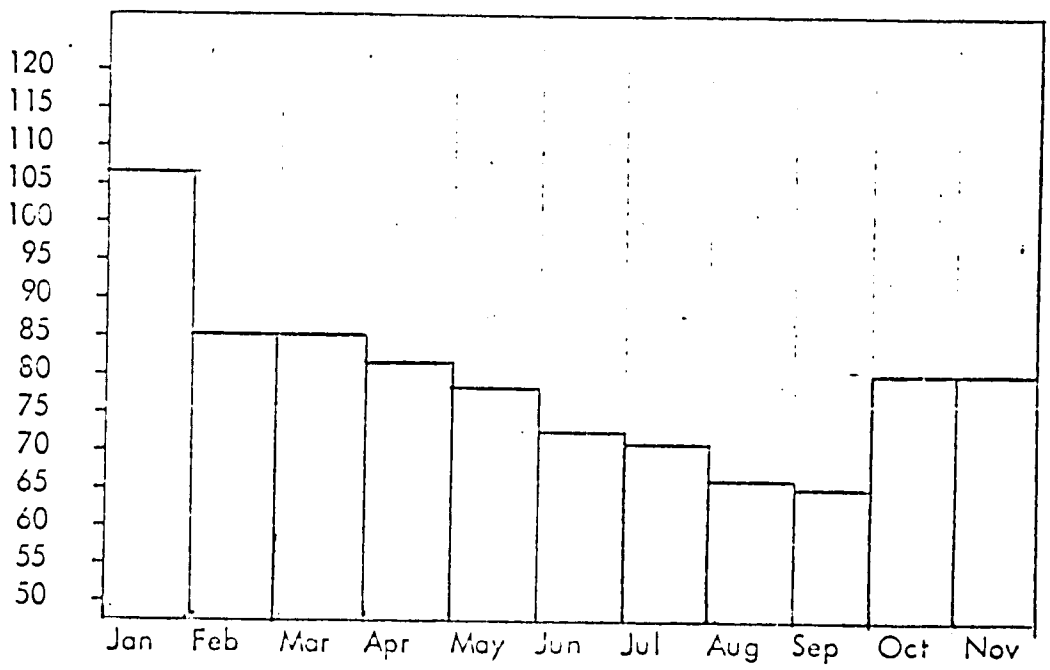
TABLE 2

Reciprocal Labor Cooperatives by Sex
For the Gbannah Town of Gipo, 1968

	NUMBER OF COOPERATIVES	AVERAGE MEMBERSHIP	AVERAGE NUMBER OF TURNS PER MEMBER PER YEAR
MEN:	11	12.5	2.7
WOMEN:	14	19.3	2.0

FIGURE 1

NUMBER OF LABORERS EMPLOYED FROM THE 13 VILLAGES OF GBANNAH



Source: Cocopa Plantation Labor Files, 1967

This fact brings up the third facet of on-going development in Gbannah, new needs for capital accumulation and investment. Cash cropping is different from traditional cropping in several ways. Principally, it requires an initial investment in processing equipment. The main cash crop in 1968 was sugar cane. The cane was processed into a local rum. Such processing required a mill and distilling equipment not available in the local economy.

Initial capital was being derived from two principle sources: labor earnings and savings societies. The latter were often organized by women, a role in development that could be easily overlooked (Riddell 1978). In general, the larger the economic unit the more resources of labor, land and capital it had at its disposal. In the initial two decades of adjustment to the new economic situation, the kinship and traditional system of organizing the members of the society were actually strengthened in those families most active in the national economy.

The Changing Habitat

The scope of the changes made have been directly translated into new uses made of the environment. An analysis of aerial photographs seemed the best way of determining both the extent and effect on the environment of these strategies.

After a search of 5 years, I finally located what I understand are the last extant copies of a 1953 aerial survey of this part of Liberia undertaken by Aereo Survey of Philadelphia. The negatives had long since disappeared. This was the earliest aerial photography of the region for which I could find any record. Luckily, in 1967 the USAF made an aerial reconnaissance of north-central Liberia. Photos from this project were made available for comparison to those of 1953.

A sixteen square mile block of land was selected as a test area.* This area was chosen because of several considerations that will probably play a role in any use of old aerial phtography for similar analysis. A difficulty common to tropical forest coverage is cloud cover. In ecozones with an annual rainfall of more than 80 inches per year the likelihood of clouds is

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* The test area is outlined on the topographic map above.

great. The photos were scanned to determine the territory free from cloud cover in both years. These regions were plotted on a map and one was selected.

The area chosen is a rising upland region with interspersed swamps in the lowlands. It is the regular farming zone of the Gbei sib (kinship unit). The photo coverage indicated that it was relatively unaffected in 1953, but by 1967 it had been transversed by the railroad that runs from the LAMCO iron mines in the north to the port of Buchanan. Also, the main cash crop is sugar cane--a crop that shows up much clearer in aerial photos than such crops as cocoa or coffee. Lastly, it is an area that I am personally familiar with and on which I had made ground observations, participated in the farming cycle, etc., during the 1967 and 1968 farming seasons.

Initial efforts at stereoscopic interpretation proved unsuccessful. At this point, Professor Frank Scarpace and Mr. Bruce Quirck made the facilities at the University of Wisconsin Remote Sensing Laboratory available. Our aim was to digitalize the photocoverage with a resolution level of two meters on the ground (i.e., area covered by each pixtel value datum) in order to pick up the irregular patterns of traditional agricultural holdings. The photo lab produced a large set of negatives at various levels of contrast from the faded prints. The most promising were digitalized and those producing the most information were then selected.

Once the negatives were digitalized, density slices were initially taken at arbitrary values. From examining the resulting print-outs and altering the values we have been able to reproduce the original photo coverage in such a way that it clearly demarcates the different regions we are interested in: drainage and ridge pattern, forest, fallow and current farms.

Although the process may sound tedious for analyzing such a small section of land, it should have very important side benefits: namely, that any photo in the series will also be analyzable under the same system with a minimal amount of modification. Second, once this has been done, comparison with satellite and more recent high altitude coverage is relatively easy.

Preliminary Results and Analysis in Progress

The results are not surprising. As the table below indicates, there has been an increase in the intensity of land use. This increase has come at the expense of high or climax forest. From the farmer's point of view, the fallowing cycle is probably not drastically affected by the first two decades of change. Perhaps the most interesting result so far is that the selection has been for the hillside locations rather than for more utilization of lowlying swampy areas. If the swamps were being more extensively utilized, the potential for an easy transition to paddy would be manifest. Rather, we see that the emphasis has been on dryland cash crops, which, as the social data indicates, offer the most return on labor expended in the new cash economy.

The next phase will be to take the same photo series and compare this data with that from an area where the people chose not to enter as extensively into market-oriented farming.

TABLE 3

Land Use by Percentage for 1953 and 1967

CATEGORY	Feb. 22, 1953	Dec. 21, 1967
1. Climax Forest ridges and valleys	7%	0.4%
2. Mature Fallow	19%	14%
3. Recent Fallow	61%	46%
4. Last Season's Farms	10%	37%
5. Farms in Prep. or not yet harvested	2%	0.9%
6. Clouds/photo border	1%	1.5%

Satellite imagery for the relatively small areas I am currently interested in has not proved overly useful. The current resolution levels available are about 80 meters on the ground and given the irregular shape of traditional fields, more information is lost than is gained. The degree of deforestation could, however, be determined.

Conclusions

The vast amount of work done on remote sensing has made available techniques which are today relatively simple for using older data that often exists in a neglected state that could increase the time base from which to monitor change (v. Hamlin and Goodenough 1978). This will allow a more accurate assessment of where we are presently in both long-term and short-term processes, ecological and social in origin.

The data indicate that the tropical forest biome is being severely affected. The ground cover is absorbing less light and heat and we are witnessing changes in one of the world's major ecozones. This will alter the rainfall pattern not only in the arid regions to the north, but also in the forest itself. For instance, Firestone has observed that the annual rainfall at its rubber plantation in Ghana has fallen perhaps as much as 30 inches since the surrounding forest cover has been removed by local farmers (Weibe, personal communication). Resurrecting and re-analyzing the older aerial photo coverage and comparing their data with the more recent remote sensor imagery will add a time dimension to anthropological and other social studies, and help make it possible to relate our knowledge of the changing landscape to specific kinds of choices made by specific human beings to definable economic social and environmental changes. It would seem to this author that this would be a necessary first step to the formation of any effective policy, either inter- or intra-national, for dealing with environmental deterioration.

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SESSION II

Conference of Commonwealth Survey Officers 1967 Paper No.

THE ROLE OF MAPS AND BOUNDARIES IN LAND REGISTRATION

BY

S.R. SIMPSON

1. Registration of title is a system by which title to land is proved not by deeds but by record in an official register which is declared by law to be unimpeachable evidence of title and is guaranteed by the State. Transactions are effected by making entries in this register, and only by this means. Dealing in land becomes, in theory at least, as quick, cheap and certain as dealing in goods.

Part I: Comparison of English and Torrens Systems

2. According to the preamble of the Land Registry Act registration of title was introduced into England in 1862 "to give Certainty to the Title to Real Estates and to facilitate the proof thereof, and also to render the dealing with land more simple and economical". It had been introduced into South Australia four years earlier by Robert Torrens and the preamble to his Act reads: "Whereas the inhabitants of the Province of South Australia are subject to losses, heavy costs, and much perplexity, by reason that the laws relating to the transfer and encumbrance of freehold and other interests in land are complex, cumbrous, and unsuited to the requirements of the said inhabitants, it is therefore expedient to amend the said laws". From South Australia the "Torrens system" spread to the other States of Australia, to New Zealand, to Canada and to various other countries which use English land law and English methods of conveyancing including the United States of America, though it has not been very successful there, mainly because Title Insurance Companies already give the benefit of insured title and, though this is not the same as a guaranteed title, there is no obvious need to substitute a 'nationalized' system for what they appear to do successfully by private enterprise. Nevertheless the word "torrens" has passed into the American version of the English language. Present dictionaries are sure to recognise it both as an adjective and as a verb and in States which use the term, the process of original registration is frequently called 'torrensing the title.*

3. In the preface to the treatise which he wrote in 1859, Torrens said: "The Law Reformer will detect in the measure of which I claim the authorship a similarity amounting almost to identity with that recommended in the report presented to the House of Commons by the Commissioners on Registration of Title on the 4th May, 1857."** That report has been called "the classic on which the English system of registration is founded"*** and from this it might be deduced that the two systems are practically the same So they are in general principles. They differ, however, in several ways in working practice and, in particular, they differ radically in the way in which maps and plans are used to identify the parcels shown on the register. This has particular importance, because the two systems meet in Africa, and much effort and money have been wasted owing to the failure to understand the difference and to appreciate some of the basic considerations involved.

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* Minnesota Statutes Annotated (West Publishing Co. St. Paul, Minn. U.S.A.) Vol. 29, p.435.

** The South Australian System of Conveyancing by Registration of Title by Robert R. Torrens, Adelaide, 1859.

*** Principles of Land Registration by Stewart Wallace (Stevens and Sons 1937) p.37.

4. In this paper I therefore propose first to describe briefly the English system so far as maps and boundaries are concerned, and to compare or to contrast it with the Torrens system. Then, after a digression on Prescription and Limitation, I shall make some observations on the Kenya system as it has developed to date, for Kenya offers a very remarkable example of the use of registration of title for the purpose of converting customary tenure to full individual ownership.

5. The use of registration of title for the conversion of customary tenure is comparatively new and is so important to developing countries that it has acquired a special urgency. Sophisticated and developed countries like England and Australia can afford the luxury and delay of arguing the merits of title registration as a means of improving their system of creating and transferring interests in land because they already have a sound enough process in "general law" conveyancing as they call the old system of private investigation of title in Australia where it still flourishes as it does in England. It is conducted by skilled lawyers in accordance with long established practice regulated either by case-law or statute. It may be inconvenient, slow and expensive but, generally speaking, it is fully effective to transfer land and ensure title with complete security of tenure; otherwise it could not have continued to survive so long in competition with registration of title which most people nowadays will agree is a much better system.

6. The position is vastly different, however, when it comes to developing countries where customary tenure is one of the principal obstacles in the way of economic progress. In these countries registration of title can be used for the purpose of substituting the provisions of a simple statutory law for the vagaries and uncertainties of customary law and so not only confer the long-term security of tenure which any form of permanent improvement demands, but also enable land to be easily and safely transferred - a mobility which the economists assure us (and indeed history proves) is essential to the proper development of land. In any case process of dealing begin to develop when land acquires an economic value as it rapidly does as soon as it ceases to be as freely available as air or water though it still remains just as indispensable to human existence. Unless some form of registration is introduced when dealing starts there will inevitably grow up methods of private conveyancing which will almost certainly be inefficient and will bring in their train all the misfortunes which flow from clouded titles. Moreover in the early stages of private ownership dealing should be subject to control if account is to be taken of what happened in India and Burma when individual title was substituted for customary tenure and where it was rapidly proved that there is no surer way of depriving a peasant of his land than to give him a good title and make it as readily transferable as a banknote. Effective control is only possible through a system of registration and this is a further reason for introducing it as quickly as possible.

7. It is evident, therefore, that though countries like England and Australia can think of registration of title merely as an improvement, albeit a very desirable one, developing countries may well regard it as a necessity, for to them it is almost a sine qua non of proper agricultural development. It follows that, unless a practicable system can be devised at a reasonable cost, the people of a developing country may be denied an administrative expedient which is imperative to the proper use of their land. Such a system will entail the mass transformation of peasant small holdings from customary tenure to some form of recorded title and it is an operation of altogether different magnitude involving quite different considerations from the leisurely English or Australian process of 'first registration' effected only when there is a transaction actually in progress, and when the cost, though considerable and far in excess of anything that can be afforded per parcel in customary land, may seem a relatively small sum compared with the amount of money

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actually changing hands. However, in this paper, I am not concerned with registration of title as a whole; nor must I embark on the question of systematic and sporadic adjudication, vitally important though this is; I must confine myself to maps and boundaries. There is no aspect of registration of title which has caused more controversy and misunderstanding.

8. I should begin by making clear the distinction between cadastral and topographical maps by defining what they mean though, of course, this is already well known to most of those who will read this paper at this Conference. I make no apology, however, for inflicting even such elementary definitions on them; it is necessary if only to show that I know and appreciate their meaning or alternatively that my version is different from that accepted or adopted by others. Only by precision of definition can we be sure that we are talking about the same thing - or know just where we differ if we are not, and wherever I am able I propose to follow the same procedure in regard to various other expressions such as "general boundaries", "fixed boundaries", "allocation maps","demarcation maps" and so on, because these expressions seem to be used in widely different senses, even by persons of the same profession and similar experience. I have omitte "guaranteed boundary" because I have never yet succeeded in discovering what it really means.

9. A "cadastral map", strictly speaking, is a map made to illustrate a "cadastre" which is a French word meaning "a public register of units of land with details of area, ownership and value compiled for the purpose of assessing and collecting land tax". A "cadastre" is merely an inventory of landed property made for fiscal purposes and it is not necessarily supported by any maps at all. The term "cadastral survey", however, has now come to be widely used with reference to registration of title, and a cadastral map in this connection has not necessarily anything to do with taxation. It is simply a map which shows how a locality is divided into units of ownership, the particulars of which are recorded in a register. It should be specially noted that physical features will not necessarily be shown on this sort of map unless they happen to be the boundaries of a holding and, of course, the boundary shown on the map will not necessarily be indicated by any physical feature on the ground. It is a map which a layman may find very difficult to use and as a rule only a trained surveyor equipped with the necessary instruments will be able to translate the map to the ground and vice versa. I venture to suggest that a licensed surveyor has a strong vested interest in such maps. They are as much a part of his stock-in-trade as are title deeds that of the lawyer - even though we are unlikely to describe them as "difficult to read, impossible to understand, disgusting to touch".*

10. A "topographical map", of course, is a map which, by means of lines and symbols, depicts what actually exists on the ground. Walls and fences appear on it whether they happen to be property boundaries or not and property boundaries will not be shown unless they happen to be demarcated by visible physical features. It is the inter-relation of maps, boundaries and physical features which is the crux of the question and which will be examined in this paper.

11. It is obvious that it is impossible to make a register and to guarantee title in respect of a piece of land unless it is possible to identify it with certainty or, in other words, to say what its boundary is. This is a question of fact, and how this fact is to be indicated on the ground as a practical proposition, and what evidence is to be required to prove it as a fact, will depend on the substantive law applicable and on the circumstances in which the land is held or used. It should be noted that the need for the delimitation of boundaries rose long before there was any question of registration of title or for that matter of survey and maps - or indeed conveyancing. There must have been a recognisable boundary to the Garden of Eden or

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* Remark by Lord Westbury quoted in Land Registration by Dowson and Sheppard (H.M.S.O. 1955) p.45.

Adam and Eve could not have been evicted! Moreover, the definition of the parcel is just as important in unregistered conveyancing as it is where the title is registered and, indeed, in Tasmania (and doubtless in other Australian States too) the survey required to support an entry in the Deeds Register is just as meticulous as that demanded for a Torrens title. Registration of title makes no difference in this regard. Title is not registered in South Africa where precision of survey takes second place to none.

12. The first point I want to make is that we must distinguish between two quite different situations when it comes to the description of a parcel and the definition of its boundary. Indeed the very word "boundary" like the word "title" has two different meanings. A person may have a good "title", in the abstract sense of having the right of ownership, without having a "title" in the concrete sense of a document to evidence that right. Similarly the word "boundary" may be used to denote an imaginary line which is the ascertainable physical limit of something owned by a person or it may denote a physical feature by which the limit is marked e.g. a fence or wall or road or ditch.* The vital question is whether the parcel is delimited on the ground by visible physical features indicating the position of the boundary, or whether there are no physical features on the ground and the boundary can only be ascertained by reference to a map or measurement from some recognisable physical feature. The Torrens system appears to ignore the former situation and the English system, it may be argued, does not take sufficient account of the latter.

13. The distinction between the Torrens and the English mapping systems sprang, in the first instance, from the different manner in which the respective registers were compiled, beginning in the middle of the last century. In the Torrens system the register consists of Crown Grants and subdivisions of Crown Grants. When the first settlers arrived in Australia there were huge tracts of undeveloped land which, by law, were declared to be at the disposition of the Crown. The requisite parcels, usually with straight sides and often too large to be wholly fenced, were cut from this vacant land and were demarcated on the ground by driving in survey pegs or by digging shallow trenches at turning points on the boundary. These pegs or shallow trenches showed exactly what the grantee actually received and, so long as they can be found, there is no possibility of any contention as to what was granted. A qualified surveyor prepared a plan showing these points and providing sufficient information to enable any other qualified surveyor to relocate them should they be lost. The lines on this plan did not represent any physical features, even if such features existed on the ground, but they merely joined the turning points and represented the length without breadth of the geometry books. A copy of the plan was drawn on the grant which itself became the register and subsequent dealings were recorded on this grant and on the duplicate which remained in the possession of the grantee. The same process was repeated whenever there was a subdivision. It should be specially noted that "allocation" and "demarcation" were part and parcel of the same process. The significance of this will become clear later.

14. In England a wholly different operation was involved when the register was started. It was, in the first place, a problem of 'adjudication', that is, of ascertaining the facts from any evidence which was available. The title could, of course, very seldom be traced back to a Crown Grant and there was no accurate record of pieces of land which had been precisely cut off from the Crown Estate. Quite probably there was no map of any sort. No corner pegs or similar marks existed to pin-point the exact line of the boundaries which in practically all cases consisted of physical features on the ground such as a fence and ditch or wall. It was a question of finding out what were the boundaries of parcels which had existed for generations and it was not usually known on which side of the fence or wall the boundary acutally lay or whether it lay down the middle; nor, in most cases, did that really matter; the only significant point was who should maintain the fence or wall

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* See Halsbury's Laws of England, Third Edition Vol.3 p.354.

and that did not necessarily go by ownership. It was a matter of agreement or custom.

15. The English 1862 Act, however, required boundaries to be precisely determined and this was one of the main reasons for its failure according to the Royal Commission which was appointed to inquire into it. The following extract from their Report is illuminating:-

> "Everyone who has had experience in conveyancing knows that, although the difficulties of identifying the parcels seem to be serious and numerous, yet in point of fact they hardly ever arise. The conveyancer sitting in his chambers, or the draughtsman preparing a plan, may find difficulty in identifying parcels of which the description varies from time to time. But the purchaser by inspection of the ground itself, by seeing with his own eyes, and by direct communication with the persons in actual occupation, is in the great majority of cases satisfied that he is getting the land he contracted to buy. If there is any border land over which the precise boundary line is obscure, it is usually something of very trifling value, and the purchaser is content to take the property as his vendor had it and to let all questions of boundary lie dormant. But the Act of 1862 prevents the transfer on these terms. People who are quite content with an undefined boundary are compelled to have it defined. And this leads to two immediate consequences, both mischievous. First, notices have to be served on adjoining owners and occupiers which may and sometimes do amount to an enormous number, and the service of which may involve great trouble and expense. This is the first mischief. The second is that people served with notices immediately begin to consider whether some injury is not about to be inflicted on them. In all cases of undefined boundaries they find that such is the case, and a dispute is thus forced upon neighbours who only desire to remain at peace".

16. It was the publication of this Report in 1870, which led to the adoption of what in the English Act are called "general boundaries". These are regarded with some scorn by adherents of the Torrens system, and indeed, despite their evident successfulness in England, are unwisely attacked by Dowson and Sheppard who call them "a euphemism for uncertain boundaries".* Unhappily this conveys quite the wrong impression. A "general boundary" means that the exact line of the boundary has been left undetermined - "as, for instance, whether it includes a hedge or wall and ditch, or runs along the centre of a wall or fence, or its inner or outer face, or how far it runs within or beyond it, or whether or not the land registered includes the whole or any portion of an adjoining road or stream".** The English system makes it quite clear where the parcel is situated and on the ground there will be no uncertainty at all as to what the boundaries are, for they are clearly visible and unmistakable physical features. These features show the general line of the boundary but do not indicate the exact location of the line within the breadth which such physical features necessarily possess. That is what is meant by "general boundaries". What to the purist may appear slovenly imprecision is in fact the soundest commonsense.

17. A striking example of the practical value of the General Boundaries rule is afforded by the cellars under the pavement which are a common feature of London houses. Without the rule a special survey would be required in each such case and would cause great expense and inconvenience to no useful purpose. It is worthwhile spending a moment or two to consider just what this means. How would it help anybody to require the owner of, say, a five storeyed house with basement built in a terrace about a hundred years ago to produce a plan purporting to be accurate to a tenth of an inch showing not only the cellars under the pavement in front, but also particulars on each floor of re-entrants or overlays which are a usual feature of terrace buildings? The exact line of the boundary at the back, possibly into some sort of

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* Land Registration by Sir Ernest Dowson, K.B.E. and V.L.O. Sheppard, Colonial Research Publication No.13 H.M.S.O. 1956, p.125.

** English Land Registration Rules 1925, r.278(2).

well and with nooks and crannies at different levels, could not be precisely determined without an immense amount of investigation which might excite dispute and is of no possible use to an owner who hopes that the house will stand for the rest of his lifetime at least. Yet this is the sort of plan which is required in New Zealand on the conversion of a title "limited as to parcels". Again it was a Torrens enthusiast who decided that this sort of plan was needed to support a register of title in Zanzibar town and, because it was impossible to produce it at reasonable cost and without endless dispute, the landowners were denied the benefits of registration of title, even though there was already available a map of the order of that which illustrates the London register with such proven success.

18. The topographical map which supports the English Register is in fact a copy of the Ordnance Survey Map. This only depicts physical features and, of course, in accordance with ordinary survey practice a line which indicates a wall or fence represents its centre-line irrespective of who owns it. The Land Registry marks by coloured lines those particular features which actually constitute the boundaries of a parcel. No dimensions are shown on this map and, as the thickness of a line on it at the town scale of 1:1250 represents a foot on the ground, it could not be used for precisely re-establishing a boundary which had wholly disappeared in areas where inches, let alone feet, really matter. From it, however, even a layman can easily identify with certainty the physical features which delimit his property; the map operates as a signpost to them and they will be readily recognised when they are seen. This is all that is needed, for if there has been occupation for twelve years, these physical features are, by virtue of the Limitation Acts, the boundaries in law as well as in fact. The law of prescription and limitation is a vital part of the whole matter and I will deal with it separately later.

19. It should be specially noted that if an owner wishes to have the exact line of his boundary ascertained within the general line, provision is made to enable him to apply to have his boundary "fixed". When this has been done and recorded by means of a plan, the plan will be deemed to be conclusive evidence of the position. Such a plan will indeed have more weight in law than the plan accompanying the Torrens certificate. However, this process is so expensive and serves so little useful purpose in practice that today an application for a boundary to be treated as fixed is almost unknown.

20. The Torrens maps are quite different from those which illustrate the English register; in effect all boundaries are "fixed" and the map shows every relevant dimension. For example, dimensions on certificate plans in Auckland are shown to 1/100th part of a link; a link is not quite 8 inches and so 1/100th part of it is less than 1/10th of an inch. This would appear to be very convenient for any landowner who wants to know the exact dimensions of his plot - and most landowners if asked will say that they want such measurements. It is also possible for a trained surveyor to use the map to re-establish a boundary mark with a very high degree of accuracy and this is another apparent advantage which any landowner will say he wants to have, but it should not be forgotten that if this is done officially, as it should be, by a licensed surveyor it will be a very expensive process costing, maybe, something of the order of the original survey and I have been informed that, if as sometimes happens, a boundary peg originally emplaced with such expensive accuracy is removed (for instance, when bulldozing a road) the owner of the plot (or even the driver of the bulldozer) will merely stick it back again more or less where it appears it ought to go with no more ceremony than would his counterpart in England where the peg has no hallowed significance. Moreover even formal replacement by a licensed surveyor is apparently nothing like as conclusive as might be imagined. A former New Zealand Registrar-General writes:- "Where the pegs have been shifted or have disappeared it is difficult to get any two licensed surveyors to agree where the pegs

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were placed originally".* The point to be kept in mind, however, is that such a map can only be drawn if the exact position of the boundary has in fact been precisely determined and this, as has already been explained is neither feasible nor necessary in respect of parcels which are already in existence on the ground as distinct from parcels which are being newly laid out.

21. The Torrens map appears to ensure quite fantastic accuracy and this induces in the Torrens adherent a completely different attitude of mind from that of the English landowner, who has no figures at all on which to base a claim. Yet oddly enough, there seems to be no such thing under the Torrens system as a "guaranteed boundary" despite the fact that many of its supporters fiercely argue that this is one of its greatest advantages. The plan recorded on the Torrens certificate of title, for all its detail, appears to be no different in its legal effect from that which accompanies the English land certificate. Both are used only for the purpose of directing the proprietor to his boundary on the ground; in the English case he should have little difficulty in locating for himself the physical feature which demarcates its whole length, whereas in the Torrens system he will require a licensed surveyor to locate the specific points by joining which the "imaginary" line of his boundary is determined, but the marks which indicate these points must actually be found in the ground. It is well established by decided cases that a parcel of land described in a certificate of title means the parcel of land marked out on the ground by pegs, the position of which is shown (correctly or incorrectly) on the plan.** The parcel of land so referred to is the parcel of land actually pegged and is not the parcel which would have been pegged if the pegs had been placed where the plan indicates that they should have been placed. In New Zealand this is succinctly summed up in the phrase "pegs are paramount to plans" but one cannot help reflecting how much more sensible and convenient to landowners is the English practice of making visible boundaries the dominant factor. Continuous boundaries of the English sort are naturally much easier to find than single points marked by buried survey marks, and even where whole buildings were blown up in the London blitz enough of the footings remained to show the parcel boundaries as indicated on the Registry map.

22. I have indeed never yet discovered anybody who could define for me the meaning of a "guaranteed boundary" nor, more significantly, have I been able to discover under the Torrens system any claim for compensation which has been paid on the grounds that an area or other measurement was wrongly shown in a certificate or title, though there have been long and bitter disputes between neighbours arising, sometimes, from the fact that the measurements in their respective certificates were at variance.

23. There is a Tasmanian case which admirably illustrates this point.*** As a cautionary tale it cannot be too widely known. The diagram on a certificate of title showed a frontage of 154 feet 6 inches on to a road though, as was later found, the actual frontage on the ground was only 153 feet 9 inches i.e. 9 inches short of what was shown on the diagram. The proprietor sold 79 feet 9 inches of the frontage to A and a certificate of title was issued accordingly. Later on B became the registered proprietor of the residue of the land which was shown on the certificate of title as having a frontage of 74 feet 9 inches. B then proceeded to build on her frontage of 74 feet 9 inches as shown on her certificate, but of course when A measured his 79 feet 9 inches from the other end, he found that she had built on what appeared to be 9 inches of his land and so he demolished that part of the building which stood on it. B raised a case against him for demolishing the building and lost it, the High Court laying down the obvious principle that, where such a deficiency existed,

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* The Land Transfer Act 1952 by E.C. Adams (Butterworth & Co. (Australia) Ltd. 1958) p.350.

** Stevens v. Williams (1886) 12 V.L.R. 152

*** Dempster v. Richardson (1930) 44 C.L.R. 576

.. have to be borne by the proprietor of the "residue". She then brought an action against the Assurance Fund based on the erroneous dimensions shown in the certificate of title, and she lost that too, as the High Court held that the error was made, not by the Recorder of Titles, but by the previous registered proprietor, who had purported to transfer more land than he actually had. It would, I suppose, indeed be strange if the State were compelled to pay compensation for the loss of land which had never existed, but surely the whole incident was solely due to the error in the diagram and what can a "guaranteed boundary" mean if a landowner cannot completely rely on what is shown on the plan which is actually drawn on his land certificate?

24. This case, however, will be viewed with amazement by anyone accustomed only to the English system. It is obvious that it could never have arisen if proper attention had been paid to the marking of the parcels on the ground. A and B were buying land, not a diagram, and any system which purports to assume (or induces registered proprietors to assume) that a diagram can be an adequate substitute for inspection on the ground can be, as this case shows, very expensively deceptive. If the boundary between A and B was not clearly marked on the ground, measurement and agreement were imperative before the diagram could be relied on. In the event, what appeared to be accurate measurements proved to be an expensive trap because B, to the tune of two lost law suits in the High Court, found that it had merely deceived her in a way which would have been impossible if she had regarded the diagram only as a "signpost" to some mark - and preferably an obvious and visible mark- on the ground. The so-called "guaranteed boundary" was just a snare and delusion.

25. It is not surprising to find that Curtis and Ruoff say: "The Torrens system contemplates that all titles will be supported by a meticulous survey but any Englishman who questions the wisdom of his native rules for general boundaries would do well to study the vast labour and expense and multiplicity of disputes that are born of too nice a regard for this question".*

26. I shall be glad if anybody can tell me what possible useful purpose it served to require a proprietor to have drawn (doubtless at very substantial cost) a map enabling his flat to be described as "all that piece of land, delineated and coloured purple on the map in the margin as lies above a height of 85.35 feet above the datum for levels adopted by the Melbourne and Metropolitan Board of Works and below a height of 95.55 feet above the said datum". To refer to a block of air as "a piece of land" exemplifies legal absurdity too, and the application of land law to air (or even, as in England, to the floors of the buildings which, though more solid than air still have none of the indestructible permanence which is the essential and unique characteristic of land) can only produce difficulties and anomalies in the future. This elevated parcel, or stratum as they call it in Australia, can not be pegged, and this alone will be new material for legal argument when the experts disagree, as they doubtless will, as to its precise position in the air. Happily, however, in Australia (or, at least, in New South Wales) they have now solved the problem of the sale of the freehold or fee simple of flats which is such a feature in modern cities where there is multi-storey development. In New South Wales there is an admirable Act called the Conveyancing (Strata Tiles) Act 1961 and this will repay study though, incidentally, a Scotsman will tell you that the problem was solved in Edinburgh more than a century ago by the system of appointing a "factor".

27. There is another point I should mention in connection with an "index map" or "general map" and which distinguishes it from individual certificate plans separately prepared. There can be no "overlaps" or "gaps" in individual plans which are

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* Registered Conveyancing by Curtis and Ruoff p.12.

prepared merely by outlining parcels on such maps. It is like cutting a jigsaw puzzle out of a picture: obviously the pieces must fit when put back into the place from which they were cut. But the pieces will not necessarily fit if they have not been cut from the same sheet but have been separately and independently prepared, and gaps and overlaps are by no means unknown when it comes to piece together plans which have been drawn at different times by different surveyors.

28. In comparing the English and the Torrens systems there is one situation where it might be thought that they would meet on common ground. In the case of a building estate there is no question of old established boundaries. When an English building estate is first contemplated it is just as devoid of marking on the ground as its counterpart in Australia - or anywhere else for that matter.

29. The Torrens approach, of course, is that it is merely another subdivision and it must be pegged and surveyed just like any other subdivision. Indeed Australians want this done because they frequently buy vacant plots and wait for years before they build on them; they like to think of them as being safely pegged out on the ground and backed by an accurate map. In any case the developer is probably making big money out of his subdivision and there is no reason why he should not pay for the new maps and survey. It is all very sensible if in fact this high standard of survey is needed for making maps of the order of the ordnance survey and is used for that purpose. If full value is really being obtained from this work there is nothing more to be said, but if it is too elaborate, or is being wasted or duplicated, then something may be gained from a study of the English practice.

30. H.M. Land Registry has devised a special procedure for building estates as the visible physical boundaries on which the English system of registration relies are lacking. The developer is encouraged to submit two copies of the estate layout to the Registry for approval. The layout plan must be accurately drawn to scale (not smaller than 1:1250 and usually 1:500), but it does not have to be drawn by somebody with special qualifications, for the "licensed surveyor" who alone may prepare plans for legal purposes in many overseas countries does not exist in England. The Registry checks the plans, by using scales and, if satisfied that the layout does not include land which extends beyond the boundaries of the land owned by the developer as shown on his title plan, approves the plan and returns one copy to the developer. Transactions can then be arranged in respect of the plots as shown and numbered on the layout plan, but an instrument of transfer, like any other transfer of part of a registered parcel, must be accompanied by a plan of the part to be transferred. This 'transfer plan' will usually be a printed copy of the layout plan with the relevant plot outlined in a distinctive colour.

31. In the meantime, as the estate develops, the Ordnance Survey is constantly brought up to date and whenever it shows that development has differed from the estate layout plan, the Registry takes up the matter with the developer's solicitor and requires an amended layout plan to be submitted. As the English practice is to buy a ready build house rather than the undeveloped plot popular in Australia, the Ordnance Survey map is usually available for use in the preparation of a registry plan based on the transfer plan but where it is not the boundaries are plotted on the registry plan from the transfer plan. The registry plan in the latter case will be marked as 'subject to revision on survey' and on revision of the Ordnance Survey map a new registry plan will be substituted.

32. The whole emphasis in this procedure is on the actual development on the ground and should a survey plan show that this differs from the transfer plan either the fencing or the transfer plan must be altered so that they accord. In England people buy land, not diagrams, and what they buy they must indicate on the ground by boundaries effective enough to be observed by their neighbours; the buried peg or concealed boundary mark has no place in this system. I feel sure that there is a lesson in this English practice not only with regard to building estates but with regard generally to

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'allocation plans' (i.e. plans which show how it is intended that the land should be laid out) and their relation to the Registry Map (i.e. the map which is used to support the Register). The English building estate layout plan is merely an allocation plan, but transfer plans based on it are successfully used as a basis for registration until such time as a plan showing actual development can conveniently be substituted for it. Incidentally the major part of the cost of bringing the Ordnance Survey constantly up to date in respect of registered building estates is borne by the Land Registry and the balance by the Ordnance Survey Department. It is not borne by the developer and I know an Australian Registrar who has questioned the English procedure because of its cost to public funds. But it must be kept in mind that the Ordnance Survey map is used by a multitude of people for all sorts of purposes. It must be brought up to date in any case. Its use by the Registry kills two birds with one stone. Can the same thing be said for a cadastral map made and used only for purposes of registered title?

Part II: Prescription and Limitation

33. At this point I propose to say something about the law of prescription and limitation because it vitally affects maps and boundaries. It is a key factor in registration of title, though this is not always realised, perhaps because, like so much of English land law, it appears difficult and complex, and its principles and the reasons underlying it are not clearly understood.

34. Prescription is the name given to the legal rule which enables a right or title to be gained by lapse of time. It is either (a) positive i.e. long possession confers a positive title or (b) negative i.e. the title obtained arises merely because the real owner has, after a certain length of time, been barred of his remedy because he has not pursued it within the time laid down by statute. In English law "prescription" (by which is meant only positive prescription) is confined to the acquisition of such rights as easements and profits and is firmly distinguished from "limitation" whereby title to the land itself is obtained by "adverse possession". This negative approach whereby the rightful owner merely loses his rights because of his negligence in asserting them makes the matter more complicated than the positive approach of, for example, the Sudan law whereby peaceable, public and uninterrupted possession without the permission of any lawful owner actually confers ownership.

35. However, whether negative or positive, it is generally agreed by writers on English land law that "some such principle is necessary to every system of law"* and Professor Cheshire, for example, having said "It is an evil that a person who has wrongfully seized land belonging to another should be allowed to keep the land against the true owner but it would be a greater evil if a dispossessed owner were allowed after any interval of time, however long, to commence proceedings for recovery"** goes on to quote a remark of Lord St. Leonards made in a case in 1852: "All statutes of limitation have for their object the prevention of the rearing up of claims at great distances of time when evidences are lost: and in all well regulated countries the quieting of possession is held an important point of policy".***

36. Indeed the whole principle is so generally accepted and seems so logical and irrefutable that it is difficult to understand why it was every supposed that registration of title had a special quality which somehow invalidated the law of limitation. Despite its negative form its true purpose is not to punish the negligent owner but to quiet possession and so far as the man in possession is concerned it

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* The Law of Real Property by Megarry and Wade Second Edition (Stevens and Sons, 1959) p.954.

** Modern Real Property by Cheshire Ninth Edition Butterworths 1962 p.783.

*** Dundee Harbour Trustees v. Dougal (1852) 1 Macq. 317.

can make no difference whether the title of the real owner rests on a register of title or on ordinary title deeds which may be just as good evidence of his legal ownership. Yet in the early days of land registration in England "indefeasibility of title was" in the words of Curtis and Ruoff "worshipped with such idolatry that the legislature made it at first impossible (Land Transfer Act 1875, s. 21) and later on, extremely difficult (Land Transfer Act 1897 s. 12) for a squatter to obtain a title by adverse possession against a registered proprietor".* It was not until 1925 that the law was altered to recognise that registration of title should make no difference to the law of prescription and limitation.

37. Much the same thing also happened under the Torrens system. The original South Australian statute in 1858 made no mention of prescription and limitation, but as soon as this omission was noticed several of the Australian colonies and also New Zealand enacted a provision specially excluding the operation of the statutes of limitation in respect of registered land. Victoria was the first of these colonies to discover how unwise it was to abolish so sensible a law, for land abandoned after the gold rush remained registered with indefeasible title in the names of persons who could not be traced and it was manifestly absurd, as well as very inconvenient that there should be no possible way for those occupying the sites to obtain title. The law in Victoria was therefore amended to provide for the acquisition of possessory title, and Western Australia followed suit. Tasmania, which with Queensland had originally remained silent on the subject, later adopted the Victorian amendment; and, in 1939, South Australia made a partical concession to the Statute of Limitations.** In 1963 New Zealand surrendered and amended its Land Transfer Act 1952 to allow limitation to operate in respect of registered land and now only New South Wales (and its offshoot, the Capital Territory of Canberra) remain obdurate in Australia.

38. However, several other countries still artificially protect registered title, e.g. the Malayan Land Enactments provide that no title to land adverse to or in derogation of the title of the registered proprietor shall be acquired by any length of possession or by virtue of any limitation enactment, and the Sarawak Land Code contains a similar provision. Curiously enough it was also introduced into the British Solomon Islands in 1957 by a draftsman (who, brought up in English law in England, should have known better), but their Ordinance has now been amended to allow prescription to operate. In Singapore, Baalman, a New South Welshman, followed the South Australian line of partial concession when he drafted their new Ordinance in 1956. So it will be seen that there is still a body of opinion which considers that the mere fact of registration of title and the provision of a good map can make unnecessary a provision of law which has been found essential in most civilized countries and is of very respectable antiquity, for it is the 'usucapio' of Roman law.

39. It is unfortunate that the term 'land stealing' has often been associated with adverse possession, for usually there is no dishonest motive at all, and the original occupation arises from misunderstanding or mistake and not from any deliberate taking of somebody else's land. The most useful, and indeed the most common, application of the doctrine of adverse possession is in stabilizing occupation lines, where genuine error has lead to a comparatively insignificant change in boundary which no one would think of disputing unless incited to do so by meticulous measurement and talk of guarantee. There will be no such incitement if the rule is that occupation in due course confers ownership for, when the prescriptive period has elapsed, the physical boundary delimiting on the ground the area actually occupied becomes the boundary in law as well as in fact, and so a claim can no longer be made years after a boundary fence has been inadvertently erected in the wrong place unbeknown to either owner.

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* Registered Conveyancing by Curtis & Ruoff (Stevens & Sons 1958) p.676.

** Much of this information has been obtained from the Commentary on the Torrens System in New South Wales by Baalman (The Law Book Co. of Australia) p.178.

40. This rule is clearly also of great practical convenience to conveyancers, for it means that they can safely accept the boundary they see on the ground without requiring expert survey corroboration that it exactly corresponds with the layout shown on the registry plan and demarcated by pegs or other concealed marks which may have disappeared or will be difficult and expensive to find. It will only be necessary to have recourse to the tape where there are no physical boundaries on the ground or where such boundaries have not stood sufficiently long.

41. The significance of this point is well illustrated by a case in New Zealand which is often quoted.* A man owned two contiguous building plots which were shown on the Register as two parcels though on the ground they were a single unit of property owned by one person. On this property the owner built a house which he thought to be on one of the two parcels as described on the Register. In due course the two parcels were sold to different persons. One purchaser bought the house and the land that was fenced off with it, and the other bought the vacant land on the other side of the fence and house. Each bought what he saw and neither got more or less than he bargained for. However, later on, survey (at whose behest and for what reason or purpose is not recorded) revealed that the dividing line of the original property was not where the parties had believed it to be at all material times, but actually lay through a room of the house. The court had no alternative but to say that this was the boundary, for in New Zealand that was the law, and the author of a handbook for the use of survey students which I bought in Auckland in 1959 complacently remarks that this case "shows how necessary it may be for a purchaser to have a survey made, even though the Land Transfer Office may not require one".** A prudent purchaser was therefore compelled to incur a considerable expenditure in calling for a survey to show that what he saw on the ground accorded exactly with what was shown on the plan. I must be forgiven if I say that this might be good news for aspiring surveyors, but was not likely to be so welcome to landowners. This position, of course, does not arise where the map only indicates a visible physical feature which is the boundary in law as well as in fact.

42. In fact, the operation of the law of prescription (whether positive or negative) in developed areas where boundaries are physically fenced or walled has the effect of subordinating the certificate plan to whatever has existed on the ground for the period of prescription or limitation (which is twelve years under English law). The cadastral map of New Zealand represents imaginary lines joining pin-points in the tops of survey pegs hammered deep into the ground, may be half a century or more ago, and it wholly ignores the walls and fences actually enclosing the parcels with which, indeed, the imaginary lines may not be coincident. But since the change in law in 1963, how long will this sort of ghostlike grid serve any useful purpose? As soon as the boundaries on the ground, have by virtue of the law of prescription, become the boundaries in law as well as in fact the only map which will properly illustrate the register will be a topographical map and the original certificate plans with their precise dimensions will no longer override the occupational boundaries if they are different from them. The whole situation has been transformed and no doubt something less onerous in the way of certificate plans may be a possibility.

43. But it is not only in New Zealand that something less onerous is indicated - nor is it only in respect of plans required for registration of title. The same meticulous survey is found in Africa and where title is not even registered. I would suggest, for example, that when a plan, with dimensions shown to one hundredth part of a foot costing more than £30 in fees (subsidized at that) is required to support

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* Zachariah v. Morrow and Wilson (34 N.Z.L.R. 885).

** Summary of the Law Relating to Land Surveying in New Zealand. Third Edition by E.M. Kelly, published by the N.Z. Institute of Surveyors, p.296

the grant of a mosque site in a village where land is cheap and precision relatively immaterial, and where the boundary is unlikely to be moved and it will not really matter if it is, there is scope for new thinking if we are to make the best use of men and materials in the survey field.

44. To emphasize this point, I have attached as Appendix A a note (not written by me) on the adjudicuation of title in a village whose identity I have, I hope, suitably disguised. As Appendix B I have attached the supporting map. Any practical minded person who is interested in the subject and can spare five minutes to study this note and map will find food for reflection in the apparent uselessness, not to mention the costliness, of this operation. It is not, as one might suppose, some curious survival from the past but was done within the last eight years or so and the same procedure still continues. To contrast with this map I have attached as Appendix C a section of a map of a place where existing physical features have for long indicated property boundaries, just as they did in the village of Blank. This map was sent to me as being suitable for the purpose of illustrating a register of title. Incidentally it was sent by a New Zealand licensed surveyor.

Part III: The Kenya Registered Land Act, 1963

45. Kenya is a useful country to study not only because, as I have already said, it affords the most outstanding example of the use of registration of title for the conversion of customary tenure to individual title, but also because it is a country where the Torrens and English systems exist side by side. The Registration of Titles Ordinance 1919 introduced registration of title in the Torrens form, but the Native Lands Registration Ordinance 1959 which was used to convert customary tenure to individual title was based on the English system, particularly in respect of mapping, and so is the Registered Land Act 1963 which has unified the two systems, though many of the titles under the Registration of Titles Act have not yet been changed over. I attach, as Appendix D, Division 3 of Part II of the Registered Land Act 1963 (and as Appendix E comparative extracts from the latest version recently drawn for the Turks and Caicos Islands). This Division is entitled Maps, Parcels and Boundaries and deals with the subject more comprehensively and systematically than any other Registration Act or Ordinance with which I am familiar.

46. The Torrens type of precise individual plans was established in Kenya earlier than the Torrens system itself, for it was introduced by the Land Titles Ordinance 1908 though the General Map system would have been infinitely more practical for the purpose of the adjudication of title on the Coast for which that Ordinance was intended. The Torrens type of plan was also naturally adopted for the Crown Grant system under the Crown Lands Ordinance 1915, as this was precisely the sort of system from which it originally came, and for which it is entirely appropriate. It was, of course, automatically used when the Torrens form of registration of title was introduced in 1919.

47. It was, however, neither desirable nor, without great delay and expense, was it possible to use the Torrens system of pegging and meticulous survey when it came to the conversion of native customary tenure. There were far too many small parcels. In any case use and occupation were the principal objectives and the precision marking of corners by concealed marks would have had none of the practical advantages of the visible continuous boundaries which are so much more useful to anybody occupying land. Such boundaries indeed were themselves an integral part of the whole scheme, because enclosure - that is the putting in of proper fences - was as essential to improve agriculture as it was to mark boundaries for the purpose of title. There was not, of course, any difficulty in determining the exact line of the boundary as, on consolidation, new boundaries were laid out just as in the case

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of a Crown Grant, and so the English difficulty of ascertaining the precise line of the boundary did not arise, nor did it even arise in practice in respect of the original fragments, for these were pointed out by the owners with remarkably little dispute. It was intended that the boundaries of the new holdings should be demarcated in length by physical features (mainly growing hedges) and these were to be the boundaries in law as well as in fact on English lines. It was thought that, as soon as the boundary fences had grown sufficiently, aerial photography would enable a map, similar to the English Ordnance Survey, to be produced quickly and cheaply. In the meantime, if the promised titles were not to be disastrously held up, registration had to proceed on the strength of the original 'allocation maps', which were the maps drawn to indicate how the new consolidated parcels, replacing the fragmented holdings, were to be laid out on the ground. These maps were not drawn under the aegis of the Survey Department, nor did the Survey Department assist in the actual demarcation on the ground.

48. In the event, however, aerial photography proved more difficult and much slower and more expensive than had been expected. By no means all the boundaries became air visible at the right moment; some hedges died, and some were never put in despite every effort to enforce the fencing policy; much ground survey was always necessary (which enormously increased the cost) and there was not the staff available. By the end of 1965 less than a third of the 1½ million acres of land registered had been 'finally' mapped and in the settlement schemes there was a backlog of a million acres.

49. On the subject of the original maps the Lawrance Mission observed: "It was was inevitable that in the early days of the crash programme not all the work was of even quality, nor of course was it of uniform pattern. Nevertheless, not all the work, even at that time, was bad, and some of it was quite good. Much of the very early work has been re-flown and final maps produced. We have had pointed out to us examples of very bad cases, but in adjudication sections selected at random a comparison of acreages computed on preliminary and final plans revealed a very small number of significant differences, certainly not enough we would think, to justify the very considerable cost of re-mapping".*

50. Their Report went on to say: "For future work in consolidation areas we consider that with the Survey of Kenya responsible for the laying out of plots on the ground, with a tightening up of the survey methods and more supervision and checks, a map can be produced in the first place which is quite adequate for registration purposes and to assist with any subsequent re-location of boundaries and the survey of subdivisions".

51. I have quoted this in extenso because I believe that the crux of the whole problem in these schemes of development or redevelopment of customary areas is the relationship between allocation maps and demarcation. Torrens type survey requires a licensed surveyor to peg out the parcels as shown on the allocation plan and then to survey the pegs as actually emplaced in order to produce a certificate plan. In my experience in the Sudan, for example, a frontage of, say, 100 metres precisely surveyed and marked on the ground by boundary stones could not be subdivided on the register into five plots each with a frontage of 20 metres and so made available for disposition without first pegging each plot, though the pegs were likely to disappear before development was begun and would then have to be replaced by the same process of formal survey. The equivalent of the layout plan approved by H.M. Land Registry would have saved the first survey which in practice served no useful purpose unless development was imminent. In the English system, as we have seen, the Ordnance Survey is constantly revised as development takes place. In the context of the Kenya

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* The Mission on Land Consolidation and Registration in Kenya, 1965-1966 Ch. XIV para. 13.

Settlement Areas the equivalent of this would be ground survey as boundaries are put in, the allocation map (i.e. layout plan) being corrected if needs be, but used meanwhile for the purposes of registration. In England there is no attempt to finalize the whole matter at once as is envisaged in the Kenya 'refly' technique. Clearly there is something to be learnt from this.

52. In any case, however, the original Kenya processes, though conducted by 'amateurs', have produced acceptable results, and may suggest to the 'professionals' ways in which this vital part of the procedure can be speeded up and made more economical. Indeed this seems to me to be the greatest challenge to the practical surveyor in this field at the present time. The allocation maps must be so 'adjusted' at the time of demarcation that they will adequately serve the purpose of registry index maps, and this must be done at sensible cost and within the capability of available staff. It requires ingenuity and commonsense, and above all, a real knowledge of what the maps are wanted for.

53. This, therefore, brings us immediately to the purpose for which the plan is used in the Registry. The Lawrance Mission say (Chapter XIV paragraph 22): "Maps are required by a registry firstly to identify on the ground a plot shown on the register;* secondly, to assist in the re-location of a boundary should it be moved or lost; thirdly to enable subdivision to be effected; fourthly for the calculation of plot areas".

54. The first of these requirements is obvious and needs no comment, but it is in regard to the second that there is the greatest need for a proper appreciation of what is involved administratively. The very word "locate" (and so "re-locate") is another of these ambiguous words. It can mean (a) "to find the position of something" or (b) "to put something into position", and there is obviously a wealth of difference between (a) finding something which actually exists like a fence or wall (or even the traces of a fence or wall) and (b) putting back into place a boundary which has wholly disappeared or perhaps was never demarcated. The English Ordnance Survey (and so the map which supports the English register) is of such quality that it will enable the physical feature it depicts to be 'located' (i.e. found) with certainty and to be 'relocated' if that merely means to find that physical feature again, but as I have already said (para. 18) it would not enable a boundary which had wholly disappeared to be relocated (i.e. re-established or put back into place) in the same way as would the Torrens type of deed plan with its precise dimensions.

55. Thus it was obvious that where the Torrens and the English systems met, as in Kenya, boundary relocation might be confusing and, therefore, the Kenya Act dealt with the point specifically. It enables any "interested party" to apply to the Registrar "to determine and indicate" the position of an uncertain or disputed boundary and expressly provides that the Registrar "may receive such evidence as he thinks fit", thereby indicating that the Registrar may use other than survey evidence, if he wishes. This puts into formal terms a useful and convenient service which is provided by the Registry. It must be distinguished from an application to "fix" a boundary in the English sense** for which provision is expressly made in the next section of the Kenya Act and it has no exact equivalent in the English system. The re-establishment of a boundary mark under the Torrens system would be done by a licensed surveyor and would not be part of the Registry service. The provision that no court shall entertain any action or other proceedings relating to a dispute as to the boundaries of registered land is derived from Cyprus*** where the land officers were frequently required to indicate boundaries because unlike Kenya there were no marks on the ground and landowners were in constant need of getting them indicated by some impartial person.

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* Cf English Land Registry Act 1925 s.76 "... and the field plan, if any or general map shall be used for assisting the identification of the land".

** See para 19 above.

*** Cyprus Immovable Property Law s. 58(1).

56. In Kenya, however, it appears that there has not been much "uncertainty or dispute" about the boundaries of registered plots and, if the proof of the pudding is in the eating, it is particularly significant that the Lawrance Mission were able to discover less than twenty cases where the services of the Registrar had been sought to relocate a boundary, though it is some ten years since registration was started in the customary areas and there are about 275,000 parcels on the register (excluding township plots). Even where 'final maps' had been produced to replace the original maps, it is instructive to note that the Registrar did not seek professional survey assistance to relocate the boundary. In no case does there appear to have been any great difficulty and this alone is strong ground for assuming that the original maps are adequate for the needs of the Registry. At least there is no evident justification for replacing them, not even if it would cost only 20 cents an acre instead of something of the order of 20 shillings. The functioning of the Registry has in no way suffered from their use, and this is the only sensible criterion.

57. The third requirement of the Registry - to enable subdivisions to be effected - brings me to the whole question of 'mutation' (i.e. an alteration in the boundary of a registered parcel) and to replanning which involves mutation but, for the purpose of this paper, I think I need say no more than that if a system of registration of title is applied to an area before any necessary replanning or parcel re-arrangement has been set in train it may have the effect of fixing a bad pattern of land holding which will obstruct good land use, and it may fix it almost indelibly because the cost of effecting individual mutations through formal registry procedure, and the difficulty and delay in getting them done, will inhibit change instead of facilitating it.

58. It should be noted that if a boundary is changed, in effect a new parcel is created: this is given a new number and the old number is not used again. This system of 'unique numbering' is a useful safeguard against duplication and confusion and is to be preferred to subdivisions of the original number which is a practice followed in many countries.

59. In fact the system of numbering now followed in Kenya can be strongly recommended. A parcel is described by reference to the registry map and there are no special title numbers. The name of the registration section, block number (if any) and parcel number as used on the map serve as title numbers. This means that the registers of all parcels in the same area are kept together and this has obvious administrative advantages. It also saves the cross-indexing of title numbers. It makes it very much easier to divide up a registry, should this be necessary, as it often is because registries grow and get too big or there are political changes; Sydney and Canberra in Australia and Lagos and Ibadan in Nigeria are two examples of where it would have been invaluable. As it was the registers had independent title numbers and so each folio had to be examined to see whether it must be transferred or not. This would have been avoided if the title numbers had been the same as the parcel numbers on the Registry Map. Yet it is astonishing how few registries have adopted this simple device, despite the fact that it is recommended by Dowson and Sheppard who, I think, may have first seen it in use in the Sudan - though it is, of course, the natural way of indexing a deeds registry when this is done by parcels and not merely by parties. Unfortunately it was not even adopted in Singapore when only recently a new register of title was started there.

60. The Kenya Act makes special provision for what are called 'filed plans' (i.e. an ad hoc plan filed in respect of a particular parcel), but it is not intended that there shall be a filed plan in respect of every parcel (which has always been the practice in the Torrens system and is now the practice in England). Anyone can buy a copy of the relevant part of the Registry Map if he wishes, and the file plan is intended to be used only if it is needed to augment or amplify the information available on the Registry Map. It can illustrate any special detail on any scale which may be appropriate or it may even be merely a sketch showing particular dimensions. It must be remembered that it is the relationship of a parcel to its immediate neighbours which matters to its owner; so far as he is concerned its precise position on the world's surface is immaterial.

61. The fourth and last requirement listed by the Lawrance Mission - that the map is needed for the calculation of plot areas - will surprise anybody brought up only in H.M. Land Registry in England, where no measurements or dimensions are shown in the register or on the general map. Nor do I think that most Torrens registrars, or indeed conveyancers under the Torrens system, would consider themselves concerned with areas or dimensions, for the plan is regarded as the concern only of the professional surveyor, and the conveyancer takes no responsibility for it - or even for the identification of the parcel itself. But most countries, and in particular developing countries, will find a land register supported by an adequate map a very valuable, if not indispensable, adjunct to effective land administration. Areas are a very useful part of the record, but here again the commonsense approach is often strangely lacking. If, with a quite misleading implication of precision, the practice is to show areas to three decimal places of an acre, the addition of the word 'approximately' does not indicate that what is shown as, say, 9.672 acres is about $9\frac{1}{2}$ acres and that this is what is really intended and is close enough for all practical purposes. Similarly the expedient of leaving blank the space provided on the register for 'approximate area' and preparing a separate list (available to anybody who wants to see it) merely multiplies the records to no useful purpose, for the idea that it in some way protects the Government or warns the individual is fallacious.

62. In any case in Kenya any such expedient is quite unnecessary, for it is expressly provided (in s.148 of the Act) that, as between the government and a proprietor, no claim to compensation can be made on account of any surplus or deficiency in the area of measurement of any land disclosed by a survey showing an area differing from the area or measurement shown in the register. As between the proprietor and any other person six months is allowed for a claim because the price may have been fixed at, say, so much an acre or per square yard as shown on the register, and it may be fair that the price should be adjusted if the register was wrong.

63. A simple provision on these lines will save much abortive litigation, but only the Sudan - where it originated - and Lagos have it in addition to Kenya.* In Uganda, on the contrary, there is provision that if any person sustains any loss or damage by any rectification of certificate of title occasioned by any inaccuracy in any plan used on the sale of land by the Crown, he may bring an action against the Government,** but I have no information on how this works in practice or if anything has ever been paid under it. It looks to me as if it merely assures the accuracy of Crown grants, and gives a grantee no more right than he has in any case because, clearly, unless the grantor has granted the land he has undertaken to grant, he must be liable for breaking his undertaking whether the title happens to be registered or not.

64. In fact it will round off this point and will bring me back to the basic difference between the Torrens and English system (which is where I started this paper) if I conclude by quoting a passage from a Report which I wrote ten years ago on the Registration of Title to Land in Lagos.*** "As I have drawn attention to the difference in first registration between a system based on recording titles stemming from Crown (or State) grants and one which aims merely at recording and establishing titles which already exist, it may be useful to mention here that this difference in origin may account for continuing differences in the subsequent organization of registration itself. For example, in some systems the original Crown grant acts as

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* Note. The Seychelles have recently adopted it and it is also included in legislation prepared for Malawi (since enacted) and for the Turks and Caicos Islands.

** Uganda Registration of Titles Act s.192.

*** Lagos: Federal Government Printer 1957 page 25.

the certificate of title, and the register is kept on a copy of it; but it is in the survey approach and ideas of mapping generally that the distinction is principally marked. An analogy will make the point clear. If I buy two pounds of salmon from the fishmonger at fifteen shillings a pound, I shall expect to get two pounds of salmon and indeed, I shall be defrauded if, having paid my thirty shillings, I do not get it. If, however, I take a fish, which I have caught, to the fishmonger and ask him to identify and weigh it, I shall not be defrauded if he makes a mistake, for I shall still have the actual fish and no less (or more) than I had before. If I eat it, I can suffer no loss from anything that the fishmonger said, and, if I sell it, his error will only affect me in so far as I have relied (or the law may have compelled me to rely) on his weighing and indentification. Thus Crown grants, like the purchased fish, must clearly be up to weight and specification, and if the survey which measures them and ensures their identification is wrong, the recipient may be positively defrauded. In Crown grants measurement, not title, is the dominant factor, and so survey takes on a specially important role. In London (and Lagos), however, the Registry is only required to "identify and weigh"; it does not grant, and so survey plays a somewhat different part. I have elaborated this point because I believe that in this difference of origin may lie the explanation of some controversy and misunderstanding which otherwise is very puzzling."

LONDON,

FEBRUARY, 1967

APPENDIX A

Note on the Adjudication of the Village of Blank

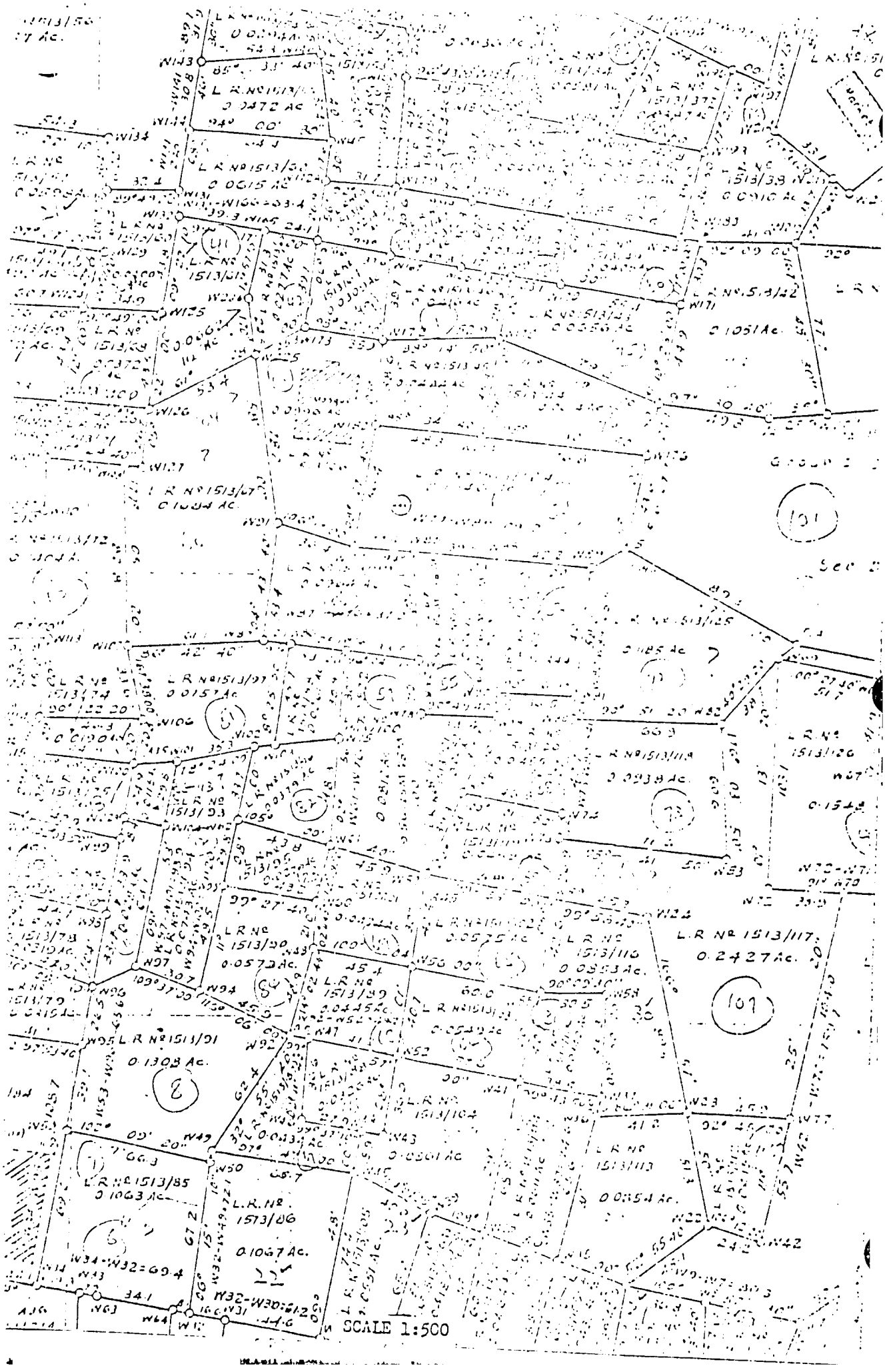
Blank is a village area comprising a total of some 11 acres, occupied mainly by persons whose families, we were informed, had been residing there for upwards of 200 years. Owing to the re-alignment of the main road (which previously passed through the village) the village is unlikely to undergo development of any sort in the foreseeable future. Apart from the installation of some petrol pumps on one plot, no development appears to have taken place even when the main road passed through, and how much less is it likely now that the road has disappeared. The villagers subsist well, but produce little in the way of marketable goods or crops, so that there is hardly any money in circulation. We were advised that the value of land at Blank, even if anybody wished to buy it, was unlikely to exceed £50 per acre, and although obviously well constructed and cared for, few of the buildings would add much to the value of the land.

2. However, the main block of the village has now been adjudicated, and some 130 plots put into individual private ownership, for which certificates of ownership are about to be issued and registered, each having attached to it a deed plan. We have not been able to ascertain the total cost to Government of the complete exercise for this village, but the normal cost of a deed plan for areas of this nature is in the region of £10, to which has to be added the proportionate cost of the work carried out by the Adjudication Officer and his staff. It would appear that the adjudication has cost Government probably an average of £20 per plot, whilst the average value of the plot is no more than £4. The total amount recoverable from the proprietor is £4 10s. 0d., but the chances of recovery are slight.

3. An additional factor is that every square inch of land in the village has been adjudged as belonging to individuals, and a perusal of the plan which is attached will show that, apart from the main road which was acquired by Government some years ago, there is apparently no means of access to 95% of the plots, nor are there any open spaces. The Ordinance saves existing rights of way, and in fact footpaths, minor roads, and open spaces exist on the ground, but one can imagine the difficulties with which a stranger, who wanted to purchase one of the plots, would be faces when endeavouring to find out what rights of access he would have.

4. The proprietors are, in most cases, in no position to be able to afford to pay the costs involved in obtaining probate or letters of administration for the purpose of keeping the title up to date, so that within one generation the register would be completely ineffective, and a process of re-adjudication necessary because of the impact of the laws of inheritance.

5. We feel that the application of registration of title to areas of this type, where no development is likely and consequently land has little or no value, and where it is not necessary to secure the economic use of land, may well be a disservice rather than a service to the inhabitants.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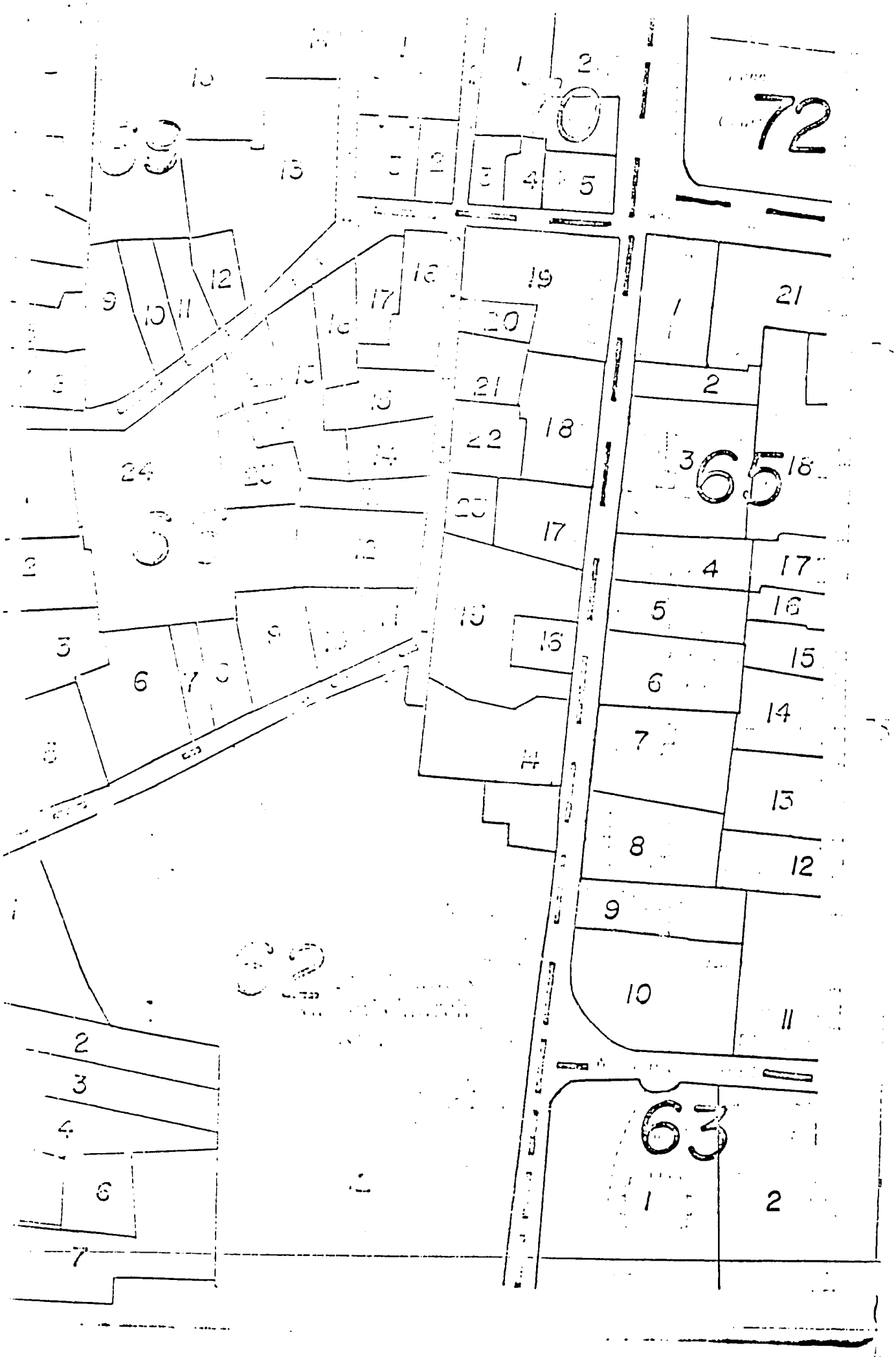
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Laws of Kenya (Revised Edition 1964)

THE REGISTERED LAND ACT (CAP. 300)

PART II - ORGANISATION AND ADMINISTRATION

Division 3 - Maps, Parcels and Boundaries

Registry Map

18. (1) The Director of Surveys shall prepare and thereafter maintain a map or series of maps, to be called the registry map, for every registration district.

(2) Where for any registration district, or for a part thereof, no map has been so prepared, the Registrar may himself cause a map or series of maps to be prepared for that registration district, or for that part, and thereafter maintained, and such map or series of maps shall be deemed to be the registry map until the Director of Surveys prepares a map or maps under subsection (1) of this section and delivers it to the Registrar.

(3) On the registry map, every registration district shall be divided into registration sections, which shall be identified by distinctive names, and the registration sections may be further divided into blocks, which shall be given distinctive numbers or letters or combinations of numbers and letters.

(4) The parcels in each registration section or block shall be numbered consecutively, and the name of the registration section and the number and letter of the block, if any, and the number of the parcel shall together be a sufficient reference to any parcel.

(5) The Registrar may, at any time, cause registration sections or blocks to be combined or divided, or cause their boundaries to be varied.

(6) A plan may be filed in respect of a particular parcel to augment the information available from the registry map, and the filing of the plan shall be noted in the register.

NOTE. Compare clause 14 of the Turks and Caicos Islands Registered Land Bill (below).

Power to alter registry map and to prepare new editions.

19. (1) Where the Registrar is maintaining the registry map he may, or in any case he may require the Director of Surveys to, correct the line or position of any boundary shown on the registry map with the agreement of every person shown by the register to be affected by the correction, but no such correction shall be effected except on the instructions of the Registrar in writing in the prescribed form, to be known as a mutation form, and the mutation form shall be filed.

(2) Whenever the boundary of a parcel is altered on the registry map, the parcel number shall be cancelled and the parcel shall be given a new number.

(3) Where the Registrar is maintaining the registry map he may, or in any case he may require the Director of Surveys to, prepare a new edition of the registry map or any part thereof, and there may be omitted from the new map any matter which the Registrar considers obsolete.

NOTE. This section is defective in that it does not distinguish 'correction' from alteration. See clause 15 and 16 of the Turks and Caicos Islands Registered Land Bill (below).

Further surveys.

20. The Registrar may cause a survey to be made for any purpose connected with this Act, but, where the registry map is maintained by the Director of Surveys such survey shall be used to amend the registry map only if it is approved by the Director of Surveys.

NOTE. This provision is included in clause 15 of the Turks and Caicos Registered Land Bill (below).

Boundaries.

21. (1) Except where, under section 22 of this Act, it is noted in the register that the boundaries of a parcel have been fixed, the registry map and any filed plan shall be deemed to indicate the approximate boundaries of the approximate situation only of the parcel.

(2) Where any uncertainty or dispute arises as to the position of any boundary, the Registrar, on the application of any interested party, shall, on such evidence as the Registrary considers relevant, determine and indicate the position of the uncertain or disputed boundary.

(3) Where the Registrary exercises the power conferred by subsection (2) of this section, he shall make a note to that effect on the registry map and in the register and shall file such plan or description as may be necessary to record his decision.

(4) No court shall entertain any action or other proceedings relating to a dispute as to the boundaries of registered land unless the boundaries have been determined as provided in this section.

(5) Except where, as aforesaid, it is noted in the register that the boundaries of a parcel have been fixed, the court or the Registrar may, in any proceedings concerning the parcel, receive such evidence as to its boundaries and situation as it or he thinks fit.

NOTE. The marginal description of this section in the Turks and Caicos Registered Land Bill has been changed to "General Boundaries" in order to indicate clearly its connection with the English system.

Maintenance of boundary features.

23. (1) Every proprietor of land shall maintain in good order the fences, hedges, stones, pillars, walls and other features which demarcate his boundaries, whether established

pursuant

pursuant to the requirements of any other written law or pursuant to an order of the Registrar or of the proprietor's own accord.

(2) The Registrar may in writing order the demarcation within a specified time of any boundary in such permanent manner as he may direct, and any person who fails to comply with such an order shall be guilty of an offence and liable to a fine not exceeding two hundred shillings.

(3) The Registrar may in writing order which of adjoining proprietors shall be responsible for the care and maintenance of any feature demarcating a common boundary, and any proprietor so ordered to be responsible who allows the boundary feature or any part of it to fall into disrepair or to be destroyed or removed shall be guilty of an offence and liable to a fine not exceeding two hundred shillings.

Interference with boundary features.

24. (1) Any person who defaces, removes, injures or otherwise impairs any boundary feature or any part of it unless authorized to do so by the Registrar shall be guilty of an offence and liable to imprisonment for a term not exceeding two months or to a fine not exceeding two thousand shillings, or to both such imprisonment and such fine.

(2) Any person convicted of such an offence, whether or not any penalty therefor is imposed upon him, shall be liable to pay the cost of restoring the boundary feature, and such cost shall be recoverable as a civil debt by any person responsible under this section for the maintenance of the feature.

Combinations and subdivisions.

25. (1) Where contiguous parcels are owned by the same proprietor and are subject in all respects to the same rights and obligations, the Registrar, on application by the proprietor, may combine these parcels by closing the registers relating to them and opening a new register or registers in respect of the parcel or parcels resulting from the combination.

(2) Upon the application of the proprietor of a parcel for the division of his parcel into two or more parcels, the Registrar shall effect the division by closing the register relating to the parcel and opening new registers in respct of the new parcels resulting from the division, and recording in the new registers all subsisting entries appearing in the closed register:

Provided that -

(i) nothing shall be done under this section which would be inconsistent with this Act or any other written law; and

(ii) no parcel which is subject to a lease shall be subdivided.

Reparcellation.

26. (1) The Registrar may, on the application of the proprietors of contiguous parcels who are desirous of changing the layout of their parcels, and with the consent in writing

of

of all other persons in whose names any right or interest in such parcels is registered and of any cautioner, cancel the registers relating to such parcels and prepare new registers in accordance with the revised layout:

Provided that, where in the opinion of the Registrar a proposed reparcellation involves substantial changes of ownership which should be effected by transfers without invoking this section, he may in his discretion refuse to effect such reparcellation.

(2) Upon any such reparcellation, the new parcels shall, notwithstanding section 38 of this Act, vest in the persons in whose names they are registered.

Extracts from Turks & Caicos Islands Registered Land Bill

The following are three clauses from the Registered Land Bill which has been prapared for the Turks and Caicos Islands and which make constructive comparison with sections 18, 19 and 20 of the Kenya Act:-

Registry Map.

14. (1) The Registry Map shall be compiled from the demarcation maps made under the Land Adjudication Law, 1966, and shall be divided into registration sections which, so far as is possible, shall have the same boundaries and names as the adjudication sections; the registration sections, where the adjudication sections are so divided, shall be divided into blocks which shall be given the same letters or numbers or combinations of letters and numbers as are shown on the demarcation maps.

(2) The parcels in each registration section or block shall be numbered consecutively following the numbering in the adjudication proceedings, and the name of the registration section and the number or letter of the block (if any) and the number of the parcel shall together be a sufficient reference to any parcel.

(3) The Registrar may, at any time, cause registration sections or blocks to be combined or divided, or cause their boundaries to be varied.

(4) A plan may be filed in respect of a particular parcel to augment the information available from the registry map, and the filing of the plan shall be noted in the register

Correction of the Registry Map and new editions.

15. (1) The Registrar may cause to be made a survey of any land for the purposes of this Law and, after informing every person affected thereby, may cause the Registry Map to be corrected as a result of such survey.

(2) The Registrar may, at any time, direct the preparation of a new Registry Map or any part thereof, and there may be omitted therefrom any matter which the Registrar considers obsolete.

Mutation.

16. (1) On the application of a proprietor of land, and subject to the agreement of all persons affected thereby, the Registrar may order the alteration of the Registry Map, but no such alteration shall be effected except on the instructions of the Registrar in writing in the prescribed form, to be known as a mutation form, and the mutation form shall be filed.

(2) Whenever the boundary of a parcel is altered on the Registry Map, the parcel number shall be cancelled and the parcel shall be given a new number.

SESSION III

A MULTIPURPOSE LAND RECORD SYSTEM FOR ALASKA:

A FEDERAL PERSPECTIVE

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I. INTRODUCTION*

The topic of multipurpose cadastres is certainly a relevant one for this conference on surveying and mapping. In fact, as we shall see later, modern surveying and mapping techniques provide the foundation on which multipurpose cadastre systems are built. (We should note at the outset that "multipurpose cadastre" is one way to refer to land data systems structured to serve multiple uses.) Such multipurpose systems can be particularly useful as aides to decision-makers who must deal with complex resource issues. The massive effort now underway in Alaska to inventory, select, and transfer ownership rights to land and other natural resources can be greatly facilitated by the use of multipurpose cadastre systems.

The following discussion is divided into four areas. First, a review of the history of multipurpose cadastres and an outline of the specific characteristics of a multipurpose cadastre is presented. Second, examples of needs and uses that multipurpose cadastres can serve are reviewed, noting in particular the needs in Alaska. Third, the potential role of a Federal Advisory Committee in the development and implementation of a multipurpose cadastre in Alaska is considered. Finally, several suggestions of an adhoc Federal Advisory Committee that has held informal discussions will be reviewed.

II. MULTIPURPOSE CADASTRE (MPC) HISTORY

In order to establish a framework for our discussion, consideration of the history of cadastre development and review of cadastre definitions are in order. For example, Binns provides a definition that contains information on both the origin and contents of the cadastre:

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*The views expressed herein are not necessarily those of the U.S. Dept. of Agriculture or the University of Wisconsin-Madison.

> "Cadastre is a technical term for a record showing the extent, value and ownership (or other basis of occupancy) of land. The word is derived from the Latin word capitastrum which was a register of capital or units made for the Roman land tax (capitatio terrena). Strictly, therefore, a cadastre is a record of areas and values of land and of landholders for the purposes of taxation. In practice however, the cadastre serves two other equally important purposes. It provides a ready means of precise description and identification of particular pieces of land and also acts as a continuous record of rights in the land" (2, p. 14).

The earliest recorded use of cadastre-type records dates from about 3,400 B.C. (3, p. 2). Egyptian agricultural settlements along the Nile, Tigris, and Euphrates Rivers were regularly subjected to substantial floods. In order to maintain orderly agriculture production and to facilitate the collection of land taxes, the Pharaohs developed rudimentary cadastral arrangements, consisting of maps and written records on clay tables (10, p. 5). Both the Greeks and Romans later established elaborate land record systems, primarily to support the collection of land taxes.

By 400 A.D. the first register of rights to land was developed in England (2, p. 4). Within the technical limitations of the time, property was described with scrupulous care and a register was also kept, recording all deeds and mortgages. In 1085 and 1086, a second cadastre project, the Domesday Book, was completed in England. The Domesday Book, one of the better known cadastre projects, combined both fiscal and census data on land resources in a single system (3, p. 5). Furthermore, these data were organized into shires (similar to our counties) and within shires, further organized by feudal lords to facilitate collection of taxes and control by the King. Similar cadastre developments were carried out in France, by Louis VI in 1115 and by Napolean in 1807.

Recent Developments

In spite of the long history of cadastre system use, progress in the development of truly comprehensive cadastre systems has been relatively slow. Record systems containing comprehensive land data are the exception rather than rule in many parts of the world. However, several factors have combined to provide renewed emphasis for multi-purpose cadastre development. These factors include:

- an accelerating need for information about land resources that cadastre-type systems can provide,
- a rapidly increasing cost of operation for many on-going land record activities, and
- the increased availability of affordable hardware on which cadastre systems can operate.

Therefore, substantial work on the development and implementation of modern cadastre systems has been carried out during the last 10-15 years.

HUD RESPA Study

In the United States some of these recent record system development efforts have been limited to a fairly narrow approach, in an attempt to meet a specific need. Work carried out pursuant to the Real Estate Settlement Procedures Act of 1974 (RESPA) is an example of this approach. Section 13 of RESPA required the Department of Housing and Urban Development (HUD) to place in operation several model land title record systems. The primary thrust of the RESPA activity was to reduce title transfer settlement costs, therefore, the project objectives were fairly narrow:

- To facilitate and simplify land and mortgage transactions,
- To reduce the consumer cost of such transactions,
- To evaluate the feasibility of developing a national uniform system or systems of land title recordation (11, p. 1).

HUD had two additional general objectives for RESPA, (1) to ensure that the management, development, and implementation of each system remained local in origin, and (2) to ensure that the results of RESPA demonstration projects were transferrable, so the results as to documentation and software could be shared with other interested jurisdictions.

The RESPA activity was successful in achieving its local origin objective due in large part to making demonstration grants only to jurisdictions who had already made a substantial commitment to land title records improvement. It is too soon to determine if the transferability objective will also be achieved. The unavailability of documentation thus far suggest the results in this regard will at best meet with only limited success.

The opportunity to use RESPA project results for the development of multipurpose cadastres was limited by the decision to concentrate on improvements only for land title records. A similar project in the State of Kentucky focused on computerized data systems for tax assessment of real estate (5, p. 89).

NSF Assessment System Study

The Kentucky Department of Revenue was awarded a grant by the National Science Foundation for a study of computerized real estate

assessment and land records systems. In addition to the Department of Revenue, the Council of State Governments, the University of Kentucky, Battelle Memorial Institute, and several private consultants made up the project team. The inclusion of the term "land record systems" in the project title was intended to insure that broad, multiple uses, besides value assessment be made an integral part of the study. However, as the project evolved, attention focused almost exclusively on the assessment records, looking at ways to assist local governments in the development of computer techniques and statistical methodologies. A major proportion of project resources were devoted to development of complex software for use in local government assessment systems. Therefore, the broader, multipurpose objectives of the project were never realized.

USDA Ownership Monitoring System Study

Several recent projects have addressed the broader concerns that are necessary in order to develop multipurpose cadastres. One of these efforts involved the study of four alternative systems for monitoring the extent of foreign land ownership in the United States. This project was mandated by Congress as part of Section 4(d) of the International Investment Survey Act of 1976.

In the 4(d) project the characteristics of four types of information systems were described, and each of the systems were evaluated in terms of their technical, administrative, economic, legal and political feasibility (9, pp. 110-111). One of the systems studied was a network multipurpose land data system (MPLDS), that is for all practical purposes equivalent to a multipurpose cadastre.

The study described both the structure and content of the network MPLDS, and set forth several underlying assumptions concerning MPLDSs in general. An overview of these MPLDS assumptions is useful as to the understanding of multipurpose land data systems in general (6, p. 186).

First, an MPLDS cannot be justified for any single function, such as tax assessment, or the monitoring of U.S. real estate owned by foreigners. Rather, a number of functions must be presumed users, in order for an integrated system to be a cost-effective approach. Also, it is assumed that the costs of some tasks currently carried out by government will be lower when multipurpose systems are in place. For example, by combining data collection efforts, both personnel costs and data storage costs should be reduced, since fewer separate file systems will need to be maintained. A recent case study in Wisconsin regarding the public costs of maintaining government land record systems supports such assumptions (4, pp. 1-2).

An even more important benefit that can be assumed to accrue to government is the capability of carrying out new and more complex tasks than had been possible in the past. These new tasks may previously have been prohibitively expensive or technically impossible. One such new research task is the capability of making inter-class comparisons of landowners (e.g., aliens vis-a-vis non-resident citizens, resident farm landlords vis-a-vis resident farm operators, etc.). Another example in Alaska is the ability to reconcile the claims of various government (federal, state, and local) and private (corporate, partnership, individuals, etc.) owners as to specific parcels of land.

In most parts of the U.S., the major user, and therefore the major beneficiary of multipurpose land data systems is assumed to be local government. That is, occasional data needs such as the incidence of ownership and control of real estate by aliens, will require the funneling of such data to state and federal coordinating locations. However, because of the structure of our government, with land matters generally delegated to local government, and the importance of property data at the local government level, it is expected that local government offices will be the primary user and receive the majority of the benefits. As the Wisconsin study suggests, local government is where the greatest investment in gathering and managing land records is taking place.

A final assumption as to MPLDS concerns their capability to provide status as well as transaction data regarding specific classes of landownership. While the monitoring of purchases within given periods (e.g., transactions per year involving specific owner classes)., is an important capability, the ability to measure and analyze the status of ownership and control of land by classes of owner (e.g., foreign, corporate, non-resident, etc.,) is more important. This status capability would permit inter-class analyze of ownership patterns as well as comparison between given time periods and points in time.

MPLDS Structure

The MPLDS developed as part of the foreign land ownership project is a three part system, made up of fiscal, juridical, and environmental components.

The fiscal component has been described by Binns as a cadastre, composed of "a record of areas and values of land and of landowners for the purposes of taxation" (2, p. 14). We can expand this definition of a cadastre to include a juridical (or title) component, containing records of rights to ownership and control of land, and also an environmental component, containing records on physical qualities of the parcel. Thus defined, the MPLDS is a three part cadastre.

The general system structure (see Table 1), assumes an MPLDS will exist in each county or other appropriate local jurisdiction (e.g., borough in Alaska, town in some New England states). One office in each jurisdiction will provide the focal point for the data system. Because of existing data files and institutions, either the recorder or assessor would be the logical office to serve this lead role. It is not necessary that land data from files in all local government offices be added to the files in the lead function office. Rather, compatible, standardized indexing systems will be used throughout a jurisdiction, for example making possible the intra-county linkage of all land data files. The intra-county linkage of widely dispersed land data files is particularly adaptable to jurisdictions that have developed, or are in the process of developing computerized record systems.

To facilitate compilation of regional, state, and national data, local data systems should be linked through a standardized network. It is <u>not</u> necessary that such links be computerized, just so long as a standardized procedure is established to provide data needed for evaluation and decision-making by state and federal agencies. Proto-

TABLE 1--MULTIPURPOSE LAND DATA SYSTEM STRUCTURE

General Structure

Stand-alone system in each county
Build on tax record system
Compatible indexing linking offices within county
Compile county reports, using State/Federal network
Automated system
Voluntary participation
Initial inclusion of all private land

Specific Structure

Ownership parcel is basic data unit
Use unique identifying number
Maintain large-scale map set
Parcel index for each data file
Cross reference indexing to facilitate access via multiple systems
Eventually add coordinate-based description for each parcel

types for state networks of county systems exist in the foreign ownership reporting systems currently operating in Iowa and Minnesota (13, pp. 40-44).

Table 1 also contains a list of specific structural components of the network MPLDS. These include, (1) use of the ownership parcel for the basic data unit, (2) unique parcel identification system, (3) large scale maps, (4) parcel indexes for each land data file, (5) several cross-reference indexing systems, and (6) coordinate-based parcel descriptions when the MPLDS is fully developed.

MPLDS DATA CONTENT

The data content of the three cadastres is described in Table 2. The data description assumes existence of the system structure outlined above. Also, the data content is described in terms of the complete, ideal MPLDS. Clearly, major improvements would result from implementation of multipurpose systems, even if only a portion of the data items proposed here are included.

Fiscal Cadastre

Three major types of data items are proposed for the fiscal cadastre, concerned with either the owner, the parcel (land or structure), or latest transfer. Also, the contents of the fiscal cadastre described in Table 2 are in general terms (as are the descriptions of the juridical and environmental cadastre described below). Therefore, while the specifics of such items as name and address are readily apparent, other items conceal a wide range of detailed information. For instance, characteristics of structures include a data base sufficient to drive a complex multiple regression value assessment system. Land use of the

TABLE 2--MULTIPURPOSE LAND DATA SYSTEM DATA CONTENT, BY CADASTRE SUBSYSTEM

Item	Contained in:		
	Fiscal	Juridical	Environ-mental
Owner			
Name	x	x	
Address	x	x	
Residency	x	x	
Citizenship	x	x	
Type	x	x	
Total holdings	x		
Seller			
Name		x	
Address		x	
Parcel			
Identifiers	x	x	x
Land:			
- description	x	x	
- location		x	
- size		x	
- current land use	x	x	x
- planned land use			x
- zoning	x	x	
- liens		x	
- value	x		
- special assessments	x		
- special exemptions	x		
- ground cover			x
- soils			x
- topography			x
Structures:			
- type	x		x
- value	x		
- characteristics	x		
- building permits	x		
- building inspections	x		
Transfer			
Date	x	x	
Type	x	x	
Recorded documents	x	x	
Interest acquired		x	
Price		x	
Seller name	x		
Seller address	x		

parcel provides for a number of categories for both current and planned uses. Similar detail on zoning is possible, depending on the complexity of the zoning ordinance in use.

In comparing the network MPLDS fiscal cadastre with current systems in local government, several points are clear. First, some of the data suggested for the ideal fiscal cadastre are already contained in the data systems maintained by most local assessors. Owners name and total assessed value are examples of such items. Second, some of the items are found in a few operating systems (e.g., those using computer-assisted systems to assess property.). Items concerned with the size and quality of the structure, as well as quality of the neighborhood are examples of these items. All of the suggested data would be useful, either to assessing officials or other present and potential users who would benefit from having access to such data. The residence, address and citizenship of owner and taxpayer, as well as applicable land use classes are examples of such items.

The data items related to structures have been more clearly defined for single family residential parcels. This is due to the predominance of such parcels in most jurisdictions, as well as a growing capability to use these data in computer-assisted value assessment systems.

A major difference between the fiscal cadastre and current assessor files is the provision for time series data in the fiscal cadastre. That is, the contents of assessor files generally pertain only to current conditions, values, etc. By maintenance of historical files, the fiscal cadastre will facilitate the analysis of changes over time (e.g., as to market value, assessed value, and land use).

Juridical Cadastre

Whereas the fiscal cadastre is concerned largely with data related to assessment and tax collection, the contents of the juridical cadastre relate largely to questions of ownership of each land parcel in the geographic area included in the cadastre.

As was the case in the fiscal cadastre, some of the suggested data in the juridical cadastre are already included in title record systems in many jurisdictions. Examples of such data include the name of the owner (grantee) and seller (grantor), the interest acquired (owned), the date of transfer of specific property rights, the property description, and an index to information contained in the title record system.

Some of the data suggested for the ideal juridical cadastre are found in some presently operating systems though usually not uniformly found even within a given jurisdiction. Examples of such items include address of owner, type of owner, type of transaction, and liens against the parcel. It is proposed that these items be available in the juridical cadastre for all parcels.

Several suggested data items are not currently available, or if so, only infrequently. Examples include residence and citizenship of owner, zoning in effect, land use, and several items that are currently "non-record" (i.e., they are usually not recorded). The items suggested for the juridical cadastre apply in general to all types of real estate, ranging from single family residences to farms and manufacturing plants.

Use of the land record system for monitoring and analyzing the status of ownership (i.e., who owns what at a given point in time),

will require changes in both content and operation of the present land title record system. Presently, the title system is organized to record each transfer of property rights. Evaluation of a title involves examination of the series of transfers (i.e., the chain of title) concerning a parcel, to be certain there are no breaks in the chain. The chain of title system is seriously deficient as to such tasks as determining the status of ownership at a given point in time. Therefore, to answer such questions, new data, such as the network MPLDS includes, must be compiled and currently collected data must be linked in order to permit a fast, accurate response to such inquiries.

Environmental Cadastre

A relatively small number of data items for the environmental cadastre are outlined in Table 2. If resources, support, and need are all displayed, this cadastre could easily become the largest of the three. These data are concerned primarily with the physical characteristics of the parcel (e.g., whether a house or other structure exists on the property, the existing land use, ground cover, and land use regulations that exist). In addition to parcel identifying number, several geographic area designators are included (i.e., school district number, census tract and census enumeration district numbers). When all three cadastres are fully operational, and when appropriate overlay software are available, these area designators can be eliminated from the individual cadastre record. This elimination will be possible if two assumptions are realized. First, the parcel identifiers used will be in terms of geographic coordinates. Second,

software will be available to facilitate the generation of the area designators, based on a description of the particular area (e.g., school district), in terms of the same coordinate system as is used in the parcel identifier system. Until such time as these capabilities are available, the area designators should be maintained with each cadastral record.

National Research Council Study

A second recent activity that is of major importance to the development of improved land record systems, is a study by the National Research Council's Panel on a Multipurpose Cadastre (10).

The National Research Council is the research arm of the National Academy of Sciences. The Panel on a Multipurpose Cadastre spent over a year studying the need for a multipurpose cadastre (MPC), what it should look like, and what the local, state, and federal roles in such systems should be. The final report of the Panel is in strong support of many of the conclusions of the USDA three part conceptual system outlined above. Note for example, the components of an MPC outlined in Figure 1.

- Geodetic survey reference framework (a network of surveyed points on earth's surface).
- A series of current, accurate large scale maps.
- Cadastral overlay (essentially a map of ownership parcels).
- Linkage mechanisms

  (These include:

  - Ownership parcel as basic cadastral unit
  - Parcel identification systems
  - Parcel locator numbers

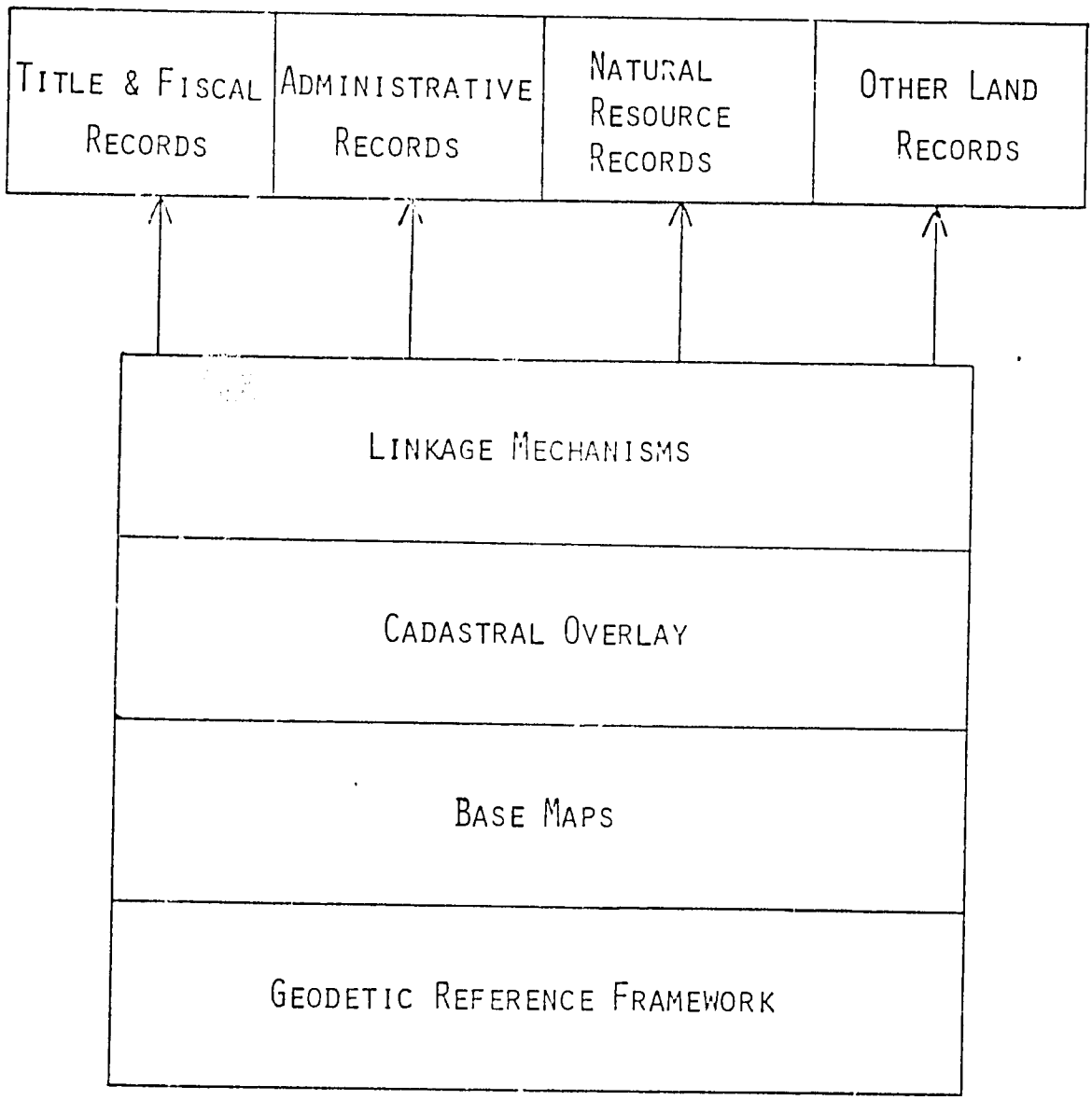

FIGURE 1. COMPONENTS OF A MULTIPURPOSE CADASTRE

Source: (10, p. 14)

- Parcel description
- Uniform data identification

  (i.e., all data carries at least one identifier.)

The MPC panel report also included a number of conclusions regarding the role of local government in the development and operation of MPC's, as well as suggested requirements to insure maximum efficiency of such systems.

- Development of a MPC will require reorganization and quality control of existing governmental functions, rather than creation of new functions.
- Gradual, phased implementation is necessary (because legislative and budgetary processes of government tend to address short term problems, rather than long term improvements).
- Each county should provide a mechanism to coordinate the numerous county offices involved in a MPC (e.g., recorder of deeds, county surveyor, assessor, planner, abstractor, etc.).
- The content of land records are usually more related to functions of local government than to state or federal agencies.
- Most operations as to specific land parcels occur at the local government level (county or municipal).

The Panel also made two recommendations regarding the role of local government (e.g., county, city, borough) as to MPC development and operation:

- Local governments continue to be the major access point for local land information.
- Local governments should have the primary responsibility for developing and maintaining the MPC in their community.

Finally, the MPC Panel reached several conclusions as to requirements for efficient land information systems in general:

- Establishment of coordinating mechanism for existing land-related functions. (We will return to this point later.)
- Standardization of procedures and terminology to assure efficient acquisition, storage, maintenance, and retrieval of land information and records.
- Preparation and maintenance of a system of base maps and cadastral overlays that meet MPC standards.
- Creation and maintenance of a land parcel register, including a unique parcel identifier, position of the parcel in a common reference frame, and data from boundary surveys, including boundaries of any easements or use restrictions.
- Coordination with private sources such as utilities, transportation systems, title insurers, and abstractors.

The MPC Panel report also outlines appropriate state and federal roles for MPC development. Included for state government are recommendations related to coordination, standardization, guidance, and cost-sharing. A second National Research Council study on MPC's has recently been completed. The final report of this second study, entitled Procedures and Standards for a Multipurpose Cadastre, will be available soon.

III. CAPABILITIES AND USES OF MULTIPURPOSE LAND DATA SYSTEMS

A brief review of the capabilities of a multipurpose cadastre is relevant for an understanding of the possible capabilities and benefits of such systems. Table 3 contains a list of a number of functions that can be served by a multipurpose cadastre. Several of these functions are discussed in this section, both in general terms and in specific benefits and uses that are applicable to Alaska.

TABLE 3--FUNCTIONS SERVED BY A MPC

Assessment	Regulation
Title	Public Land Management
Surveying	Public Policy Research
Mapping	Public Program Research
Land Use	

Assessment

A number of functions are routinely the responsibility of local government, one of which is the assessment of real property and the collection of taxes based on this assessment. Traditionally, the assessment function includes several distinct tasks, such as listing, value assessment, equalization, billing, and collection.

The first step in property assessment is compilation of a complete list of all taxable parcels in the jurisdiction. The basic purpose of the assessment list is to ensure that all parcels are included and assessed. A MPC that is regularly updated, particularly as to subdivisions, consolidations, and additions of improvements, will provide the requirements for the assessment listing task.

Valuation, a second assessment task, is one of the largest and most complex tasks of local government. As pressures increase for more

uniform procedures and assessment, computerized assistance for valuation will continue to expand. Data for a number of variables must be collected, stored, and retrievable for each parcel, to permit use of multiple regression and similar techniques. The fiscal cadastre component of the MPC will be necessary if most jurisdictions are to handle the valuation task efficiently.

A number of other assessment tasks can be performed more cheaply and produce a higher quality product using MPC. These tasks include equalization (i.e., the adjustment of assessed values to a common base), billing, and collection. Because of the relatively heavy use of computers in the assessment function, this area should be one of the leaders in development and implementation of the MPC.

Land Title

The land title function includes two major tasks, maintenance of title records and title evaluation at time of transfer. The MPC can simplify and improve the quality of both of these tasks.

In the U.S., maintenance of title records is the major job of recording fficials. This task includes maintenance of copies of all land transfer documents, as well as index systems to facilitate the retrieval of documents related to each transfer.

A juridical cadastre will involve the use of geographic identifiers for referencing all parcels and related documents, rather than by name of the seller or buyer, a common current practice. This change will allow recorders to index, file and retrieve documents more quickly and with less chance for error. Also, other local government offices, such as the treasurer, clerk, and clerk of courts will be able to use the

same system for their records, thus making their files compatible with the recorder. This compatibility will increase ease of storage and retrieval and thus efficiency of all involved offices.

The evaluation of the quality of title, required at time of transfer, is almost always carried out by the nongovernment sector. Therefore, title insurers, abstractors, and lawyers who evaluate titles will benefit from the vastly improved juridical component of the MPC. Again, these improvements will result from the reduction of errors in indexing and storage, and in the increased speed with which documents can be retrieved.

The capabilities of an MPC for handling land title records and information is important in all parts of the United States. However, the benefits in the land title area are probably more important in Alaska than in any other state. This importance is due to a number of factors, including the size of the State and the vast natural resources in the State (8, pp. 2-3). However, the most important need for an MPC in Alaska at this time is to deal with the massive land transfers that are now occurring.

Two major legislative acts, the Alaska Statehood Act and the Alaska Native Claims Settlement Act (ANCSA), have triggered a massive land transfer process. These two statutes alone call for ownership transfer of two-fifths of the land area of the state within a 25-year period. The evaluation and selection process probably pushes the land area involved to well over 50 percent. A large number of transfers, partial estates, and tentative applications both to and from the State

have been generated. Oil discoveries and substantial increases in the price of minerals have also resulted in increased activity in mineral claims, which tend to complicate the land title record system. Therefore, the demands on Alaska's land title system are currently greater than any other state.

In spite of these large demands, the opportunity for and likelihood of major advances in land title record systems are also greater in Alaska than any other state. For instance, most land is still in state or federal ownership. Therefore, a modern land title system initiated now can incorporate most private land transfers. Second, recent extensive surveying and mapping activities can provide the necessary spatial framework for land title descriptions. Third, since Statehood, the land title recording system has been an integral part of and coordinated by the Divison of Technical Services within the Department of Natural Resources. Therefore, the recording system is much less diverse than systems in the lower-48, where there is little or no state involvement. Finally, there is an interest by all levels of government, ranging from boroughs such as North Slope, to departments within the state, through Federal agencies, such as BLM and SCS, to actively work to ensure the best possible land record system in Alaska. These factors are present in a combination that simply does not exist anywhere else in the United States.

Surveying

Surveying is another major user of an MPC. As used here, surveying includes all activities used to determine the shape, size, and location of land parcels and survey monuments relatable thereto, by using linear and angular measurements and applying the principles of geometry and trigonometry. Surveying uses of the MPC will range from the highly precise first-order geodetic control network to property surveys of individual land parcels.

Several generalized uses of survey data will be possible with the MPC. For instance, the location of individual monuments, points, and lines can be stored in a format to facilitate their use. Once accuracy and precision standards are in place, computerized manipulation of survey location data can be used for detailed analysis of particular projects.

Implementation of the MPC can also be expected to improve the quality of survey data itself. First, uniform recording and storage systems should help improve the accuracy of surveys. Certainly, the accuracy of surveys in relation to each other (e.g., reduction in gaps and overlaps), can be expected to improve. Second, widespread, easily accessible survey data should reduce the need for wasteful duplicative property surveys that are often required under the current system.

Much survey activity has been completed in Alaska in the last 20 years, and much more is underway or planned. This concentration of survey activity can provide extra benefits if results are organized in an MPC. Conversely, many of the benefits of these survey activities may well be lost if the results are not competently organized, as in an MPC.

Mapping

Maps range widely in terms of scales, information, and detail. The obvious waste in the current system due to duplication and limited applicability of data for alternative uses due to inappropriate scales, is one of the reasons that mapping uses will be a major beneficiary of the MPC.

Mapping serves two major functions in the MPC. One, substantial amounts of data currently available on maps can be placed in the MPC data base by use of digitization technology. Two, the usability of most land data is measureably enhanced if graphic display of specific data are possible. Specific output needs can be satisfied by altering such factors as the area to be included, boundaries, scale, features, and detail of the material to be displayed. This capability permits retrieval of only data needed and also provides for the display of these data in the most usable form and format.

Users of the mapping capabilities of the MPC range from resource planners to owners of individual land parcels. While MPC users have current access to similar data, the MPC is expected to provide the needs of many new mapped data users as well.

Land Use

The environmental cadastre includes data on the status of land use and planning. Data on the status of land use includes descriptions of current landownership patterns (class of owners, size of parcel), current land use patterns (residential, agriculture, or specific crops), land capability patterns (based on soil classes, moisture availability), land cover patterns (plant species, forest cover), and wildlife patterns (species monitored in given areas).

Planning data, the second major category of land use data, result from the analyses of status data by planners and the creation of a plan of what could, should, or might be the future land use. As such, planning data may include status data, usually subjected to analysis and assumptions, to estimate or suggest the future direction for a specific area. Physical data are often combined with socio-economic data and policy objectives to produce a land use plan.

The MPC will provide a data base that will serve planning with much less duplication of data collection and stored data files than is currently the case. The key factor is use of the parcel based system, coupled with coordinate identifiers for each parcel. With the increased planning requirements for many State and federally sponsored programs, it can be expected that planners will be a major user (as well as data provider) of the MPC.

Public Land Management

Another task the MPC can fulfill concerns the management of public lands. Because of the large proportion of public land owned by the Federal government in the U.S., (34 percent of all lands, 85 percent of all public lands), a great majority of the use of the MPC for land management can be expected to involve Federal agencies. However, because state, county, and municipal governments own 155 million acres, the MPC can also expect state and local government to be a major user of the data base it provides. Because of the substantial proportion of land currently owned by the State of Alaska and the large increase in state-owned land that will occur in the near future due to the Statehood Act, this land management capability is especially important to the State of Alaska. The following

example of use of the MPC by a Federal agency exemplifies the potential for improved land management capability for all related users in this area.

The U.S. Forest Service has given high priority to improving boundaries and boundary records of land under their jurisdiction. The Forest Service administers nearly 188 million acres of public lands that involve 272,000 miles of property boundaries, over 1.4 million property corners and tens of thousands of land parcels (13, p. 40). Currently boundary disputes are resulting in losses of timber sales of about $25 million annually. Pending trespass cases will cost about $112 million to resolve (13, p. v). A system capable of accurately maintaining the parcel boundary file would produce substantial benefits to the Forest Service in terms of savings of personnel, time, and reduced number of conflicts that require lengthy court proceedings.

Public Policy and Program Research

One final function the MPC will serve concerns research on potential policies and on-going programs, particularly Federal programs. Because of the standardized framework the MPC will provide the most cost-effective way to more clearly define particular resource issues where a policy decision is needed. Also, the MPC will provide the base for consideration of several alternative policies by decisionmakers. For example, the MPC will provide the capability to quickly obtain estimates of the impacts of proposed alternative solutions to a particular policy problem. Answers can be obtained to hypothetical questions by manipulation of data stored in the MPC. Finally, the MPC should improve the quality of the policy that is finally selected for implementation.

Federal, state and local governments will all find the policy evaluation capability outlined above useful. Also, the system will provide the basis for explanation of the policy to the general public. A clear, concise explanation of the policy to be implemented, the reasons it was selected, and government expectations of the policy should result in a clearer understanding and more rapid acceptance of the policy.

IV. FEDERAL ADVISORY COMMITTEE

The previous discussion of the structure, capabilities, and need for multipurpose cadastre systems has suggested there will be numerous beneficiaries when such systems are successfully implemented. Among the beneficiaries will be local, state, and federal government agencies, native corporations, private corporations, and private citizens. Because of the nature of our governmental structure, state and local governments will have the major roles in development and operation of multipurpose cadastres. At the same time, federal agencies have much to gain and much to offer in regard to multipurpose cadastre development.

Federal agencies have a long history of successful management of federally owned land resources in Alaska. While substantial acreages are being transferred to the State (and some on to private owners), the federal agencies will continue to be responsible for managing substantial Alaska land for the foreseeable future. Therefore, because they are knowledgeable about the resource base and because they need a better data base for decision-making, federal agency personnel can and should provide substantial guidance and assistance in the development of multipurpose land data systems. One way to provide this guidance and assistance is through a Federal Advisory Committee.

Similar efforts in the past demonstrate that such a committee is workable. For example, in the mid 1970's, the Joint Federal-State Land Use Planning Commission was successful in collecting resource data and making initial efforts to develop comprehensive data storage systems (1, p. 3). A Federal Advisory Committee on land data systems could work closely with the Committee on Natural Resource Information Management (CONRIM) or similar groups in order to maximize the effectiveness of all concerned.

While the Federal Advisory Committee idea is still in the proposal stage, a number of federal agencies and federal agency personnel have been cooperating on an adhoc basis for the last six months. The Ad Hoc Committee has examined several issues of the type a Federal Advisory Committee would consider.

Some preliminary conclusions developed for three technical and educational issues are outlined below. These discussions and conclusions are not necessarily <u>the</u> answer in these three areas, but rather indicate the approach and kind of expertise that federal agencies could bring to bear on the many land record issues with which Alaska is faced.

<u>Multipurpose Cadastre Education Component</u>

Jerome Smith, of the Department of Housing and Urban Development has outlined the conceptual framework for an Education Committee for the Multipurpose Cadastre (12). Smith suggests a number of institutional constraints and issues that tend to support the status quo, as opposed to the development of an MPC. An education program is proposed that would develop public and private awareness and support for an MPC. A committee of potential MPC users and government staff is suggested. and an extensive list of potential MPC user groups is provided.

A detailed plan for the development and operation of the Education Committee is also included.

Current Status of North Slope Borough Mapping and Geodetic Control

Last year Douglas J. Wilcox, of the Department of Interior, examined the current status of mapping and geodetic control in Alaska's North Slope Borough (15). The purpose of this review was to provide recommendations as to additional geodetic survey work needed. Particular attention was given to geodetic control needs for new large-scale cadastral mapping and for digitizing existing topographic maps as well as any future cadastral maps that become available.

Wilcox concluded new geodetic surveys will be necessary (15, p. 3). The extent of needed surveys will depend in part on the usability of previously established geodetic control monuments. Final determination of new survey need depends also on the map requirements that are established for the MPC.

Wilcox also recommended "---additional analysis on how the current doppler and inertial surveys done by BLM might be improved in accuracy to be accepted by the Federal Geodetic Control Committee (FGCC) ---" (15, p. 3). Such analysis is necessary to determine the most cost-effective way to meet accuracy standards. Wilcox concludes that the MPC Map Accuracy Standards proposed at the Third Alaska Conference on Computer Graphics and Geoprocessing be used as an interim standard for the MPC that is being developed for the North Slope Borough (15, p. 4).

Land Unit, Land Unit Identifier System

Because of past work in MPC development generally, and identification systems in particular, I was asked to consider possible land unit and land unit identifier systems for use in MPC for Alaska (8).

In this evaluation, it was assumed that the land unit identifier serves two functions:

1. To uniquely identify each land unit in a system, and
2. To link various data about the unit to the individual land unit record (8: p. 6).

It was concluded that because of the complexity of the Alaska land record environment, the basic land unit for any multipurpose system developed must be more general than the typical parcel owned by a private citizen. Other studies were reviewed that suggested that in the long run, a geocode identifier based on geographic coordinates, is probably the best method for identifying land units. However, because of the cost of implementing and operating such a coordinate system, a more simple, less costly approach was recommended for the present time.

It is suggested that the Public Land Survey System (PLSS) be used as the framework for the land unit/land unit identifier system in Alaska. The 640 acre section would be the basic unit in the system. The identifier assigned to each unit (section) would be based on the standard meridian, township, range, and section nomenclature. In cases where units cover more than one section, the data file for each sectional unit would include a listing of other sections that were part of the multisection unit (e.g., this might occur in case record files of DNR or BLM.). One option that should be considered here is to use the same geocode unit identification system that BLM currently employs. In areas where density (of people, resources, or uses) dictate, the identifier could be made more precise by extending it to the 1/4 section, 1/4 1/4 section, 1/4 1/4 1/4 section etc (8, p. 8).

The PLSS based identifier was evaluated by examining it in comparison to several pre-established criteria. The conclusion reached was that for the present time, the PLSS based system is a suitable land unit identifier for Alaska in terms of simplicity, uniqueness, flexibility, accessibility, and economy.

CONCLUSION

A modern multipurpose land record system is needed in Alaska. The state's needs, as evidenced by the land transfer and resource management problems that presently exist, require application of the best thinking and latest technology available. Fortunately, a number of programs that will support and/or be part of a multipurpose cadastre are already on-going. These include, among others, a state coordinated land title system, availability of remotely sensed imagery for large parts of the state, an active geodetic survey program, and widespread interest at all levels of government in land data system improvement. Continued coordination and cooperation among all parties involved are also important. The formation of a Federal Advisory Committee can provide both improved system coordination and improvements in the data base for all users. Both are critical to the long run success of multipurpose cadastre operation.

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WESTPORT LAND RECORDS MODERNIZATION PROJECT: RESULTS AND IMPLICATIONS

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WESTPORT LAND RECORDS MODERNIZATION PROJECT: RESULTS AND IMPLICATIONS*

ABSTRACT

Presented are results and implications obtained from an interdisciplinary project which is focused upon the modernization of large scale land records through institutional reform, improved economies of positional

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* The Westport Land Records is an interdisciplinary research project. Participants are provided support by the Dane County Regional Planning Commission, the Wisconsin State Cartographer, the Departments of Civil and Environmental Engineering and Landscape Architecture, and the U.S. Department of Agriculture-Natural Resources Economics Division. Primary funding is from a U.S. Department of Agriculture, College of Agricultural and Life Sciences HATCH (CSRS 5146 grant.

technology, and emerging trends in computer technology. The results include the spatial merger of ownership and resource records, the planning opportunities and applications of such data mergers, and the implications concerning resultant problems concerning spatial reliabilities and accuracy. Overall implications to planning and computer related professions are provided.

PART I: ISSUES ADDRESSED

Modernization of large scale (1:400 to 1:24,000) land records in North America is being driven by the concurrent emergence of institutional reform, improved economies in positional and informational technology and the general need to improve archaic land record procedures. This overall trend has been characterized this way:

> "..we are in the process of and witnessing a change in geographic and cartographic technology and its utilization in public administration surely as significant as that manifested by Napolean's cadastre, and for the same reasons: ground swells in the demands placed on governments for programs, services, and controls, and a concomitant increase in technological capability. We are witnessing the initial period of a third order marking the confluence of government and technology. (Mitchell, 1980)

To address, as Mitchell suggests, this "change in geographic and cartographic technology," participants in the Westport Project addressed the following issues in relation to modernization of land records. For the purposes of introduction, a brief discussion of each follows:

definitions -- the development of common definitions for various terms and concepts. This is being accomplished to bring some semblance of codification and order to a presently confused situation. This confusion is a particular problem when various discipline's attempt to communicate and establish understanding. For example, the following is our operational definition for the term "land records":

> Those spatially related documents that record governmental interest in the physical, legal, and environmental aspects of the land - whether in, on, above or under the surface of the earth.

Additional terms have also been defined (see Appendix A).

In addition, the Westport Project has focused upon those large scale records which are defined by Dueker

(1979) and Kilpack (1982) as routine governmental responsibilities such as land tenure and economic records in contrast to non-routine responsibilities such as one time land use modelling efforts (see Table 1).

TABLE 1: TYPES OF COMPUTERIZE LAND RECORDS SYSTEMS

Non-Routine	Routine
Abstract boundaries (e.g., land forms)	Non-abstracted boundaries (e.g., state, county, township boundaries)
Qualitative evaluation (e.g., solid waste disposal siting)	Social Records (e.g., Census)
Land Use Modeling (e.g., electrical transmission corridor selection)	Economic/Fiscal Records (e.g., tax parcels)
	Land Tenure Records (e.g., property boundaries rights and encumbrances)
	Environmental Records (e.g., soil surveys)

This distinction is useful for both understanding differences between various type records plus the different computer systems which support these two different types of records.

perceptions and attitudes towards modernization -- the survey and analysis of those involved and responsible for land record collection, management and/or use focused upon each groups' perceptions and attitudes toward land record problems and modernization. The need for this survey is based upon the assumption that modernization will require the participation of many groups. Understanding each group's attitude is an essential first step toward gaining their involvement (for additional information see Portner and Niemann, 1982).

trends in modernization -- modernization of land records is being precipitated by various trends including the explosion of computing in general and specifically due to cheaper memory, more friendly interfaces, the apparent efficiencies of computing for records management, and the development of quite sophisticated graphic and mapping technology. In response to this computer technology, plus concern for the archaicness of existing land records, governmental institutions at the federal, state, and local level are beginning to respond to issues of modernization. In addition, improvements in positional

technology are making large scale land records improvement both technically and economically feasible.

positional transformation and integration -- the advent of digital computing, the expansion of positional technology, and technology which allows for digitization of spatial records, provides for the ability to spatially merge a variety of records from various sources and various scales. The development, testing and evaluation of such procedures are important components of any modernization system.

development of large scale (1:400 - 1:24,000) digital data bases -- a primary activity has been the digitization of various large scale records including ownership/taxation boundaries, and various resource records including prime agricultural land and wetlands. This was accomplished to determine the problems involved, and to investigate the local and regional planning applications of such data bases.

spatial merger of resource and ownership records -- the spatial merger of propietary or tenure interests in land with the quantities and qualities of various natural

resources has been a missing element in most land modernization efforts. This merger was accomplished also to determine the problems involved and to evaluate the potential applications and implications of such a merger.

applications in rural landscape planning -- a scenario for the selection and preliminary design of subdivision. This provided a process by which to utilize various digital data bases, test various forms of comnputer graphic technology, plus merge various land records.

accuracy and reliability of digital records -- the advent of computer technology and the development of transformation procedures has resulted in the ability to spatially and statistically merge a variety of land records. The resultant spatial accuracy/precision of such transformations was addressed as well as the reliability of various land record mergers.

incremental and mutational solutions to modernization -- land record modernization is being pursued in a variety of ways. Some procedures include extensive comprehensive mapping and digitization programs; and some are more geographically incremental. The former are initially expensive and the later less expensive, but possibly not

as efficient in the long term. Comparisons between comprehensive systems are discussed in relation to more incremental approaches.

PART 2: TRENDS IN MODERNIZATION

A. Federal, State and Local Activities

There are both insitutional and technological trends in North America which are (a) resulting in the modernization of large scale land records, and (b) developing integration procedures of these records with particular focus upon cadastral or ownership records as an essential data set.

For example, institutional interest exists in various forms including research groups such as universities and the National Research Council, various professional organizations, and even the Office of Management and Budget. As a result, a variety of wide-ranging activities and public organizations over the past twenty years have emerged. This has been summarized by various authors including Clapp and Niemann (1977) and McLaughlin (1981).

Significant private organizations have as well been active (Petersohn, 1981). Extensive bibliographies have been developed on various aspects of the subject by Moyer (1978) McLaughlin (1975) and Booz, Allen and Hamilton, Inc. (1979). Summaries of National conferences and symposium which have focused upon land records modernization problems have been published by Cook and Kennedy (1967), White (1968), Konecny (1969), Philips (1975), and MOLDS (1979). And in 1980 a specific conference was held on the actual interface or merger of large scale cadastral records with planning, and resource and engineering records (Clapp and Niemann, 1980).

federal activity

Government interest at various levels is emerging. Intial concern at the federal level with land records improvement resulted in a variety of recommendations in 1973 from the Office of Management and Budget Task Force on Mapping, Charting and Geodesy (National Research Council,1973).[1] In addition, the Council of State Governments has sponsored a series of studies which have addressed integration and modernization improvements (Patton, 1975).

[1] This report and resultant recommendations were since updated. See Federal Surveying and Mapping: An Organizational Review, National Academy Press. 1981.

Most recently there has been considerable activity within the National Research Council. In 1980 the National Academy of Science's Committee on Geodesy published a report on the Need for a Multipurpose Cadastre (National Research Council, 1980). This panel concluded that

> "there is a critical need for a better land information system in the United States to improve land conveyance procedures, furnish a basis for equitable taxation, and provide much needed information for resource management and environmental planning"

The panel made the following six recommendations:

1) Federal legislation should be prepared to authorize and fund a program to support the creation of a multipurpose cadastre in all parts of the Nation and that the Office of Management and Budget designate a lead agency for the multipurpose cadastre.

2) Technical studies should continue to be sponsored by the federal government to identify consistent land information and display standards for use among and within federal agencies and between federal and state governments. These studies should rely on the

authority of state governments to adopt the standards and organize the data collection, in cooperation with the federal government to ensure compatibility on a national basis, delegating these functions to local government where appropriate.

3) Each state should authorize an Office of Land Information Systems, through legislation where necessary, to implement the multipurpose cadastre.

4) Each county government (or municipality where appropriate) should create an Office of Land Information Systems in coordination with such offices as the recorder of deeds, county surveyor, assessor, planner, and county abstractor, if any.

5) Local governments should be the primary access point for local land information.

6) Support should be provided by the federal government for the establishment of a center or centers of excellence in land information science, for the purpose of providing a program that develops scholars and professionals. The curriculum should include direct experience with land data systems problems.

Since this 1981 report another panel on the multipurpose cadastre has been convened to address and focus upon issues of implementation. Their report is complete and pending review. Also in 1981 the National Research Council established a Committee on an Integrated Land Data Mapping. This committee is addressing issues of spatial integration of digital cartographic information with the modernization of the cadastral foundation of much of the U.S. - the Public Land Survey System (PLSS). Their report has been reviewed and is pending publication.

State Activity

As federal interest emerged, concurrent activities followed at the state level. It was focused upon state interest and responsibility and federal program responsiveness to the state's needs. In this regard, the Council of State Governments conducted a series of three case studies. These case studies were funded by the Resource and Land Investigations program (RALI) of the U.S. Department of the Interior; they were focused upon the more general concern "about the avilability of adequate land use data and land information within government for land and resource planning and management." The three case studies were conducted in the states of Connecticut, Texas and Wisconsin; of the three, the Wisconsin project was unique in that it (a) documented

a set of problems generic to most land records; (b) included and evaluated all land record producers including the semi-public utilities; and (c) identified the costs from the perspective of the taxpayer to assemble and maintain the local, state and federal land records activities for the state of Wisconsin (Larsen et al., 1978).

Basic Land Records Problems

In the initial part of the study, land record users, producers, and managers were asked to identify land record problems and land records which exemplify such problems. Seven problems emerged: accessibility, availability, duplication, aggregation, integratability, confidentiality confidentiality, and institutional structure. When these seven problems were compared with land record products, it was evident that existing land records were frought with the identified problems.

Land Record Producers

Traditionally evaluation of land records has focused upon a federal agency, a level of government or a particular geographic entity. Focusing upon all public and semi-public land record producers resulted in, for the first time, a citizen perspective of the magnitude of the

land record fragmation and functional overlap among existing state structures and among state, federal and county levels of government.

Land Record Costs

A third and equally important component of the Wisconsin Case Study was to approximate the cost to collect and maintain Wisconsin's land records from a citizen or taxpayer's perspective. Annual per capita land records costs were estimated for local, state and federal units of government including the semi-public utilities. It was found for fiscal 1976 that Wisconsin's 4.4 million residents paid approximately $17 each for information about the state's 35 million acres of land for a total of $78,730,306. This consisted of $25,349,545 for federal activities, $11,582,818 for state, $41,117,989 for local and $10,679,954 for the semi-public utilities. In total this is equivalent to about $2.25 per acre. Also, since 1976 there is nothing to suggest that this public investment in land records has not continued at the same rate.

Besides the 78 million annually, the other major finding of the study was the level of investment for land records at the local level of government, or $8.89 per resident. This amounts to over one-half the annual expenditure. At the time this was surprising, but in retrospect

the results should have been obvious. Local government by its delegated responsibility is responsible for land taxation, school maintenance, land zoning and regulation, and the registration and recordation of property rights. The land records cost of these responsibilities appears to be reflected in the cost per capita.

The Wisconsin Case Study resulted in the following seven recommendations:

1) Land data collection should be at the lowest possible governmental level that has the technical ability to collect it accurately and efficiently.

2) Land data should be aggregated up from that lowest level to the higher levels of government.

3) Standard-setting for land data collection and display should be at the higher levels of government, to assure effective compilation and comparison among jurisdictions.

4) Each level of government, and each agency on each level, should be able to overlay or otherwise interrelate their land information, the usual method for doing this being a geographic reference system that is mathematically based.

5) Land information should be accessible and usable by all governmental agencies and levels.

6) One governmental entity on each level should be responsible for land records management and land information improvements.

7) Publicly held information about the land should be easily accessible to citizens, under uniform confidentiality standards consistently applied.

Local Activity

Large scale land records modernization appears to be particularly active within local government such as cities and counties. As the results of the Wisconsin Land Records study suggest, this is where the investment in large scale records exists, where much of responsibility resides, and most of the modernization is needed. Local government is also responsible for the cadastral or ownership record which has been a prime focus for modernization. Activity has been varied ranging from and including comprehensive efforts such as in Racine County in Wisconsin (Bauer, 1980), Fairfax County, Virginia and Lane County, Oregon to more subtle incremental approaches such as the recent elimination of the county surveyor as an elected position in Dane County, Wisconsin (Thompson,

1982). For example, the elimination of the elected position of surveyor was justified by the County Executive to assure more effective use of limited resources. He said:

"Dane County's archaic system of keeping land records is due for an overhaul officials say..." In justifing the action, the officials said,

> "Currently anyone who wants to learn about a piece of land must shuttle back and forth between several departments, some of which are saddled with written records reminiscent of the 19th century."

Besides the arguments of archaicness, improved efficiency was an important campaign theme and a modernized system has been envisioned by the County Executive, Jonathan Berry, to be a

> "one stop service for people seeking information about property, including ownership, zoning, judgments, back taxes and the like."

He goes on to say this action is

> "...the first step toward updating the county's entire record-keeping system..." and,
> "it spills over into other areas"...
> "The key to bringing the county into the 80's with computers starts with the land." (emphasis supplied).

In essence, there appears to be considerable activity at all levels of government focused upon large scale land records modernization, and this is primarily due to the need to modernize cadastral or ownership information.

B. Positional Technologies

Since the beginning of the race to space twenty-five years ago, we have witnessed profound changes in informational technology. A subset has been the development of positional technologies both for space exploration and military applications. The recent military crisis in the Falkland Islands provides an explicit example of the military implications of positional technology. As reported by the press, the sinking of the British destroyer Sheffield by a French Exocest missile was accomplished by obtaining a positional fix from a Russian satellite and relaying the geographic coordinate to an Argentine aircraft. Within four hours of Russian observation, the ship

had been located positionally, hit and sunk. These space and military developments, plus the evolution of laser technology has provided opportunities for obtaining very precise positional measurements of geographic features. For example, the applications of this technology will result in the readjustment or more precise definition of the datum and shape of North America.

Modernization of large scale land records and particularly the spatial integration of various records is dependent upon a foundation and densificiation of positional geodetic coordinates. This densification of geodetic coordinates remains the major implementational restraint. This is especially true for land information systems which are designed to integrate parcel/ownership data with other social and resource data. From the standpoint of land surveying or positional information related to ownership parcels, Langley et al. (1982) suggests that two broad areas of positional concern exist. One is the micro level delimiting individual parcel boundaries (see Table 2) and the other is the more macro level focus upon parcel/ownership integrated information systems.

TABLE 2: ACCURACY REQUIRED FOR DELINIATION OF INDIVIDUAL PARCELS (MICRO LEVEL)

1.	In Rural Areas	± 0.35'	This is equivalent to third order class II control when corners are one-half mile apart.
2.	In Rural or Urbanizing Areas of High Resource Quality or Areas Effected by Urbanization (moderate land value)	± 0.17'	This is equivalent to third order, class I, when corners are one-half mile apart.
3.	In Urban Areas (high land value)	± 0.08'	This is equivalent to second order, class II, at half-mile spacing.

As Langley et al. (1982) points out:

> "...it is increasingly being accepted that a geodetic framework forms the spatial foundation for the creation of any integrated land records and information system. It not only provides accurate and efficient means for referencing data, it also provides a uniform, effective language for interpreting and disseminating land information."

Assuming the fundamental importance of a geodetic framework, what is the technological and economic status of positional technology? Table 3 provides some insight. It describes the economic implications of various methods at various densities and accuracies. In essence, the emerging technology of the Global Positioning System (GPS) appears to have the capability to provide both adequate point position and relative position information at relative accuracies; or "it potentially represents a major breakthrough in providing efficient control densitification". (Langley et al., 1982)

In summary, development of continued computer efficiencies with the evolution of positional technology during the later half of this decade suggests that we will witness substantial modernization of large scale land records systems in North America.

TABLE 3: COST TO ACQUIRE DIGITAL COORDINATES

	Source	Accuracy	Cost per PLSS Section Corner
1.	From Geodetic and Land Survey Methods	± 0.2' - ± 15'	$500 - $1,500
2.	From Geodetic and Conventional Photogrammetric Methods	± 0.5' - ± 30'	$300 - $ 500
3.	From Geodetic and Special Precise Photogrammetric Methods	± 0.2' - ± 5'	$800 - $1,500
4.	From Geodetic and Inertial Technology Methods	± 0.2' - ± 5'	$700 - $1,200
5.	From Global Positioning System by Interfrometric Methods	± 0.1' - ± 0.3'	$700 - $1,000

PART 3: RESULTS FROM THE WESTPORT MODERNIZATION EFFORT

A. Introduction

Assuming the technology and related efficiencies, relevant to modernization of large scale land records areforthcoming, what are the implications and applications of such modernization? Within the context of the Westport Project, a land planning application has been investigated. Before this could be accomplished, however, considerable effort was expended developing a variety of large scale digital bases. These data bases and the resultant difficulties have been reported upon previously (Moyer et al., 1981 and Corson-Rikert, 1982) Importantly, however, this activity resulted in the ability to spatially merge land parcel/ownership records with land resource records using the positional foundation of section/township system of the Public Lands Survey System (PLSS).

To illustrate the potential applicability of spatial computing using large scale digital data bases, a computer assisted building scenario is developed. As described earlier, this scenario illustrates the use of data derived from routine sources. The scenario focuses upon the location of a subdivision as well as the organization of the individual properties within the subdivision.

B. Land Subdivision Scenario

From the standpoint of selecting land for development, various opportunities and constraints exist; many of these having spatial characteristics. For example, land ownership rights and incumbrances are part of a spatial-legal record of obvious importance. Fiscal value of land varies spatially depending upon a variety of factors. For example, assessed value is sometimes a useful measure of the land's economic worth. Social desires also have spatial properties and zoning may be thought of as representing society's desired social and physical relationship between various uses of land. Environmental conditions also have spatial properties, be they constraints for development such as soil structure for foundations or governmentally required limitations such as flood plain development restrictions. Let's now look at how some of the opportunities and constraints discussed above can be used in the selection and development of a subdivision.

Our scenario involves a developer wishing to purchase a large piece of real estate for development as a subdivision. Imagine that the developer has access to a large scale digital data base and computer graphics plotting software and display hardware. Also imagine that a large scale digital data base has been automated by local government as part of its routine responsibility for public land records

management. As indicated, an important part of this large scale data base is the inclusion of the property/tax parcel record in a mathematical and geodetic based upon state plane coordinates. It is also compatible and spatially integratable with other land records (see Figure 1). This data set, plus additional records, are used in the following manner to choose a suitable site for a subdivision.

Besides the property records, the remaining data files are reflective of institutional constraints to the proprietary and developmental interests in the land. For example, the system contains digital overlays for zoning, wetlands, floodplains, and an agricultural lands productivity classification. In addition, some of these land records are being digitized statewide. For example, wetlands in Wisconsin are being mapped statewide and in digital form. Also in Wisconsin, each of these resources represent legal constraints to development. Therefore, any developer must acknowledge them in his/her analysis and in any subsequent solution.

Figure 2 depicts, in computer plotter graphic form, land use zoning within a four square-mile sub-area of Westport township. Figure 3 depicts the sub-area in terms of its waterways (a river, in this case) and floodplain boundaries. Of course, floodplains are inadvisable for development and so this portion of our sub-area is eliminated from

consideration. Figure 4 depicts the wetland areas within our sub-area. These areas, then, are also eliminated from consideration.

Figure 5 depicts the agricultural lands productivity classification (which is based upon a soil classification) for the sub-area. There are three classes to this classification for the sub-area, i.e. A, B, and C, with A representing prime agricultural lands while B and C represent lands of less-than-prime or marginal agricultural quality.

Acknowledging that Class A lands are best left for agricultural uses, our developer would then be concerned with findings a piece of property that is comprised of predominantly Class B or C land.

Considering this requirement and the aforementioned floodplain and wetland constraints, a suitable site for development is determined (also indicated in Figure 5). The shape of the site is determined by the aggregate shape of the existing property parcels that would have to be purchased by the developer before development could occur.

Figure 6 depicts the conceptual solution developed by our developer. Careful study of the solution will reveal that it responds to the aforementioned floodplain, wetland, and agricultural land constraints. Figure 7 is an even

closer view of the solution. It should be noted that this graphic rendition represents the solution in schematic form; and is not meant as a working or construction drawing. It is, however, representative of potential street arrangements and connections, parcel arrangement and numbers, and other general relationships.

C. Implications

This scenario shows that major advantages exist when computers, in concert with routinely available large scale digital data bases, can be used as a planning and development tool.. First of all, the computer creates the opportunity to perform faster site analysis than is possible with the processes of manual drafting, scale-conversion, and overlaying. Secondly, the computer creates the opportunity to quickly investigate numerous alternate designs while, again, eliminating the need for time-consuming drafting. Finally, the computer can quickly change scales of output so that a solution can be readily examined in the site-specific, neighborhood, and regional contexts.

These three advantages would allow developers and those responsible for reviewing such proposals to spend their time more economically; e.g. by providing and reviewing more alternatives and spending a smaller proportion of their time tending to the activities of drafting, etc.

In general, the developer would be capable of performing more analysis and assessing more alternatives in roughly the same amount of time. When all of this is done using a large scale information base, the only outfall can be better decisions; ones more responsible to the needs of society.

PART 4: IMPLICATIONS OF DATA ACCURACY THROUGH MODERNIZATION

Besides all the potential opportunities and applications of computer graphics and associated technology, questions emerge concerning the accuracy and reliability of the merger of these various records, particularly those obtained from existing sources.

A. Reliability

This is a particular problem when land records of varying spatial reliability are merged. Figure 8, for example, illustrates what happened when 1930 ownership records, 1980 tax identifiers, and 1975 shoreline records were independently digitized, spatially transformed, and merged using state plane coordinates in Westport Township. All four records are public (routine) and presently reside, in map form, in various local agencies such as the County Surveyor, the City Engineer, the Tax Assessor, and the Regional Planning Commission. Figure 8 shows there is

considerable difference between the shoreline as plotted from the property record (dashed line) and the shoreline as plotted from a large scale topographic map (solid line). The property record has legal standing, but the topographic record probably represents reality. There are a myriad of potential explanations, but the importance to those who intend to employ spatial computing techniques cannot be understated. The integration technology is here, but the quality and reliability of the data base must always be understood. To the building industry, the implications are obvious. If this site on Lake Mendota was a prime location for a major recreational housing project, there are a host of questions which emnerge:

- How much shoreline really exists?

- How much building space really exists?

- Do existing real estate taxes and land appraisals really reflect the land value?

- Does the apparent change in shoreline suggest that excessive erosion and deposition is taking place; thereby requiring extensive engineering protection of the shoreline, etc.?

B. Accuracy

Within the Westport Project, other accuracies and reliability questions are beginning to be addressed. This has included an evaluation of state plane coordinate values calculated with software and from existing sources in comparison with on-the-ground survey procedures (Crossfield, 1981). In addition, other parcel map accuracies have been approximated (see Table 4). The results indicate that a Westport parcel data base can be transformed and improved, but not at cadastral (property boundary) standards (Mills, 1982). There is also some question if portions of the parcel file can meet national map accuracies at 1:24,000 given that ownership records in Westport are presently maintained by the County Surveyor section by section, and they are adjusted on an ad hoc basis "cartographically" by the draftsperson when sections are spatially aggregated.

The appropriateness of this cartographic adjustment procedure is questionable and the results of these procedures are being reviewed and investigated by Chrisman (1982) and others. This issue of accuracy is of particular importance in the context of digital cartography such as that being conducted by the Wisconsin Department of Natural Resources (WDNR) Wetlands Mapping Program. At present, WDNR is mapping all of Wisconsin's wetlands as part of a legislative mandate to control alteration of these resources and to determine the extent of public ownership.

TABLE 4: PARCEL MAP ACCURACY ESTIMATES

Tests	Accuracy
Section line study along subdivision (north half of sect. 21 and 22)	average of ± 2.5'
Edge matching of forth acre parcel boundaries	average of ± 4.3' (on 90% of the discrepancies were less than 10'
Additional matching examples (road rights-of-way meeting section lines)	± 50 - 75'
Town of Oregon Parcel Maps (redrafted vs. existing)	average of ± 17'.63 (or 90% of the discrepancies were less than 40'

To accomplish this legislative mandate , a mapping program was initiated. The resultant maps and digital and wetland boundaries products are of unknown spatial accuracy requiring case by case verification of boundary disputes. Table 5 indicates an analysis of the approximate accuracies of wetland boundaries with and without the use of section corner control points (Mills, 1982). The results indicate that the existing product, as well as the transformed version are not within national map accuracies at 1:24,000.

TABLE 5: ESTIMATES OF MAP ACCURACY OF WDNR WETLAND MAPS

Source	Accuracy
U.S.G.S. Topographic Quadrangle (1:24,000) National Map Accuracy Standards.	90% of well-defined points are to be within 40 feet of true position.
W.D.N.R. Maps (1:24,000)	Upper error limit for 90% of wetland boundary points fall within 200-400 feet of true position.
Westport transformed version (21 control points) (1:24,000)	Upper error limit for 90% of wetlands boundary points fall within 150-350 feet of true position.

The implications of such accuracy and reliabilities are complex. Solutions are a mix of improved mapping and computing technology, standard setting, notations of accuracy, fundamental change in land records management and more explicit statement of goals and objectives by land record system users and developers. There is little question that those responsible for land records modernization will need to recognize issues of accuracy and reliability as part of system design and management.

PART 5: POSITIONALLY INTEGRATED APPROACHES: COMPREHENSIVE OR INCREMENTAL?

Technological trends, interest in modernization and the potential applications of such suggest that land records systems which can positionally integrate and merge land records will emerge in spite of the problems of accuracy, reliability, etc. The basic question appears to be whether comprehensive or incremental approaches will be pursued (see Table 6).

TABLE 6: POSITIONALLY INTEGRATED APPROACHES

Comprehensive Approaches:

- Multi-purpose cadastral systems (e.g., Racine County, Wisconsin, Maritime Provinces, Canada)
- Parcel systems with resource data as attributes e.g., SEWERPAC coastal zone)
- Spatially comparable, but independent systems (e.g., local with county/state with national).

Incremental and Mutational Approaches:

- Public Land Survey System (PLSS) coordinate by coordinate (e.g., Bureau of Land Management and Local Government)

- Political area by Political Area (e.g., City of Milwaukee, City of Menasha, Wisconsin)

- Parcel by parcel through the use of coordinate (e.g., Dane County/Sandsness proposal)

- Data set by data set (e.g., Wisconsin Wetlands)

- Best available information (e.g., Public Land Survey System, State of Minnesota)

The distinction between the two may be somewhat arbitrary, but can be characterized as follows (Crossfield, 1982). The first group, comprehensive, tends to involve substantial capital outlays that produce an almost instanteously generated system. The second group (evolutionary), evolves slowly and requires continuous updating capabilities. The advantage of group one is that if represents a crisis oriented planning/decision process. It also may be shown that an instantaneous payback of the investment will reduce waste and duplication and result in a high benefit/cost ratio. The advantage of incremental approaches is that they do not require large amounts of initial capital investment, but instantaeous payback is not likely either, and these approaches fit present institutional/political arrangements better. This second set of approaches may as well be the only long term solution given the dynamic characteristics of the times and the technology. Table 7 provides some insight into conditions which seem to indicate

that any approach must address the concept of change due to a variety of social, technological, and legal forces.

TABLE 7: CONDITIONS EFFECTING INCREMENTAL APPROACHES

- Positional readjustment of the North American datum is expected in 1984-85

- Continued improvement in the cost and accuracy of positional technology is expected

- Geographic shifts in the need for increased spatial accuracy will continue

- Trends continue to authorize and/or require parcel descriptions through the use of coordinates

- Probable evolution towards laws requiring improved positional accuracies of property and resource boundaries

Explicit directions and procedures for large scale land records modernization remain unclear, but some trends are emerging. An analysis of various attempts to modernize land records and efforts within the Westport Project indicate that much more thought should be given to incremental approaches which respond to system elements of a dynamic nature.

SUMMARY:

- Institutional interest in modernizing land records is emerging at the national, state and local level

- Positional large scale networks are becoming technologically and economically feasible

- Large scale land records in digital cartographic form are to be expected

- Opportunities exist for quite sophisticated planning applications using computer technology and in concert with large scale digital data bases;

but,

- Important problems of accuracy and reliability must be considered.

- Important issues of incremental system evolution needs to be addressed.

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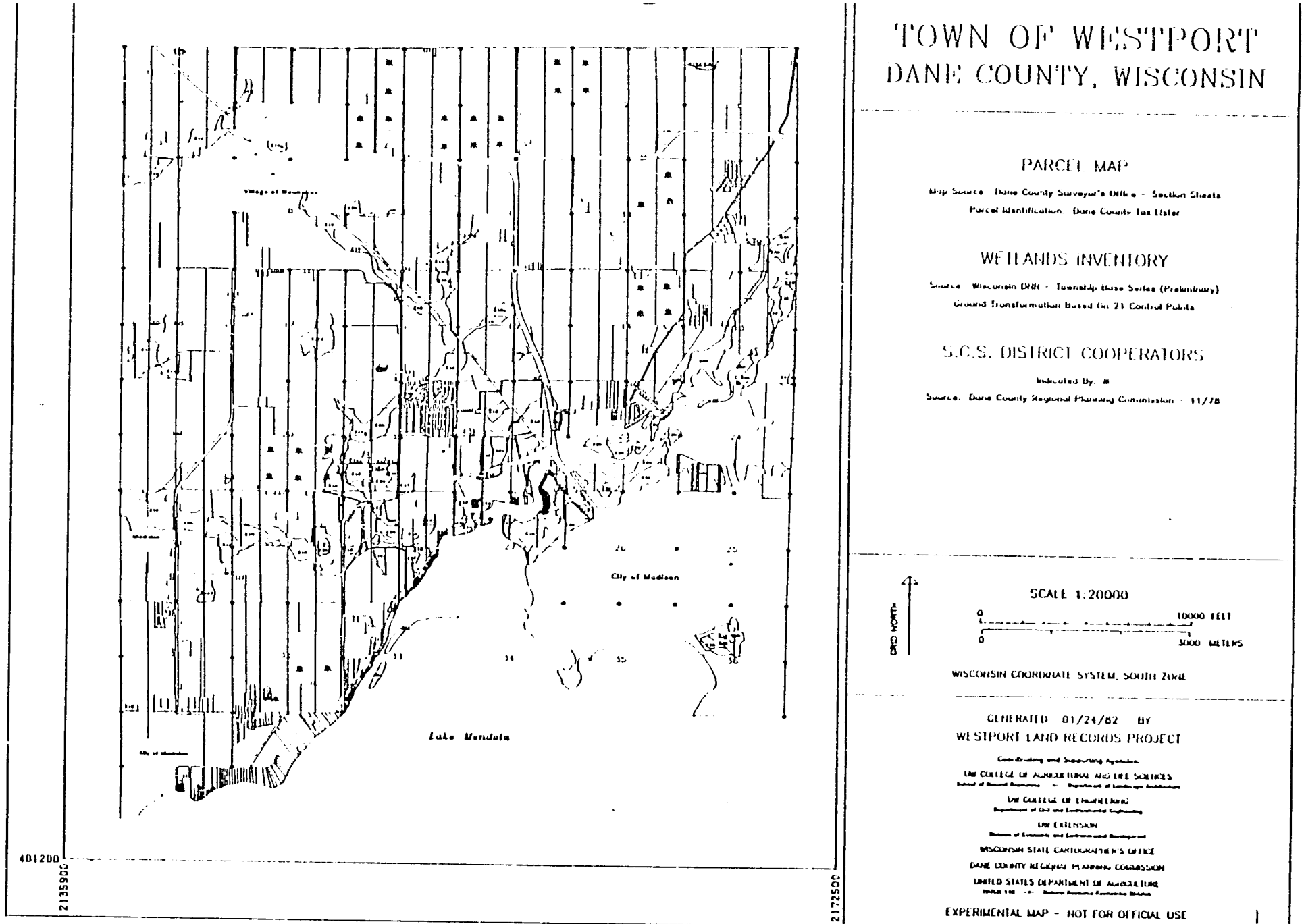

Figure 1: Ownership/tax parcels, wetlands (irregularly shaped polygons), and SCS Cooperative Districts (asterisks).

Figure 2: Land U[redacted] Zoning

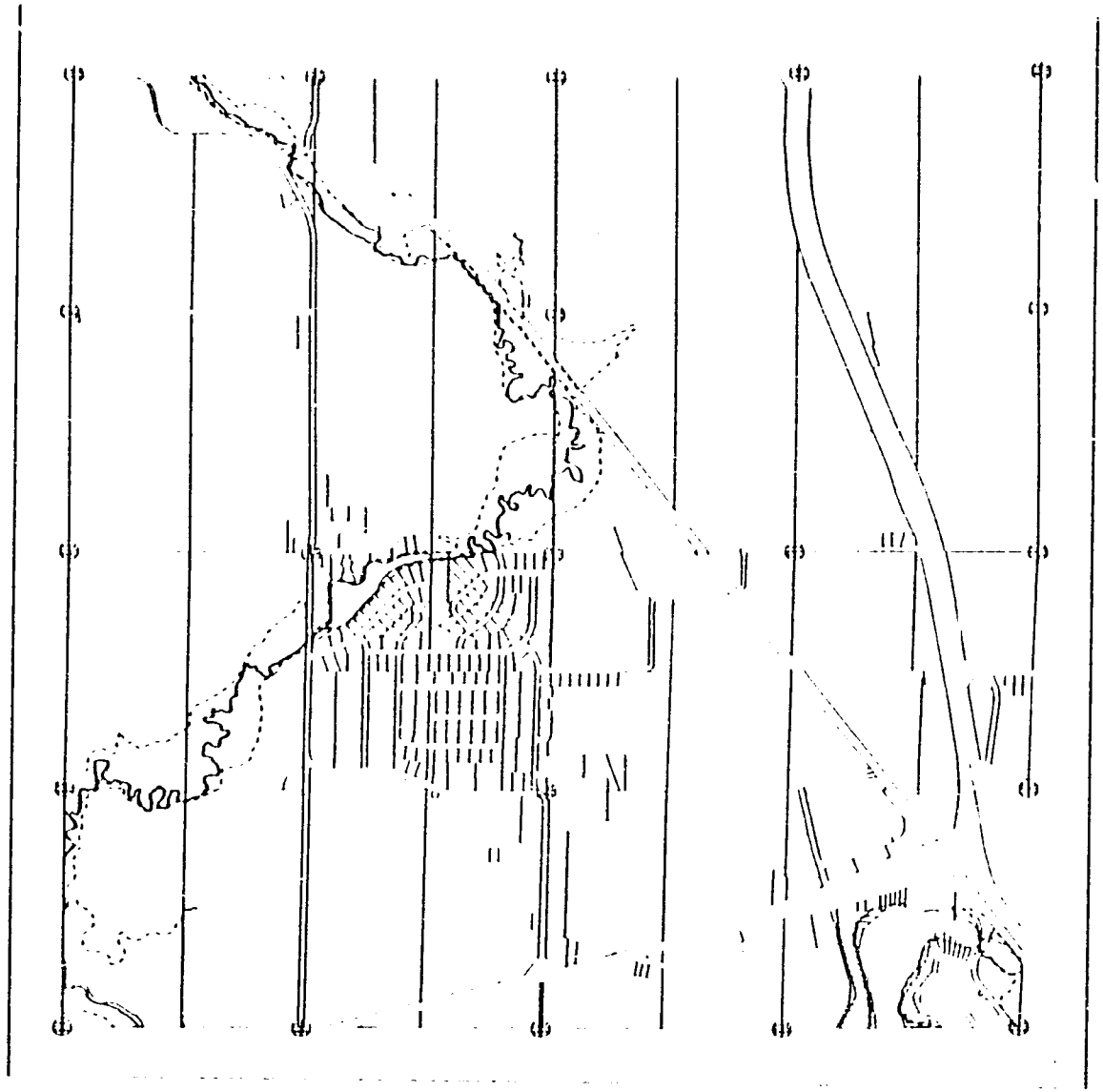

Figure 3: Water Bodies (river) and Floodplain Boundaries (dashed line)

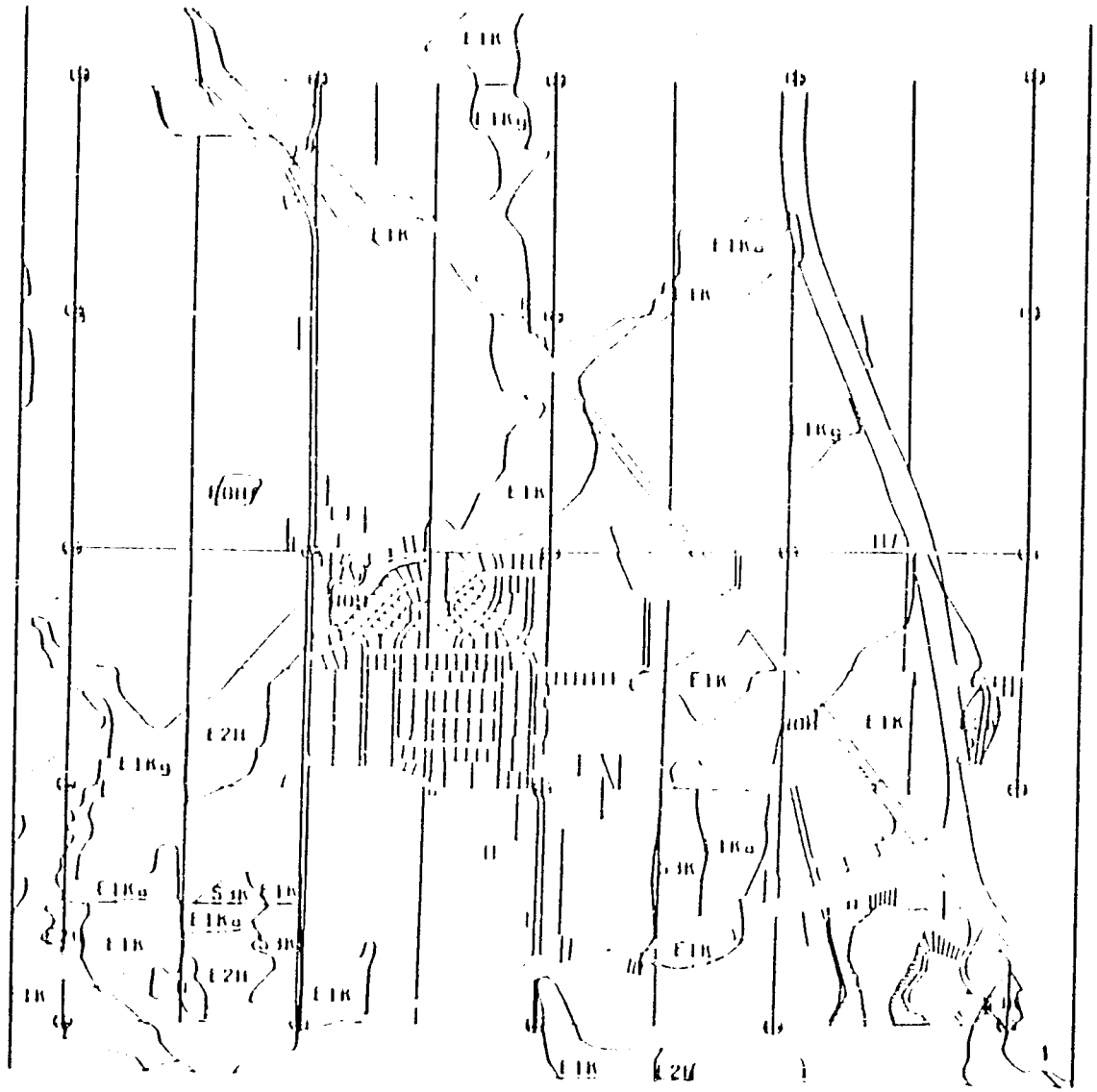

Figure 4: Wetland Areas.

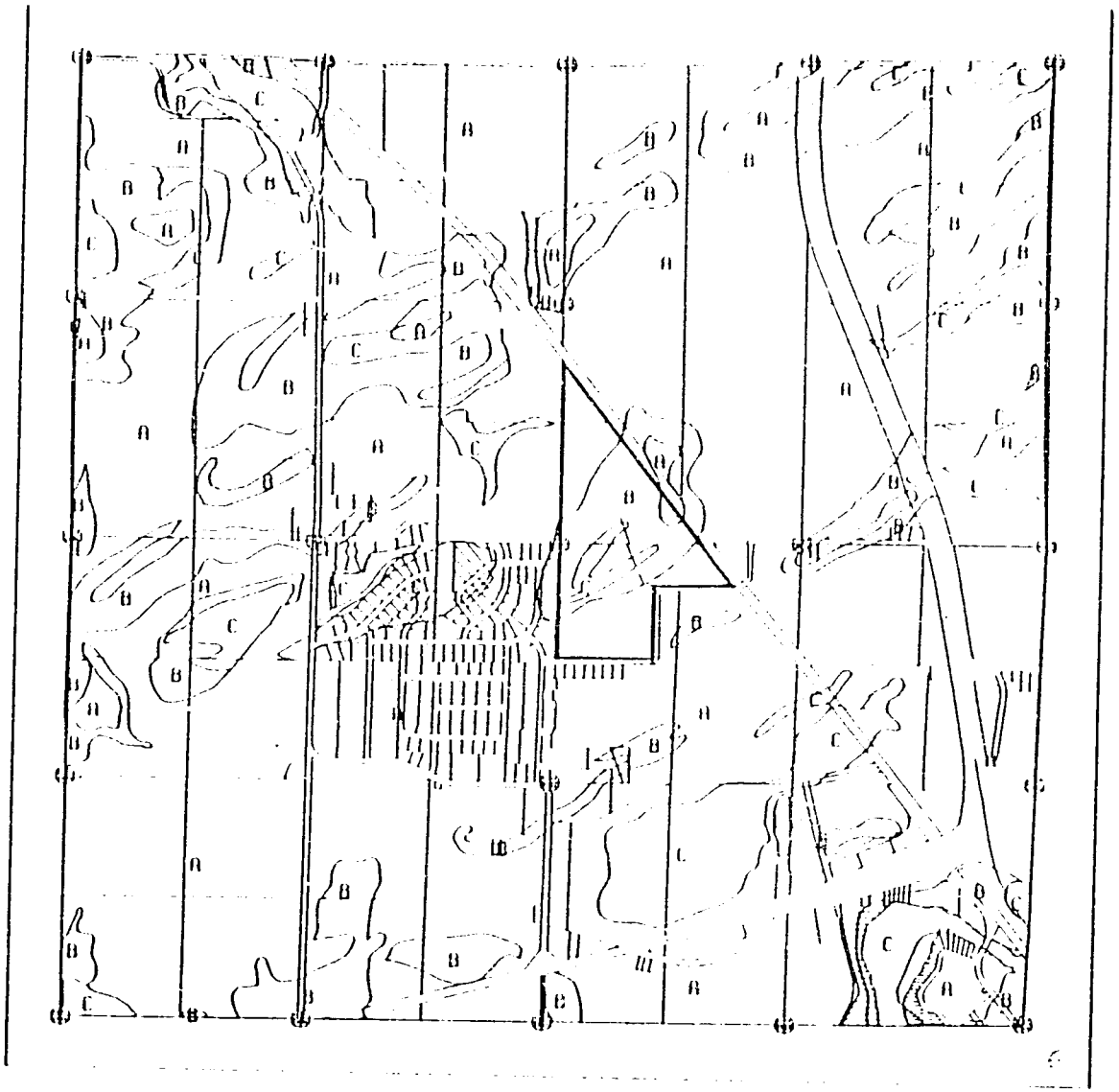

Figure 5: Agricultural Classification for the sub-area. The actual site chosen for the subdivision is indicated with a heavy black line.

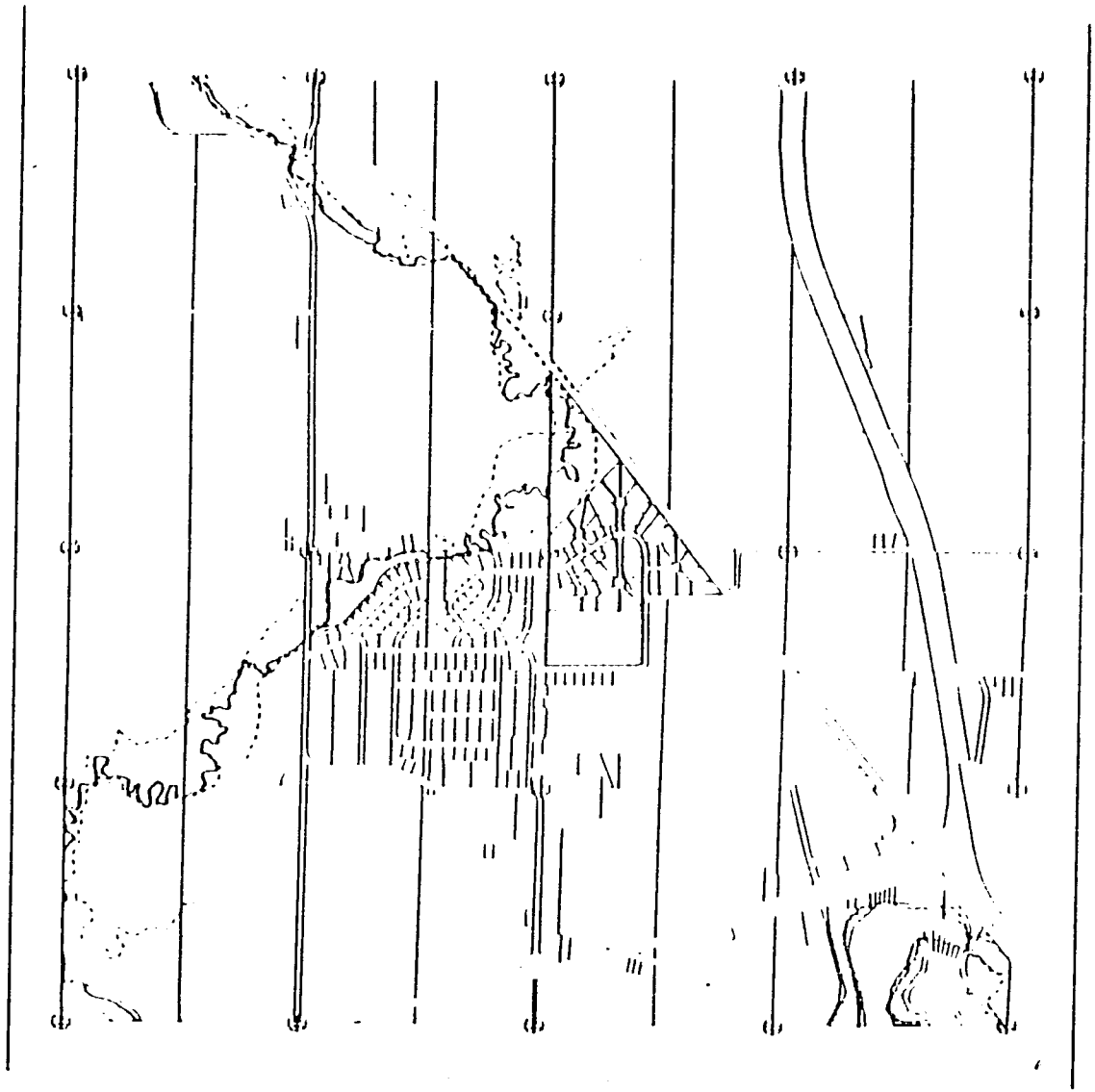

Figure 6: Proposed subdivision design.

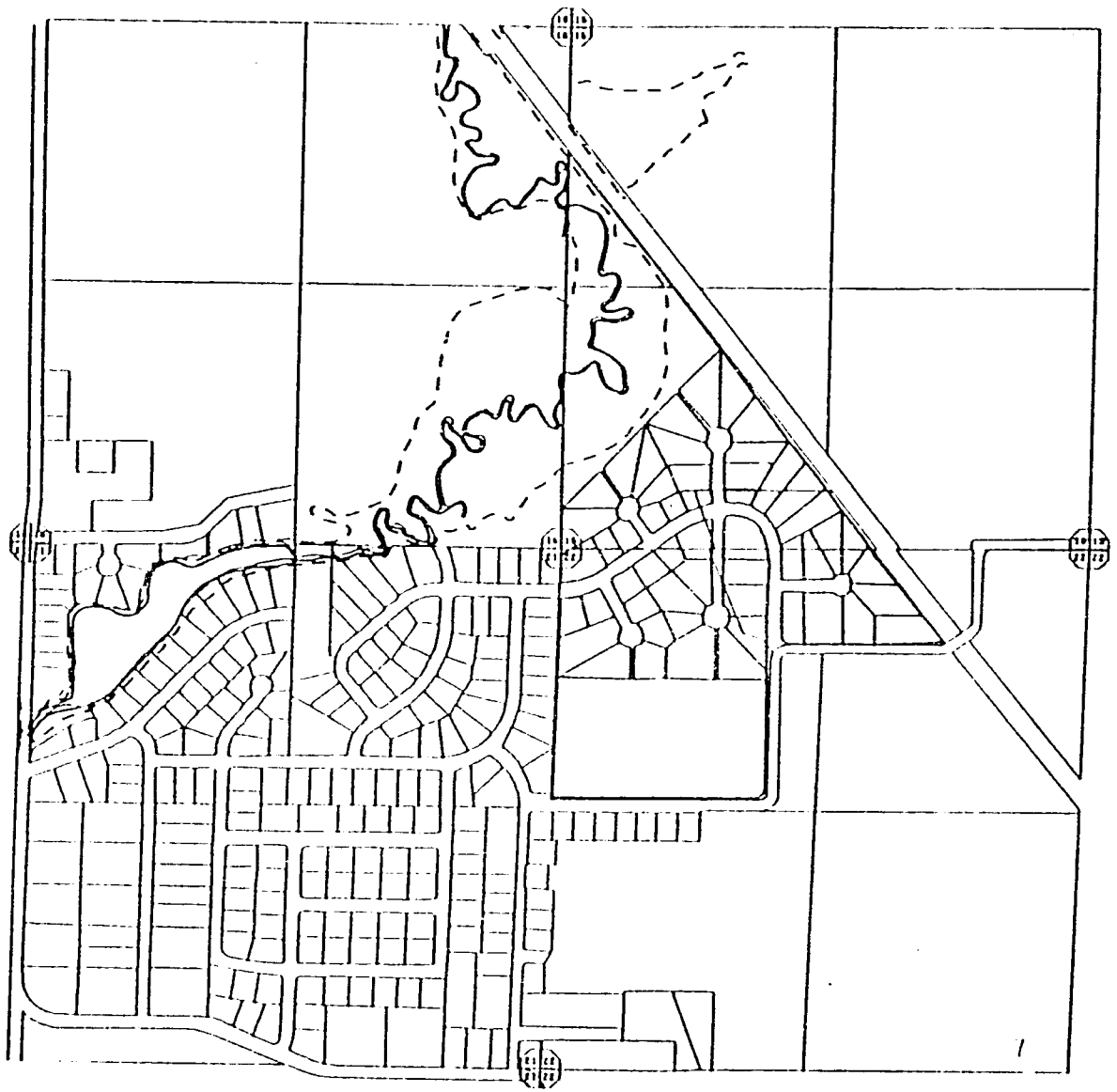

Figure 7: Proposed subdivision design: a closer view.

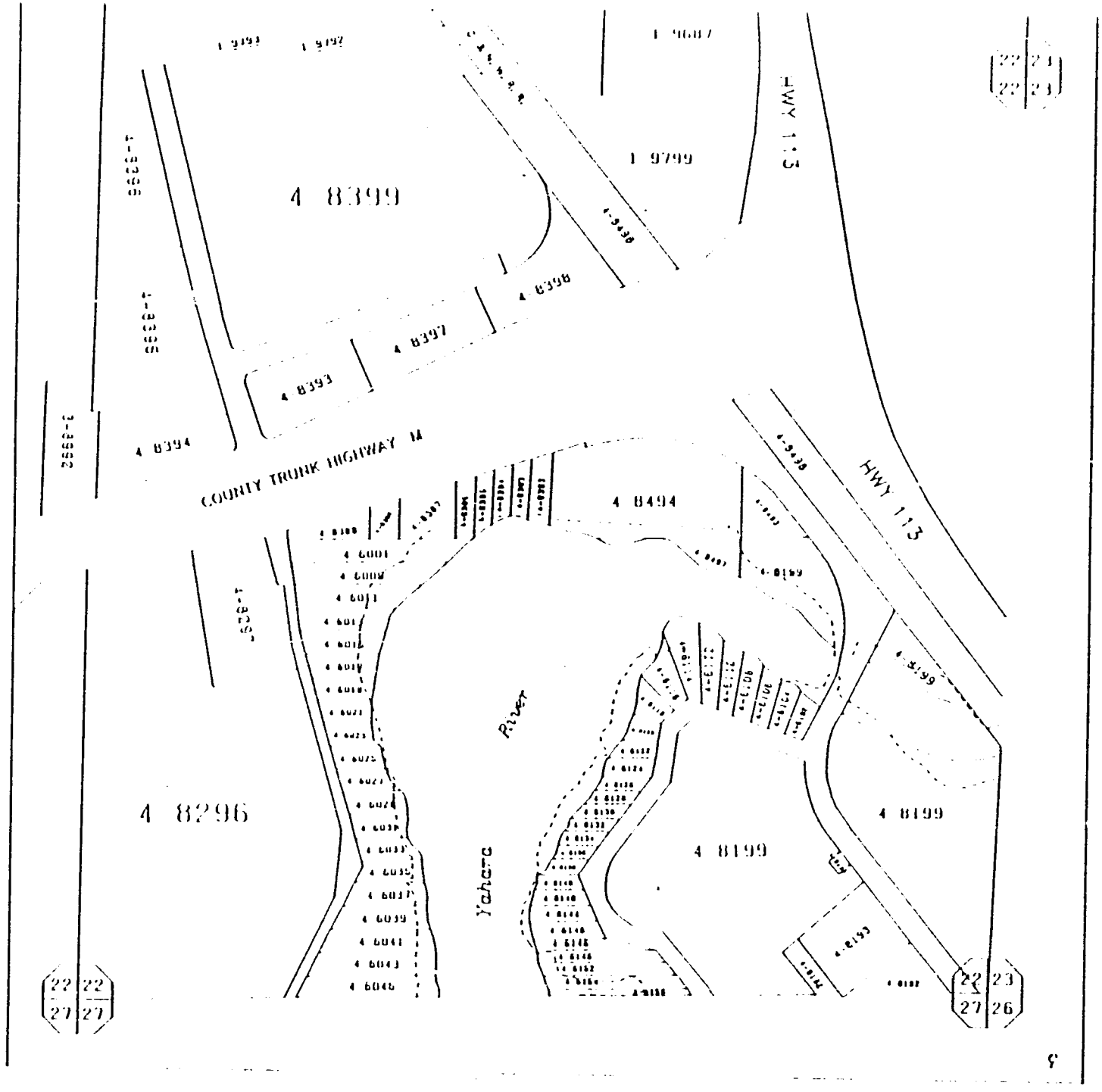

Figure 8: Property/tax parcels with parcel identifiers and shoreline boundaries.

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APPENDIX A

LAND RECORD TERMS WITH DEFINITIONS

Personnel of the Westport Project have collectively examined the popular terminology which characterizes the fields of land information systems and land records. We have come to the realization that many of these terms, e.g. cost, accuracy, comprehensiveness, have no firm or mutually accepted definition. On the contrary, they often mean different things to different individuals; especially those from different academic and professional backgrounds. To remedy this situation and to help develop a common vocabulary amongst these different groups, we have focused upon developing a set of definitions for what, in our estimation, are some of the major terms that characterize the land information system/land record fields.

The terms we have chosen to define tend to fall into one of three categories: those concerned with land records, those concerned with land information systems, and those of a miscellaneous nature. Accordingly, we present the definitions using this categorization.

TERMS CONCERNED WITH LAND RECORDS

Accessibility - refers to the extent to whih the exact information desired by the user can be obtained. Access may be hindred by several factors; including unclear or unnecessary privacy restrictions, poor capabilities to cross-reference different kinds of data, and a simple lack of knowledge about what data exists, where it is, and in what form.

It has been recommended that, to increase the accessibility of all kinds of land information, all data pertaining to a specific parcel be located in one place or accessible through a system of "information outlets".

Integratibility - refers to the extent to which two or more land information sources relate to the same indexing system and, thereby, to the extent to which these sources can be integrated in a reliable manner. Difficulties in integration can be characterized as (1) spatial difficulties involving attempts to integrate two or more

spatial sources (maps). Spatial difficulties can be attributed to differences in map scale, differences in map accuracies, and differences in spatial referencing systems (e.g. UTM versus state plan coordinates vs. latitude/longitude) or (2) non-spatial difficulties involving various types of "listed" data such as ownership records, tax rolls, etc. Non-spatial difficulties are primarily due to the different ways in which different listed data is organized. For example, ownership records are organized by owner name, while tax rolls are organized by parcel number; thereby making cross-referencing or integrating extremely difficult.

Currency - refers to the degree to which a specific land information source is up-to-date. This is, of course, reflective of the regularity with which the source is revised or updated (e.g., once per year, once every five years).

Accuracy/Validity - both refer to the extent to which a land information source corresponds to reality. Accurate/valid sources are either (1) free from mistakes in regard to listed data (e.g. the owner of a specific parcel is correctly identified); or, (2) within a specified interval of error in regard to spatial (map) data (e.g. the map is accurate to = 0.50 feet)[1]

Precision/Reliability - both refer to the extent to which a specific measurement technique can repeatedly yield the same value when measuring the same object. A precise/reliable technique (e.g. a person using a ruler) will repeatedly yield the same value (e.g. 5'10") when measuring the height of a person again and again.[2]

Completeness - refers to the extent to which a specific land information source "covers" an entire geographic area (e.g. an entire city, and entire county). An incomplete information source describes (1) a contiguous area which represents only a portion of a specific geographic area

(e.g. the wetland maps are only available for the northern half of the state); or, (2) a group of distinct, unconnected areas which, in total, represent only a portion of a specific geographic area (e.g. the wetland maps are only available for three separate parts of the state: a section of the northwest corner a section of the southeast corner, and a portion of the western boundary).

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[1] The term accuracy is used by engineers to describe the same condition which social scientists call valid. For example, the engineer will call his measurements accurate if they correspond closely to reality while the social scientist would call them valid for the same reason.

[2] The term precision is used by engineers to describe the same condition social scientists call reliable.

TERMS CONCERNED WITH LAND INFORMATION SYSTEMS

Cost - refers generally to the cost/benefit characteristics of a particular land information system. More specifically the term is concerned with (1) the initial cost of developing the system; bringing it to an operational level; and (2) use and maintenance costs of the system once it is in operation. Both of these categories should be specifically described in terms of man-hours needed and nature and extent of expertise required.

In assessing the cost of any proposed system, its cost/benefit characteristics must be compared with those of the existing system it is purported to replace.

MISCELLANEOUS TERMS

Ownership Parcel - refers to a contiguous area of land or a set of non-contiguous areas (split parcel, tc.) described in a single description in a deed or as one or more of a number of lots on a plat. This area or set of areas is owned, either publicly or privately; and capable of being separately conveyed. Ownership parcels are differentiated from (1) tax units which may or may not coincide to ownership parcel boundaries (e.g. in Wisconsin, ownership parcels less than forty acres are treated as separate tax units while larger parcels are subdivided in forty-acre tax units for assessment purposes; (2) areas of fractured rights, e.g. water rights, mineral rights, easements; which have legal geographic boundaries which may or may not correspond to existing ownership parcel boundaries; and (3) geographic storage units used for data storage in automated information systems. As geographic storage units, ownership parcels, tax units, and areas of fractured rights may all be treated identically despite their fundamental conceptual differences.

Comprehensiveness - refers to the extent to which a particular information system houses all of the different kinds of land information that could describe the area. For example, an information system that houses the tax rolls and the ownership records for a particular geographic area is not a very comprehensive system.

Responsiveness - refers to the speed with which a specific land information system can respond to a request for a specific piece of land information, i.e. the turn-around time of the system. For example, if one goes to the municipal tax assessor's office and wants to know how much tax was paid last year on a particular parcel; how long will it take to locate that information and provide it to the requesting person?

Harvard Computer Graphics Week
Harvard University
Graduate School of Design

"THE WESTPORT LAND RECORDS PROJECT"

JONATHAN CORSON-RIKERT

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THE WESTPORT LAND RECORDS PROJECT

ABSTRACT

The Westport Land Records Project is an interdisciplinary research project at the University of Wisconsin-Madison, with assistance from the Dane County Regional Planning Commission. Now in its third year, the project has developed a computer mapping system in a test area to demonstrate new technology and to help identify institutional changes and planning requirements for land records improvement.

Existing property parcel maps have been digitized for the 36 square mile Town of Westport in Dane County. Additional maps of zoning and several natural resource features have been digitized for display in combination with the property parcel overlay. The mapping system uses ground surveyed control points for registering separate map overlays and for edge-matching adjoining map sheets. Since Wisconsin is a Public Land Survey state, section corner and quarter corner monuments with state plane coordinates were chosen to serve as reference points.

Tests to evaluate the adjustment of digitized maps to control points indicate that existing maps can be interrelated successfully for applications in tax assessment or land use and environmental planning. For long-term needs and for applications demanding high accuracy, the current condition and fragmented management of source maps have emerged as major institutional and technical hurdles for land records improvement.

I. BACKGROUND

The Westport Land Records Project (WLRP) is a joint university and government research project which has developed a computer mapping system for a 36 square mile town in Dane County, Wisconsin. The University of Wisconsin-Madison and the Dane County Regional Planning Commission have cooperated to test applications of new technology and to identify issues critical to the successful planning and implementation of a modern land information system.

The Project was initiated in large part to follow up a previous study, "Land Records, a Case Study of Wisconsin".[1] The study results indicated a high degree of fragmentation and overlap in land records collection and maintenance. The 1976 costs of existing procedures were sampled at the local level around Wisconsin and collected agency by agency at the state and federal levels. Total costs in Wisconsin were estimated at $17 per citizen or $34 per taxpayer annually, with a surprisingly high $9 of the $17 at the local level, where property ownership and assessment records are kept. Total annual costs per acre were approximately $2.25.

The high level of current land records costs led Professor Niemann and others at the University of Wisconsin to feel that the initial expenses of more modern land information systems could be justified by providing better information more efficiently. A group of investigators, directed by Professor Niemann,[2] proposed a pilot study which could utilize new technology and provide tangible products illustrating the advantages of modern integrated land information for local and state governments.

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The Dane County Regional Planning Commission, or the DCRPC, began to cooperate on the project at this point. DCRPC staff had already become acutely aware of the limitations of current spatial records in the course of several extensive mapping and planning projects. Maps of physical characteristics and natural resources of the land, such as floodplains or wetlands or soil types, could not be consistently reconciled with each other due to differences in base maps and production standards. Furthermore, locally produced and maintained property ownership maps were displayed only on outmoded and inaccurate base maps dating from the 1930's, which were impossible to correlate with confidence to any other maps. Yet map composites are regularly utilized for public decisions on planning policy, and have often been adopted as part of local ordinances concerning development, farmland preservation, and protection of environmentally sensitive areas. The comparisons of property ownership with natural resources most often in demand for planning work are in fact the least reliable maps that the DCRPC could produce.

DCRPC staff had become aware of advances in mapping technology, but the costs for equipment and software and training were more than the agency could justify on its own. More importantly, the long term-solution for the DCRPC involved improvements in the source information as well as new technology. A comprehensive improvement would necessarily involve more than one agency and probably more than one level of government, with participation of utilities and other segments of the private sector potentially necessary as well. For the DCRPC, a pilot study would identify for itself and demonstrate to others the approaches most suitable for Dane County government, where local land records are maintained.

The Project Site

The Town of Westport, north of Lake Mendota and bordering on the City of Madison (see Figure I-1), presented an ideal mix of land uses and of physical characteristics for a test site. The town has large areas of farmland, rural subdivisions, urban fringe areas, a separate incorporated village that is itself expanding, wetlands, lake shoreline, and state and local parkland.

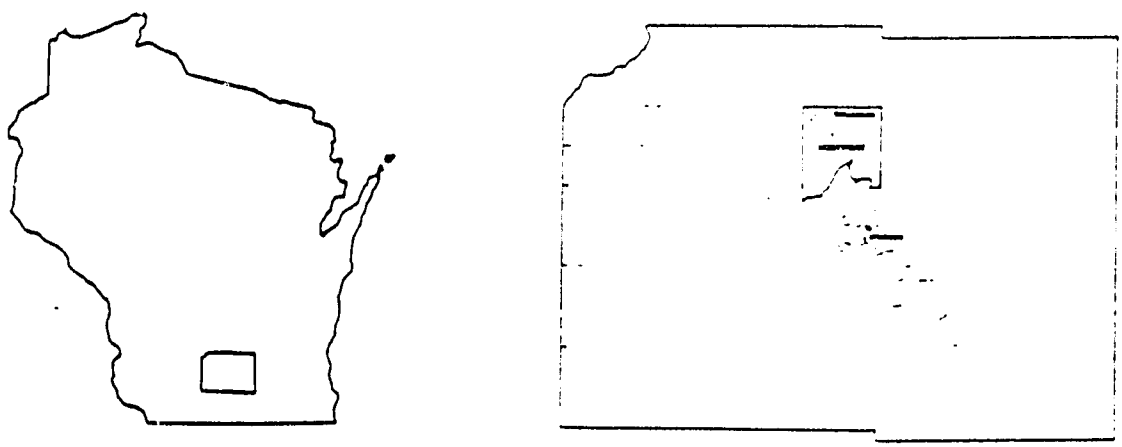

Figure I-1

The locations of Dane County in Wisconsin, and Westport in Dane County

The town had been completely remonumented in the 1960's and 1970's, because the original 1833 survey markers identifying the Public Land Survey township grid of section lines had often been lost or obliterated. New concrete and bronze monuments had been set using the best remaining evidence to recover original positions. Figure I-2 shows the Public Land Survey section line layout in Westport, with shading indicating areas annexed into incorporated municipalities. The right-hand figure illustrates the breakdown of one square mile section into quarters, with some sample parcel sizes.

Approximately one-third of the monuments had been assigned state plane coordinates, which permit the survey points to be related to each other in a

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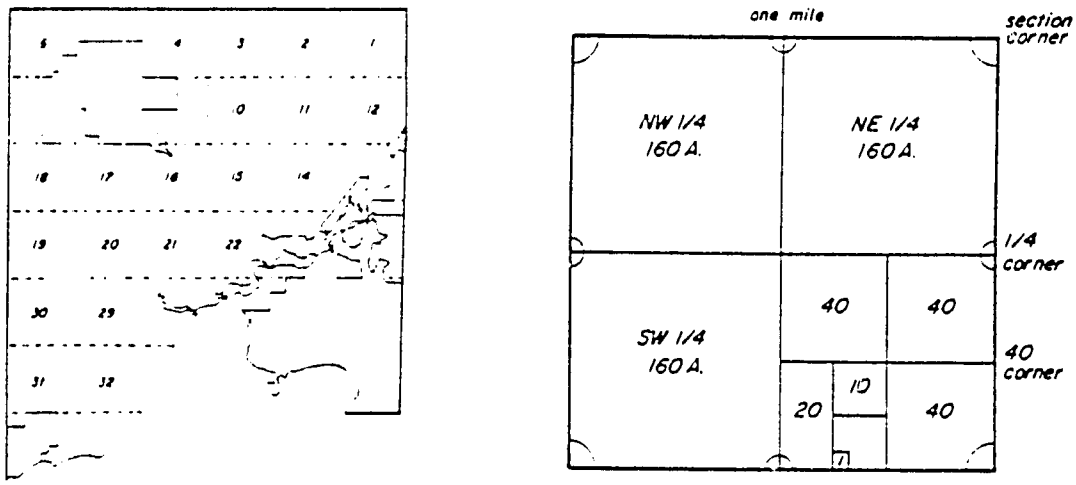

Figure I-2

mathematical framework as well as by isolated measurements on the ground. Over the course of the project, field work has extended state plane coordinates to more section corners, and even to individual property corners in limited areas of the town. Participants in the project from the UW Civil and Environmental Engineering Department have surveyed five new second order permanent geodetic control monuments in Westport, using first order national geodetic monuments in the area. Other ground survey work is being tied to the new monuments or checked against them to assure a consistent mathematical and geodetic framework for the whole project. In one 12 square mile block, photogrammetric measurements were used to extend ground-control as an alternative to completely ground surveyed methods.

II. PROJECT TECHNICAL CAPABILITIES

Hardware

The UW Landscape Architecture Department had previously acquired a stand-alone computer system for digitizing, storing and displaying data from maps. Hardware had been selected to permit data capture on a digitizer, with program control from a microcomputer and storage on floppy disks. A Talos digitizing tablet with a 40" by 64" active work surface permits the use of large original maps as data sources. A Magnavox Orion 60/S4 graphics terminal with a built-in 8080 microcomputer using the Microsoft CP/M operating system accepts the input from the digitizer and controls data storage on two separate disk drives. The Orion terminal features a high resolution plasma display screen, which permits map display at the workstation. A Printronix printer can duplicate in hard copy whatever is displayed on the Orion's screen.

Software

William Gates designed the original database concept and structure of the software for the project, and had assembled the hardware described above. When he left the project to join state government in 1980, the development of a complete database on the University's mainframe Univac 1100 series computer was scaled back and implemented by Greg Mills as a file management and plotting package, utilizing and enhancing the graphics routines available for the University's Nicolet Zeta model 3600 plotter.

The WLRP digitizing software was written by Fred Townsend in consultation with William Gates. The project software is limited by the memory capacity and slow disk input/output speed of the Orion, but the deficiencies have been

accommodated to permit a logical data entry structure and recovery from nearly all data entry errors. Map sheets are oriented on the digitizing tablet using two points along the bottom edge of the map for rotational position and two diagonally opposite points to identify the origin position and the exact current scale of the map sheet, which varies with temperature and humidity.

The basic map data entry approach starts by entry of nodes, the points at which lines on the map intersect. Each node position is digitized by placing the electronic cursor over the correct point on the map sheet. The entry procedure stores the x-y coordinate position along with the number of lines which meet at that particular node. When all the nodes for a map have been entered, a separate file of arcs or lines is entered to connect the nodes and complete the map display. Each line is matched to a starting point and ending point within a user-specified distance (usually .01 inches). If an endpoint is not matched, the line is not accepted and an enlargement of that portion of the map area is displayed on the screen to indicate the direction and magnitude of the matching error. Each node accepts only the number of lines originally indicated in the node file.

Existing software does not identify polygons (enclosed areas or parcels on the map). The software reproduces each line separately, so that displays of more than one overlay are line overplots which can be visually assessed but not analyzed by the computer.

Control

Certain key points on the original map are entered into a separate control file for later use in adjusting the scale and shape of the map. These

nodes are selected with the cursor from the master node file, and then identified through a row letter and column number index with a precise state plane coordinate. A typical property map, for example, would in Wisconsin and other Public Land Survey states have 8 key points which could be so identified--the 4 corners of the square mile section and the midpoints of the 4 sides, called quarter corners since they divide the section into quarters. Center corners are not considered reliable control points by the WLRP since the method of determining centers of sections has changed over the years.

Plotting and Adjustment

Once completed, all three files for each map--the nodes, arcs, and control points--are sent over a phone line to the University's main computer. The project has straightforward software for plotting the 3 files back at original size to check the digitizing, or for overlaying separate subjects digitized from the same map sheet. This basic plotting software can also change scales and title and date maps.

The more sophisticated plotting software was written by Greg Mills[3] using transformation routines written by Cliff Peterssonn.[4] The control points for each map are plotted according to their associated state plane coordinates at the chosen plot scale. These points are then as accurate as the plotter will permit, since they correspond exactly to the ground positions of the physical monuments they represent.

The remaining points and lines in the digital map file are transformed and assigned plotting coordinates more consistent with the new positions of the control points. The transportation varies in x and y scale across the

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map according to differences in the amount of shift in each control point from its map coordinates to its ground position.

The full reasons for and implications of the adjustment will be discussed more fully in section V. It should be noted here, however, that one direct result of the adjustment process is that adjacent map sheets will fit exactly wherever they have common control points, which for property maps fall at the corners and at the midpoint of their common side. Any number of map sheets can be plotted in combination, working in any direction. Thus the basic edge matching of adjacent map sheets is accomplished with ground control rather than by arbitrary points. More standard edge matching software could then be implemented to clean up the map displays.

Map plots can be produced with legends which include a title, sources, graphic and numerical scales, credit lines, the date, and a border that indicates the state plane coordinate window of the map frame. Variations in scale are limited only by cartographic judgement to avoid unwarranted enlargement of small scale original data. Map sheets exceeding 32 inches in width can be plotted in successive strips, although the whole of Westport can be plotted on one sheet at the fairly large scale of 1" = 1000'. Pen width, type and ink color can be varied within one plot to highlight any particular overlay subject, although individual lines within one storage file cannot be separately highlighted. No shading or three-dimensional display has been implemented, but the maps can be displayed in color on an AED 512 color graphics terminal and photographed using a Dunn 631 recording camera.

Annotation software permits polygons to be labelled as an optional map overlay, with the position, size and orientation of the label specified by

digitizing a starting and ending point within the polygon. Figure III-5 will illustrate a fully annotated plot, with a complete legend as well.

III. APPLICATIONS

The first digitizing task of the project was to build the digital property parcel overlay of the Town of Westport. Thirty-five individual map sheets, each covering a square mile section, were entered into the computer using the procedures described in section II. A sample of the original map sheets and a digitized counterpart are shown in Figure III-1. Tax parcels (limited to 40 acres) and not ownership units that may include more than 40 acres were entered as the parcels in order to correlate directly with parcel numbers of the tax rolls. Streams were not digitized from the property maps unless they actually form a parcel boundary.

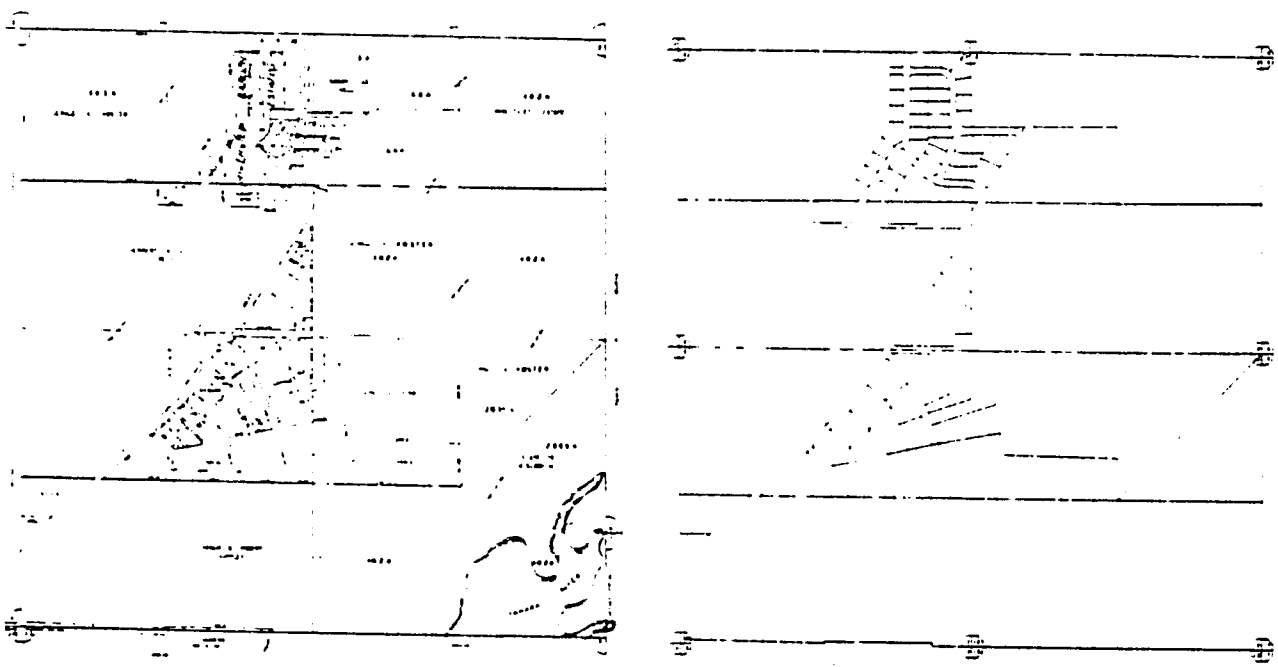

Figure III-1

All of the individual map files or any group of them can be plotted together to form one display map. This capability would eliminate the need to separately maintain a smaller scale map of the entire town, as is now done for the 35 towns in Dane County. Figure III-2 illustrates the new town-wide property parcel map.

A careful inspection of the new composite map indicates the results of the adjustment process described in the previous section. The section corners and quarter corners indicated by octagonal symbols on the map are registered perfectly with each other and with the ground control used. Mismatches of points not tied to ground control are visible; these drafting discrepancies on the separate original map sheets are usually a consequence of the planimetric distortion in the property base maps.

Further details concerning the property map sheets, the transformations performed on them, and the implications of alternative edge matching procedures are discussed in section V.

Subsequent digitizing work has sought to explore the potentials for registering other information to the property parcel overlay. Many kinds of natural resource information are only available at small scales, with the U.S. Geological Survey 7½ and 15 minute quadrangle map series the prime examples.

Digitizing small scale information often involves just one or two map sheets for the whole town. Here the control adjustment process is used primarily to register the source map information with the ground control, rather than to plot adjacent sheets together. Control points are used wherever they can be identified on the map or aerial photo base, and are

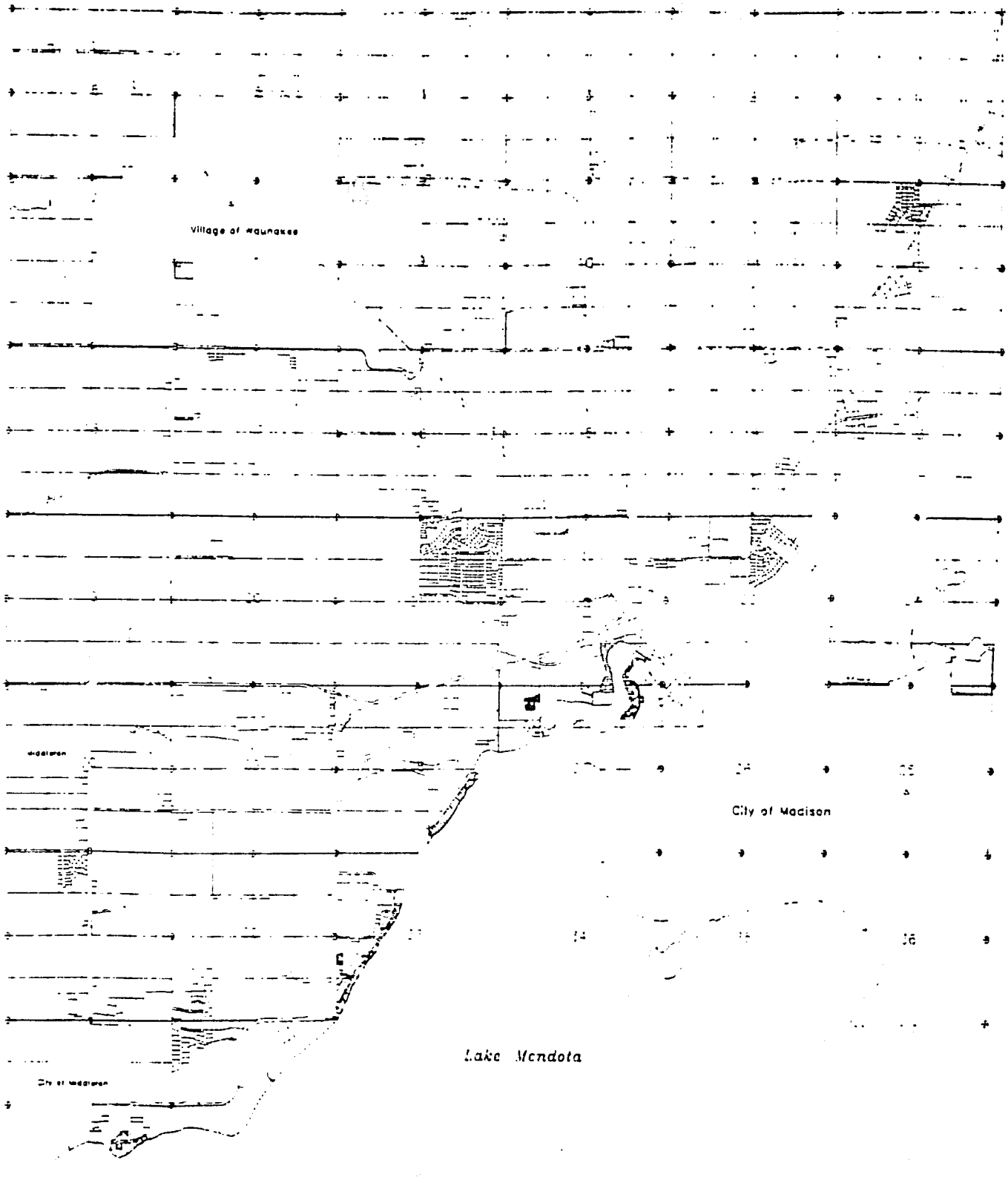

Figure III-2

likely to be spread over the whole map area rather than framing the edges as they do with a property section map. The same Public Land Survey monuments and any additional control can be used.

A sample of a small scale resource overlay plotted with the property parcels is shown in Figure III-3. A portion of the Wisconsin Department of Natural Resources wetlands inventory (originally published at 1" = 2000' on an aerial photo base) is shown plotted with the property parcel overlay for a central area of Westport. Twenty-one control points were used to register the wetlands overlay, and close inspection will reveal areas of good and bad registration. With wetlands information so subject to interpretation variability, and with problems added by distortions in the aerial photo base, the net registration is quite good. Registration of the digitized files is both easier than a manual integration and more consistent than a repetition of a manual composite would be.

The same digitizing procedures can be used to enter large scale information into the computer. Large scale maps are most often compiled by photogrammetric means using ground survey control information to compensate for relief displacement and other distortions. The maps usually incorporate contour lines at two or four foot intervals.

Some areas of Westport had been mapped at large scales by the City of Madison. Certain features on the maps were useful to the Westport Project to check the reliability of smaller scale information as well as to demonstrate the use of a variety of source maps. Figure III-4 shows an overlay of the pavement surface (dashed line) from a large scale (1" = 200') topographic map with the property parcel map of the same area. Ideally the

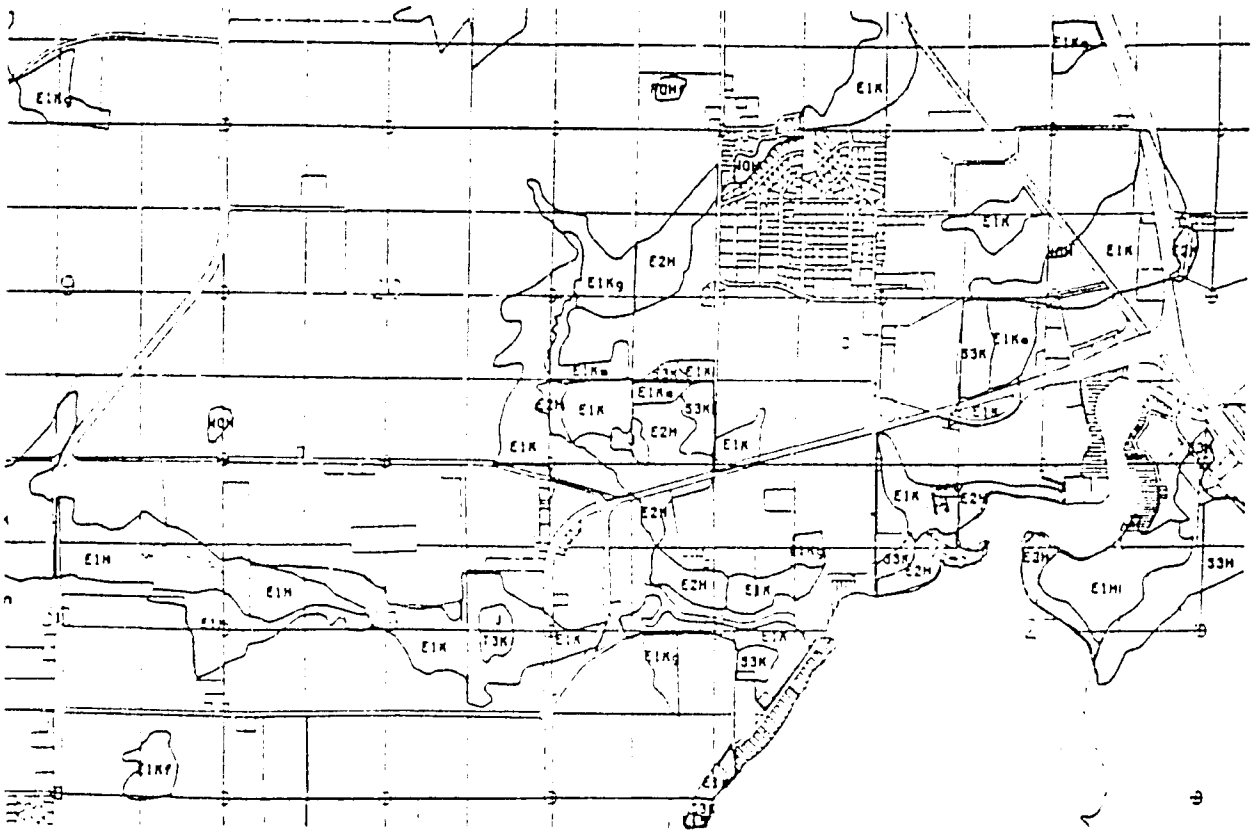

Figure III-3

pavement surface would fall at the center of each road right of way, and in fact the registration of the two independent sources is quite good. In contrast, Figure III-5 shows an overlay of two sources which do not agree. The solid line water boundary is part of the parcel overlay, while the dashed shoreline has been digitized from the same 1" = 200' topo series as the pavement in Figure III-4. The discrepancies in the shoreline are partially due to spatial errors in the property base maps, but the major difference stems from the compilation dates of the maps. The property parcel map shoreline was based on the 1908 plats of two subdivisions, while the topo map was drawn from 1967 aerial photography. Unfortunately, the 1908 shoreline is being used for assessment purposes, despite the effects of 60 years of erosion and

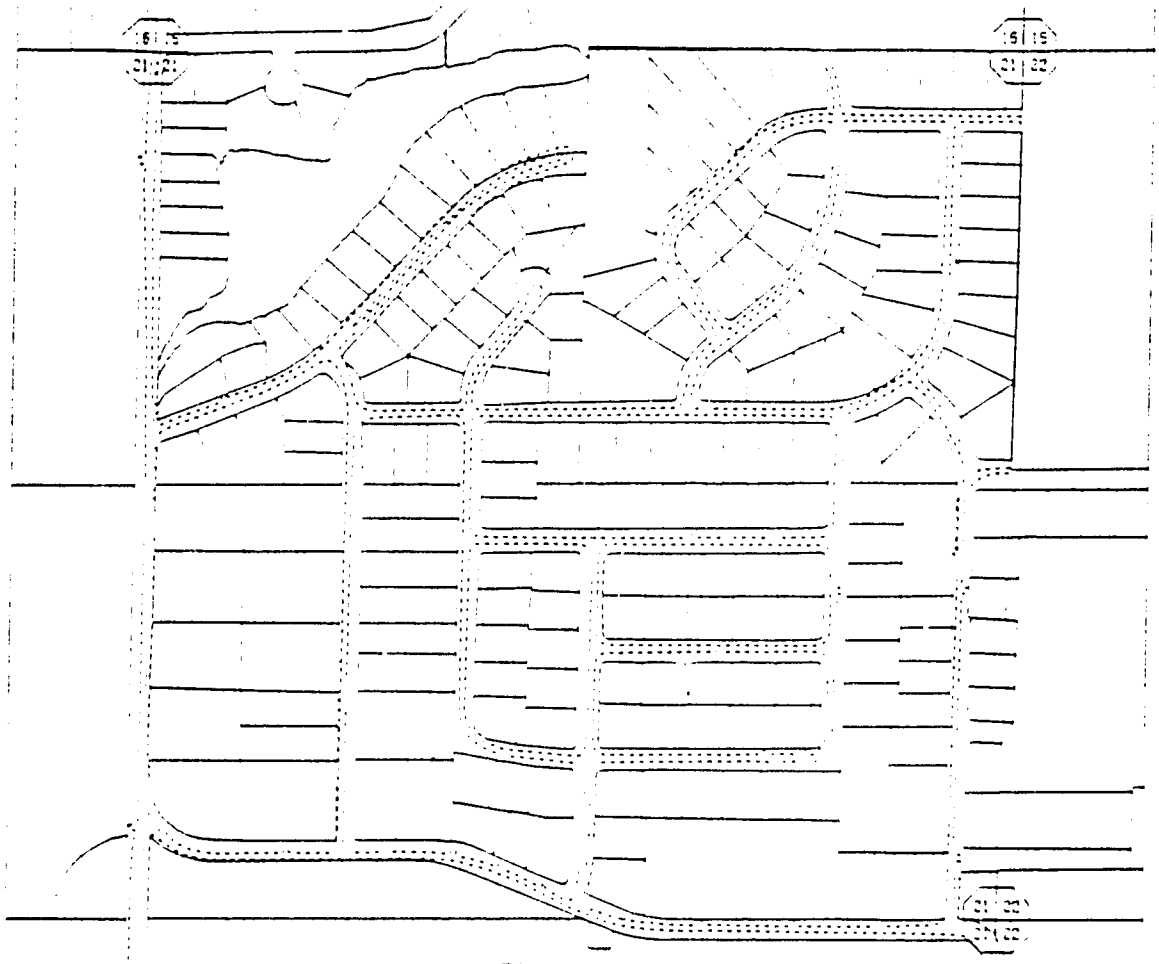

Figure III-4

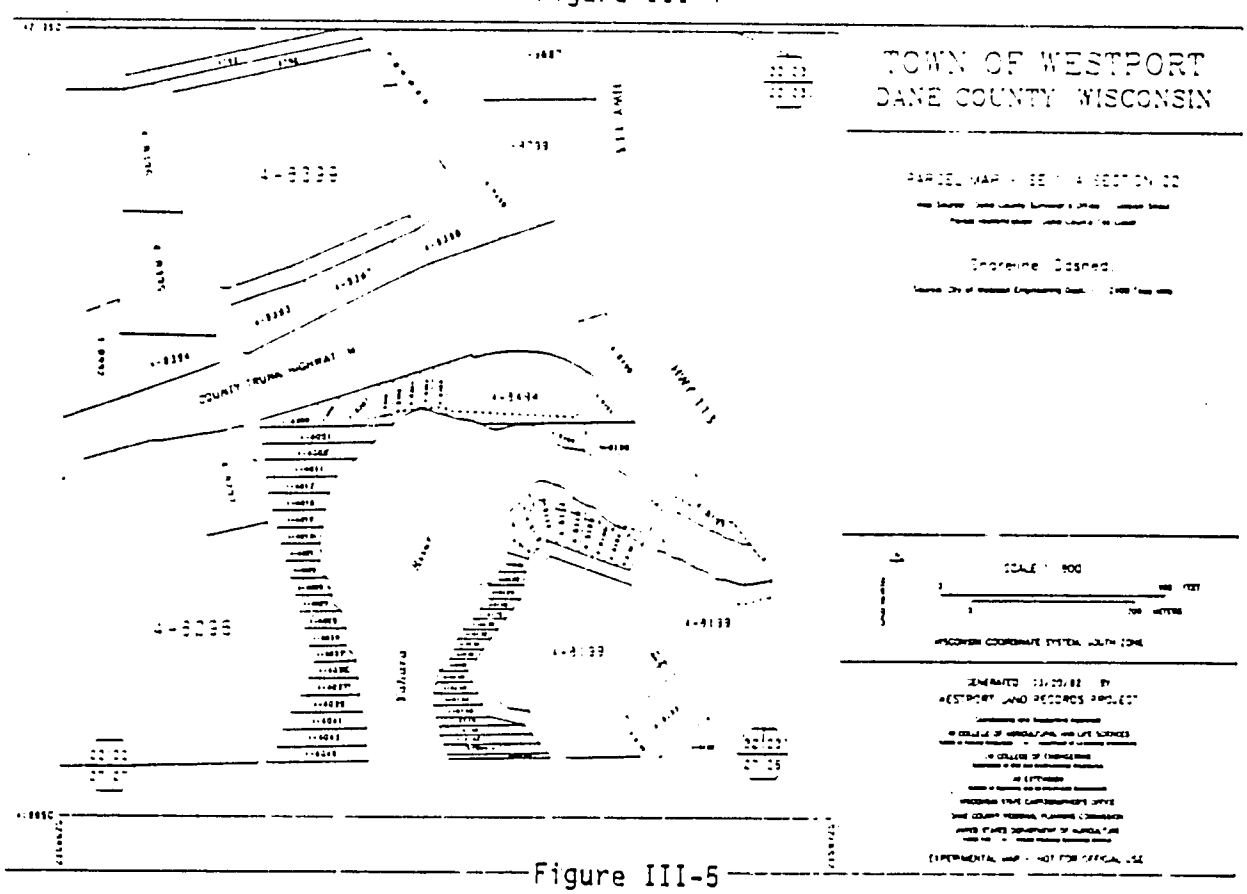

Figure III-5

deposition. Where available, large scale information could be registered with smaller scale sources as shown here, and then used to facilitate updating and correction of the smaller scale map.

The remainder of this paper will deal more specifically with using existing source maps to address immediate land information needs while permitting flexibility for improvement. Section IV will discuss how map information must be evaluated as part of the planning process for a land information system, and section V will detail how the Westport Project has dealt with source maps to permit more consistent integration of available land information.

IV. SPATIAL PROBLEMS IN LAND INFORMATION

The Westport Project has as a research project been predicated as much on exploring issues in spatial land records as it has on developing products to illustrate recommended approaches. Section III demonstrated the kinds of map products which computer graphics can provide. The manipulation of scale and the potentials for efficiencies in data entry and updating are very attractive, and many potential users consider these advantages reason enough to invest in computer graphics. Further issues and questions remain, however, which can in large part determine the long term benefit of any chosen course for better management of land records.

Perhaps the biggest single limitation for computerized land information systems is the question of original map data quality. Very often the problems which first stimulate an agency or municipality to investigate computerization run deeper than the most visible symptoms of slow turnaround time and awkward production procedures. The maps themselves may be out of date, incomplete, inconsistent, spatially warped or irregular, undocumented, and extended beyond their original purpose. New map series offering greater accuracy and consistency are extremely expensive and usually very time consuming to produce, with the added problem that in some cases the information to create accurate maps simply does not exist. Some information is subject to so much interpretation error (such as wetlands or soil types) that accurate maps are impractical, and in many cases the property ownership information for an area cannot be resolved or defined closely enough to meet even current needs for reliable and accurate information.

Each agency or municipality which collects and maps information has designed mapping procedures for its own needs, based on the amount of money and time it can devote to the task. The federal government obviously has a somewhat different level of interest than a village trying to plan a sewer extension, and both may be subject to time or financial pressures which interfere with the quality of the result. The methods of map compilation may vary all the way from the crudest of interpolations to the most precise photogrammetric procedures. Even the best maps are limited by their inherently flat representation of a three-dimensional world, and by the abstraction and generalization that inevitably accompany the scale reduction from the real world to maps.

These inconsistencies of map information have been frustrating geographers and planners and other map users for years. The usual solution has been to swallow the discrepancies through scale reduction, line width, or judicious redrafting. A fresh clean composite map looks accurate, and if it is drawn at a different scale than any of the source maps, the extent of fudging is not usually apparent. Often the problems don't show up until a later project takes some of the same source information and tries to compare it with earlier results. Figure IV-1 shows an example of what can happen to original information that is transferred successive times and then compared. Three versions of the same floodplain are shown--the thin solid line shows a compilation on large scale topo maps, the thick solid line was drawn and published by the Federal Insurance Administration on a converted USGS base map, and the dashed line is a local transposition of the FIA map to larger scale zoning map sheets. Unfortunately, the dashed version is what is used to enforce floodplain ordinances. If further sources such as the environmentally sensitive districts on the town plan maps were overplotted, the

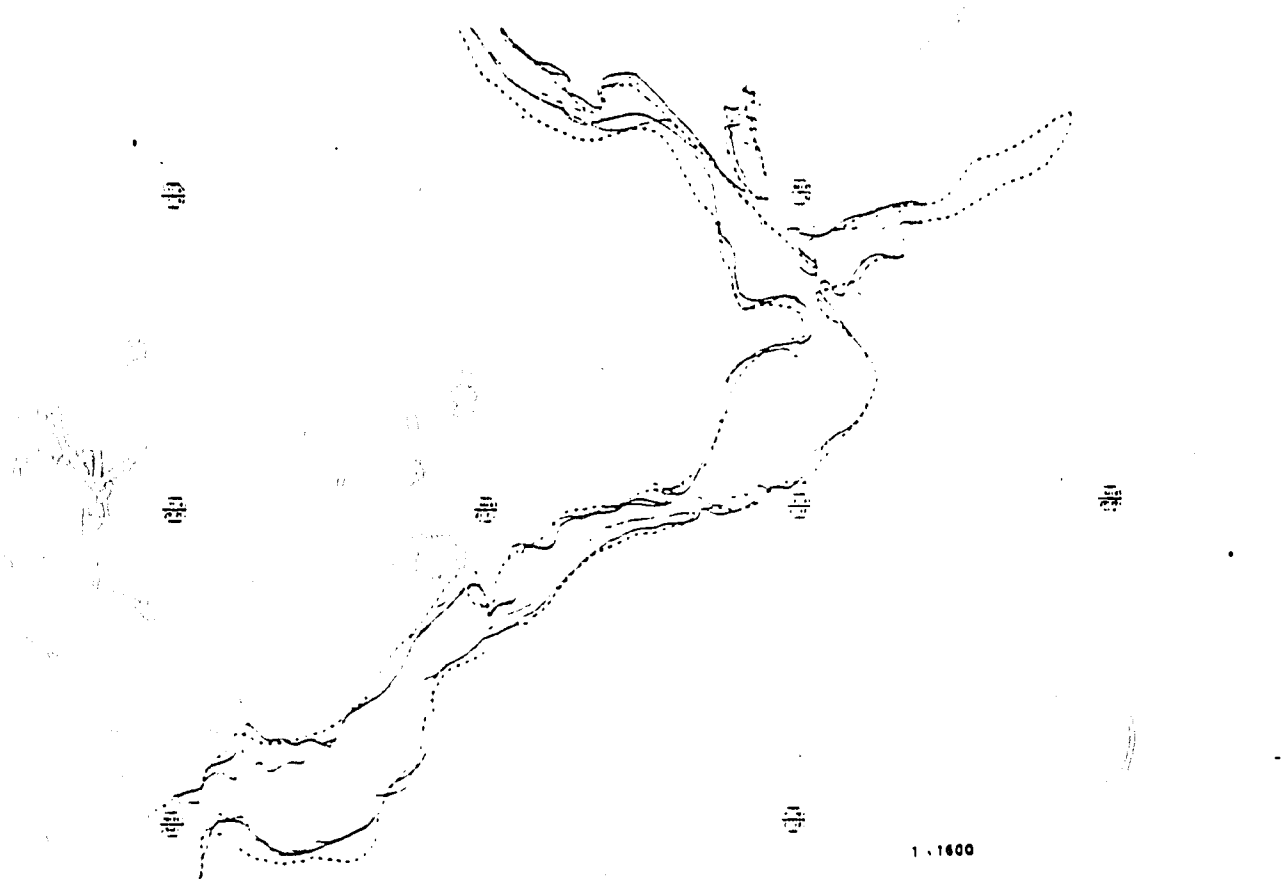

Figure IV-1

discrepancies would be even greater. The ability to digitize the best available source map, and to then plot it out at different scales as necessary for different users, would eliminate the problems of consistency and also do a lot for final map accuracy. Of course, digitizing and adjustment to ground control cannot magically produce accurate maps, but the inherent quality of the source map can be maintained rather than successively degraded by each transfer and reproduction.

However, the advent of computer techniques for map encoding, display and analysis can in other ways complicate rather than simplify the issue of land data quality. Overlays of map subjects such as property and wetlands or

floodplain or soil types may look very accurate, and the computer has in fact placed x-y coordinate values on every point and line. Advanced software can tell the user "exactly" how many acres of land fall into both floodplain and wetland classifications, or how much of Farmer Jones' land is prime farmland and should be taxed as such. But how reliable are these figures if all the information in each overlay is floating around on an imaginary surface which may or may not bear a consistent relationship to the ground? Users tend to react to the graphic presentation nd the aura of computers and conclude that the results are unassailable. Even sophisticated users who want to isolate the effects of data error and system error will find digital files nearly impossible to decipher and generalize. Consequently, a municipality or agency which has direct control over all its map data can enforce higher standards and expect better results from a land information system than an agency which must merge a variety of sources beyond its control, as is likely to be the fate of a planning agency.

One final complication relative to map data is that information will change over time. Most commercially available information system software has straightforward and convenient updating capabilities to accommodate change in thematic information over time. But can a system compensate for changes in the spatial framework of the base map information? At the very least, the changes in the North American Datum expected in 1983 should be accommodated, and more random changes in base information can be expected as surveying techniques improve and expectations for accuracy rise.

The efforts by the Westport Project to address the problems set forth in this section will be described in section V of this paper. But what is

most important to stress here is that the designers and users of any land information system understand what their inherent data quality levels are, and how problems in data quality are addressed by the system they use or that they are designing.

V. INTEGRATION OF LAND INFORMATION

The Dane County RPC and the University researchers were both aware of the problems with map sources at the outset of the project. The strongest impetus for the DCRPC's involvement, in fact, had come from frustration with the spatial problems of property maps in comparison to the natural resource information which plays such a large part in planning decisions.

Dane County is fortunate in having a large scale property map series at 1" = 400' to cover the entire 1200+ square miles of the county. The map sheets date back to a WPA program in the 1930's, when they were drawn using the then best available information. Adjacent sheets were not reconciled, probably since the most common use of the maps was to investigate ownership questions within one individual section. Unfortunately, the shape of a section map does not necessarily correspond to the shape of that section on the ground, due to distortion in aerial photos used to compile the maps or to a simple lack of information. As a consequence, modern accurate surveys must often be distorted to fit into the framework of the existing maps. The distorted version then comes into common use for comparison with zoning or floodplain or other information.

The worst case examples have been replaced by more modern maps when enough new information accumulates to resolve the questions left unanswered by previous maps and surveys. But manual redrafting is very time consuming, especially if conflicts must be researched and resolved. A good map with few problems can take 8 to 12 hours, with extra research adding time on top. No funds are available for field work to resolve discrepancies, and the county remonumentation program is concentrating on more immediate problems with obliterated or conflicting monuments.

The Westport Project investigated an alternative mapping method in a test area to evaluate the source maps and the digitizing process. Data can be entered directly into the computer as state plane coordinates, bypassing the manual drafting, the digitizing, and the adjustment processes completely. With the help of Mr. Arden Sandsnes of Royal Oak Engineering in Madison, the firm's coordinate geometry software was used to calculate state plane coordinates for property boundaries of several parcels in the Town of Oregon in Dane County. Given a state plane coordinate on a starting point, the software generates coordinates from the bearings and distances listed in the legal description of the property. These coordinates can then be plotted to produce a map of the parcels, which for the study was then compared with a recently redrafted map of the same area.

Where accurate ground surveys are available, direct coordinate geometry entry could provide an entirely scale independent property mapping file which could legally define the parcel and serve as a cadastral system. Figure V-1 illustrates the Oregon test area discussed above, with the directly entered parcels shown by dashed lines, and the redrafted and digitized parcel map shown as the solid lines. (The obvious discrepancies in the roads are the result of stopping the digitized parcel boundaries at the edge of the road right-of-way for clarity in the overall map.)

The redrafted lines are close to directly entered coordinates, but the 8 to 12 hours of redrafting time (or more) per sheet may not be justifiable if the results cannot meet the high accuracy standards which direct coordinate entry could provide. On the other hand, complete survey information of known accuracy for direct entry does not exist, and will probably only become available on a piecemeal basis over time.

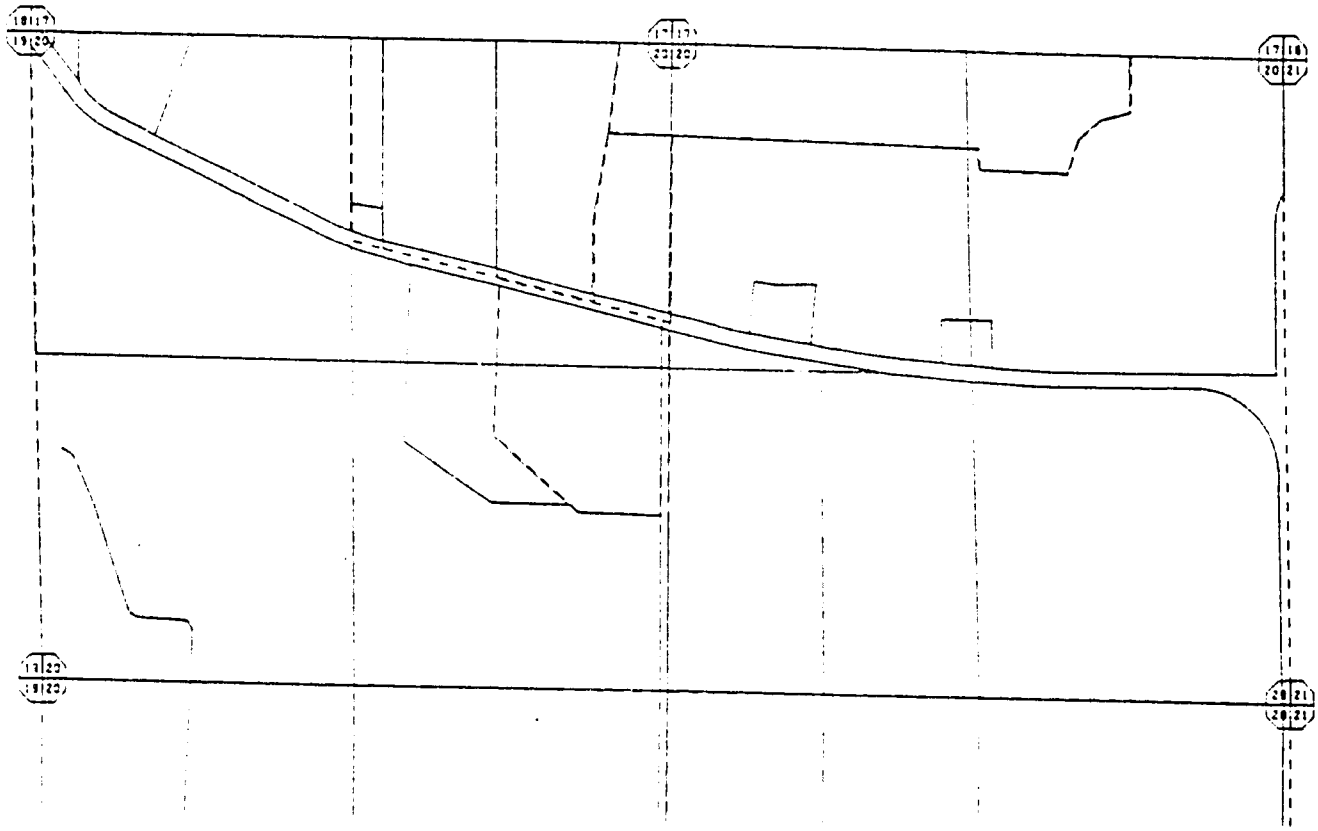

Figure V-1

Just how much of a limitation in accuracy would be incorporated into a system which uses digitized versions of existing maps? One variable is the accuracy of the digitizing process itself. The repeatability of a careful operator under ideal conditions on the project's Talos digitizer was found to be .007 inches, or about 2.8 feet at the scale of the property parcel maps.[5] Random operator error under everyday conditions would undoubtedly reduce map quality further.

The net accuracy of digitized and adjusted maps can only be conclusively investigated for small areas, by calculating coordinates from verified ground surveys to compare with the new map coordinates. In one sample area in Westport, the project conducted field surveys to compare map coordinates with

field coordinates along a section line. Points where parcels intersected along a section line were improved from an average discrepancy of 9 feet on the original map to 2.5 feet on the digitized and adjusted map, judged relative to the surveyed position of each point on the ground.[6] The survey work is now being extended to interior points of the adjoining sections to evaluate the effects of adjustment on the entire maps.[7]

In a less rigorous test, the redrafted maps in Oregon were digitized and compared to digitized and adjusted versions of the original maps they replaced. Two of the maps are shown in Figure V-2, with the original map plotted as the dashed lines. Comparisons of the digital coordinates of the old and the redrafted maps indicate average discrepancies of 22.1 feet on the left map, with 90% of the points within 48 feet of each other--not impressive.

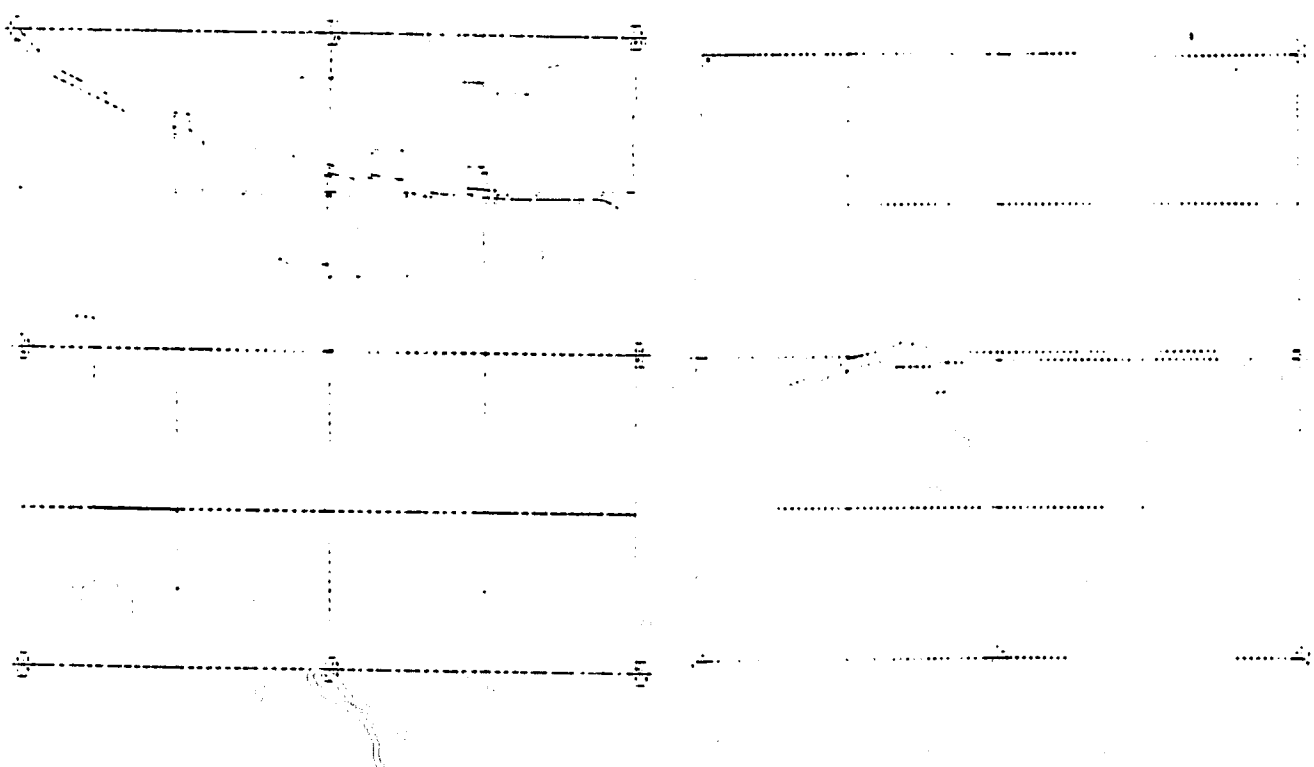

Figure V-2

The right hand map had more reasonable results, with an average discrepancy of 9.3 feet, and 90% of the points within 18 feet of each other.

The adjustment process can correct for systematic error from maps having overall dimensional errors, but cannot correct random or isolated errors. Where discrepancies become apparent--along the edges of map sheets which do not match after adjustment, for example--they are relatively easy to fix, as indicated by Figure V-3. A search of ground survey records produced a state plane coordinate for the center of the road right-of-way, which when incorporated into the map adjustment process for both adjoining map sheets virtually eliminated the matching error.

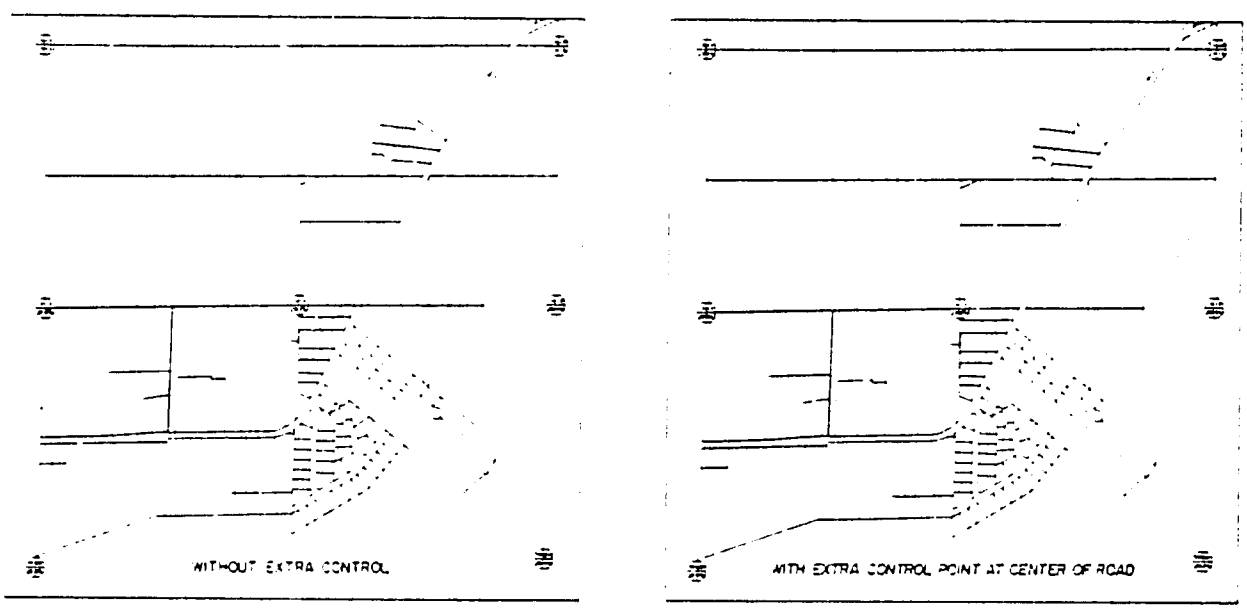

Figure V-3

The use of ground control to correct discrepancies certainly enhances the accuracy of maps more than standard edge-matching procedures do. The Westport adjustment procedure is designed to accomplish as much as possible of map registration and edge-matching through ground control, with more

cosmetic techniques limited to clean up a final display by matching lines using judgement or averaged positions.

The magnitude of edge-matching shifts which would be required to clean up a map display was tested across the whole project area as one further but indirect assessment of the accuracy of the maps. For 45 regularly spaced but uncontrolled points along the section lines, called 40 corners (see Figure I-2), the disagreements on adjacent map sheets averaged .021 inches on maps plotted back at the original scale of 1" = 400', or about 8½ feet on the ground. Less regularly spaced points where roads and parcel boundaries crossed the section lines disagreed by about twice as much, apparently because they are more prone to drafting errors. A few points were so bad on the original maps that they were still 50 feet off on the adjusted maps. Discrepancies as large as that should be tied directly to ground control, as in Figure V-3.

Considering the state of the original map sheets, where the lengths of common section boundaries often varied between 50 and 100 feet at ground scale, and angular disagreements could cause even greater discrepancies between adjacent map sheets, the edge-matching needs of the digitized maps following adjustment seem mild.

Probably the simplest way to communicate accuracy limitations is to state the scales at which the map is appropriate to use. For example, it would certainly be inappropriate to plot the Westport parcel overlay at 1" = 100' in order to scale property dimensions off the map. The adjustment process permits the parcel maps to be used more confidently at their original scale of 1" = 400', since areas in question can be checked by scaling from the section corners or quarter corners to which the survey was referenced.

In fact, the most common use of the parcel maps for planning applications is at the reduced scale of 1" = 2000' that permits showing a whole town on one sheet. At this scale the digital overlay eliminates the need for separately maintaining a composite property map, as is now done, and permits the parcel information to be registered consistently with other resource information commonly published at small scales.

Integration of Map Overlays

Up to this point, map integration has been discussed only for property parcel maps, for which expectations for consistency and accuracy are most demanding. The same procedures can be used to merge other map overlay subjects as well, as illustrated in section III, and the overall advantages of digitizing and adjustment to ground control are probably clearest when several map overlays must be integrated.

The Public Land Survey monuments work very well as registration points for nearly all available map sources. They are spaced frequently and regularly, and are maintained on the ground because of their legal significance as the starting points of property boundary descriptions. The U.S. Geological Survey quadrangle map series show the Public Land Survey section lines, so that shorelines or topography or other features digitized from USGS maps can be linked to the section corners and many quarter corners as control points. In addition, many roads and fences follow section lines, so that road features or fenceline intersections can be used on line maps or on medium or high altitude photography to indicate section corner positions. In this manner, information not specifically tied to a coordinate system can be registered to ground control adequately for small scale use of the

information. The wetlands overlay in Figure III-3 was digitized from an air photo base that had no control points indicated and no grid ticks marked on the map.

The quality of the registration of one map to another will vary with the number of common control points, their spacing, the scales of the original map sheets, and the amounts of systematic and random error in the original maps. It may not always be simple to assess the registration without field checks; the extent of disagreement between two sets of lines where it is known they should agree (along a shoreline, for example) can provide a visual measure of the probable discrepancies elsewhere on the map. Where problems show up, additional control can be added to both maps to tie them together at known points observed or surveyed on the ground.

Interpretation of the overlay of two separate maps should, of course, be tempered by any available knowledge concerning their respective reliability. In general, larger scale original maps can be expected to have smaller errors due to the scale advantage for initial drafting. In many other ways, the overlay process will be subject to systematic and random errors which cannot be easily sorted out.

The Westport Project has not yet systematically evaluated overlay registration by comparison to ground conditions. Aside from the surveying effort required for more than a trivial sampling, the project participants have been deterred by the degree to which information may be subject to interpretation errors, or may physically change over time (as in the case of the lake shoreline). Sometimes, as with floodplain and wetlands information, the legally adopted official inventory map may have more significance than an independent and possibly more accurate new map or survey would have.

The major advantage of digitizing and adjustment of separate overlays is the repeatability of the registration. The best available source map can be digitized and checked once, and then subsequently be consistently plotted at the different scales or with the different other overlays that each user may require. We saw in Figure IV-1 the confusion and error that can result from multiple transfers and versions of the same information. For planning applications, where common overlays such as floodplains are repeatedly incorporated into different studies at different scales, the ability to maintain consistency in the same information over time would significantly upgrade the quality of the final map products used for public decisions.

VI. SUMMARY COMMENTS

Any group planning for a land information system involving computer mapping must set out in advance to determine what condition available source maps are in, what objectives are to be met, and how those objectives and the information itself are likely to change over time. Participants in the Westport Project have gained some insights and developed some opinions concerning land information systems which should be summarized at this point.

One underlying belief built into the Westport approach is that each information source should be digitized and stored as a completely independent overlay. The project has no base map to which all other information has been converted, and there is no structure which codes one type of geographic unit as dominant, with all other information entered as attributes or subsets of the primary unit. One major reason for leaving separate map subjects independent is that they have been mapped independently, to different standards and on different base maps. Conversion by manual means to conform to property parcel maps or other base maps takes time and involves manual warping that clouds whatever integrity was built into the information as published. It also implies that one's base maps are accurate, which can only be true to a certain extent. Perhaps more importantly, however, the coding of some kinds of information as subsets of another locks analysis and use of the information into the original structure. If soil types are coded and digitized as sub-boundaries within a parcel, for example, and wetlands are similarly coded, then wetlands and soils can only be indirectly related through the parcel file. A user might have no interest in property parcel boundaries, but would have to use information converted to conform to parcel boundaries, with all the compounding effects that conversion would introduce.

Finally, a change in the primary unit (usually the property parcel) would require changing all dependent files as well, which would vastly increase maintenance costs and inconvenience. Flexibility for change and for alternative data analyses is likely to become a key factor for geographic information systems.

Another underlying belief in the Westport Project is that ground control information is essential for any system seriously attempting to relate different source information, even at a very small scale. Having already discussed the mechanism for using ground control to register maps, I would only stress here the need to control the degree to which information floats on maps. Digital analysis of amazing precision can be utterly meaningless without controls for accuracy, and the concepts of spatial error need to be more fully incorporated into the thinking of map users and information system promoters.

An underlying structure of ground control permits extraordinary flexibility in bringing accurate information into a system as needed. While ground survey and precise photogrammetric analysis linked to ground control are both expensive techniques for acquiring data for a whole system, they could provide very cost effective ways of upgrading the general system's data for small areas of particular concern. As an example, a planning commission could use a general level information system to search its entire region for solid waste disposal sites, and then concentrate more accurate field studies where the overall analysis indicated. Both levels of data could be registered using the ground reference points, and the level of agreement between the general predictions and the more detailed surveys could provide an estimate of the quality of the system-wide information.

A system which can be related to independent ground control can also change over time as more ground control becomes available or as individual surveyed points change over time. For example, the Westport Project initially used some section corner coordinates which were estimated by digitizing their positions on a mylar USGS topographic map. As more ground surveyed and photogrammetrically measured coordinates became available, the adjustments of affected maps were redone using the new coordinates.

Probably the strongest lesson learned by project participants is that no one idea can be pursued blindly as a single final solution, and that no user can expect to have every need or desire met to full satisfaction. The sheer cost of assembling and handling land information requires that compromises be made. The range of interests and disciplines represented in the Westport Project has helped the participants to educate themselves in the variables involved and the consequences of different approaches. As the project continues, more questions will be raised and hopefully more conclusions can be documented.

The expectations raised by new technology have in many cases led to many new problems for the early users of that technology. Hopefully, research and experience can be publicized well enough to permit greater understanding of the nature of map information and the capabilities of technical procedures. While new advances in surveying and computer technology and in software will help, there will continue to be no substitute for realistic and careful long-range planning before any investment in land records improvement is made.

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New computerization program should be a vast improvement

By David Stoeffler
Environmental reporter

THE LAND: our threatened resource
A second look

A pilot project to computerize land records in the Dane County town of Westport has shown that landowners, builders and local officials have often relied on maps and records that are inaccurate.

While showing how to find and correct errors is an important goal of the project, Bernard Niemann Jr. and his colleagues at the University of Wisconsin-Madison look at the program as a boon for landowners and land-use planners alike.

Niemann, a professor in the college's Department of Landscape Architecture, dreams of the day when a landowner can ask a computer to produce a map of his land, complete with zoning restrictions, wetlands areas, soil suitability and any other piece of information the users feed the computer.

"I want to know what infrigements are on my land," Niemann said. "An individual owner can't really, unless he's very industrious" gathering and studiously comparing all of the several different maps.

But what makes the project exciting for land-use planners is the ease with which a computer can compare and contrast the different land records and provide new maps in response to particular questions put to it.

"We're moving from maps as graphic products to an analytical function," said Nick Chrisman, an assistant professor of landscape architecture.

For example, computerized land records could have helped the Dane County Regional Planning Commission in surveying possible sites for landfills in the county, Chrisman said. All the commission staff would have done was tell the computer what type of soils, slopes and locations it was looking for and the computer would have given them maps of all the potential areas.

Combined maps created by the computer would also help land-use planners decide the best sites for future housing developments, highways and other changes.

The Westport project, now in its third of four years, is a joint effort of the UW-Madison* and the Regional Planning Commission, with assistance from UW-Extension, the State Cartographer's Office and the U.S. Department of Agriculture.

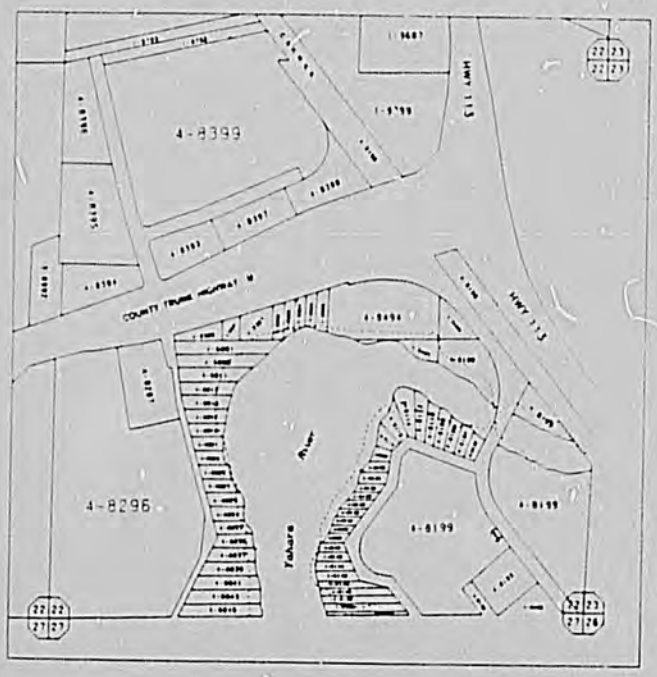
The project is somewhat limited by budget to focusing on certain parts of the town, rather than computerizing all town records. Many existing maps have been digitized for input into the computer. Most have needed adjustments for inaccuracies caused by the different methods in which they were prepared.

The project has used information from a highly-accurate Public Land Survey in the attempt to correctly match the different maps.

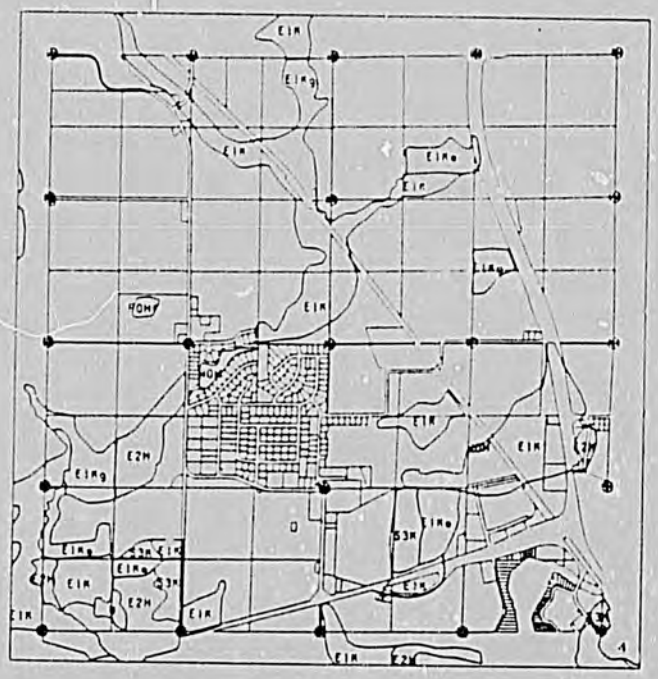
While some of the equipment needed for the computerization of land records could be viewed as expensive, Niemann noted that the costs are coming down and that the current system of keeping records is expensive, too.

A study found that in 1976, Wisconsin residents paid $78.7 million to maintain land records, an average of $17 per person or at least $34 per taxpayer. Nearly $9 of the cost was at the local government level.

Researchers are keeping complete accounts of the expenses and time associated with the Westport project in order for local governments to draw their own conclusions about the economic, administrative and subjective aspects of conversion to computerized records.



This computer-generated map reveals errors in the current maps used by property owners and the county for tax purposes. Each parcel of land is identified by number and is shown as it is supposed to be according to property maps and descriptions. The dotted line shows where the actual shoreline of the river is according to recent, more-accurate mapping.



The computer can produce a map upon command that compares the current section and property lines, plus existing subdivisions, with an overlay of the state Department of Natural Resources map of wetlands. The different designations symbolize different types of wetlands and correspond to different types of uses. This is the area of Westport near the Mary Lake subdivision. In the right-hand bottom corner is the Yahara River as it opens into Lake Mendota. Highway 113 is along the right. Highway M is along the bottom.

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SESSION V

THE COST AND VALUE OF LAND RECORDS

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ABSTRACT

The creation and use of land records in the land development process is examined as is the role of these records in understanding land tenure. The costs of maintaining the existing public records systems in Wisconsin are described. Proposals for improvement based on a geodetic control system and large scale maps or digital products are outlined. A method of measuring the benefits of such a system is proposed.

INTRODUCTION

Recent years have seen the growth of federal, state and local regulations which influence land use and development. These regulations represent a continuing tension between perspectives of land as a commodity and as a natural resource. In some circumstances the tension is seen as a war between private rights and public interests.

The regulatory process both requires and generates land data and information as the basis for risk assessment and decisionmaking. The data and information are becoming part of that which determines land tenure.

LAND RECORDS AND LAND TENURE

The relation between land records and land tenure is illustrated by the process of private land development. This process is summarized as the desire of an individual or corporation to locate, acquire, secure, and develop a specific parcel of land for a specific use. The process includes the following actions:

1. The decision to acquire and develop a site for a specific use.
2. Identification of alternative sites.
3. Characterization of the alternative sites.
4. Selection of a site.
5. Acquisition of financial support.
6. Purchase of the site and security of ownership.

7. Characterization of the site and activity sufficiently to satisfy lending, regulatory and other decisionmaking.
8. Design and construction.

Several of these activities may occur simultaneously. Others depend crucially upon the availability and quality of land data and records. We are interested in how these various actions depend upon and influence the land information system and its attributes.

The information aspect of the land development process can be illustrated by the example of a proposed purchase and development of a site for an industrial building in a metropolitan area. The process begins with identification of those jurisdictions which appear reasonable for location of the building. This requires information about land value, zoning, and physical characteristics such as soil and topography, roads, and traffic. This analysis seeks to identify a set of potential sites. Typically, the analysis does not require information high in spatial accuracy or compatibility of features. The information demands may be characterized as more qualitative than quanitative. The demands are typically satisfied from existing sources of information such as United State Geological Survey Topographic Maps and thematic products built from these maps. Othe sources may be used for special features. At this phase of the process, the accuracy and compatibility requirements remain relatively low.

The object is to characterize areas rather than specific sites with respect to features such as flood plains and watersheds, traffic, value, parcel locations generally, and other spatially extensive

features. The information is typically of an accuracy appropriate for representation on a product at a scale of 1:24,000.

These products are used to select a site or small number of sites for a more detailed, preliminary analysis. Typically data is obtained with an accuracy appropriate for representation at a scale of 1:5000. The object is to characterize the site geology, highway capacity, surface cross-sections, transmission facilities, etc.

When a single site is selected and the process of acquisition begun, there must be further characterization. The objectives are to establish specific design alternatives, the status of ownership and boundary, and to assess environmental and regulatory requirements. This effort requires data significantly more precise than that required in the earlier phases, typically data appropriate for a 1:1200 or even a 1:600 scale product. At this point, the goals of data gathering and analysis are to satisfy the lender, assure ownership and boundary, secure all regulatory permits required for the intended use, and prepare site plans sufficient for the architect and construction engineer.

This process is representative of the activities which occur when land is purchased with a specific intended use. The process is accompanied by the demand for land information and data at an increasing scale of detail and accuracy. At the beginning, data typically displayed on United States Geological Survey 1:24,000 maps is available in metropolitan areas and used. By the time permits are sought in public hearings, site specific information at large scale and accuracy are often required but not available.

The developer, or often a land information specialist working for the developer, confronts the existing public land records system. Information not available or inadequate for decisionmaking, represents a demand imposed on the developer which is satisfied by an investment in data collection. The demands are often by public regulatory agencies who must decide on land use. These agencies also rely upon the existing, public land records system for information. The perspective of the developer, or land information specialist is that "the agencies may receive a great deal of qualified data regarding a given parcel and the immediately adjacent areas but they have no framework into which they can assimilate this data."[1] Such information, and information generated by others including the agencies themselves, stand unconnected to one another at some level of precision and accuracy.

A basic land records problem is the way agencies and departments at all levels of government collect, maintain and display information about this nation's land. This problem includes the way the agencies relate to citizens and with one another as well as how each agency internally handles its land data and information.

There are several mainfestations of this basic problem. Frequently the compilation and display of data and information occurs without a knowledge of what others are doing, planning or have already done. There is often an absence of a correlated plan for reduction of cost, avoidance of duplication and promotion of exchange of land information. There is an apparent inability of government to take advantage of modern technology for storage and retrieval of the great amount of land data generated in increasingly sophisticated ways.

The result is a poor picture of physical changes in the land and of changes in land tenure. We have not developed a means to relate information about the natural divisions of the land and man's division of the land. We have no common base of information about land - its boundaries and associated rights, its accurate measurement, its physical characteristics, the layers of public control, and ultimately its profitability, use or economic potential.

THE COST OF LAND RECORDS IN WISCONSIN

Public agencies at all levels of government collect, analyze, store and disseminate land data and information. There is an investment of public money to operate the offices that execute these activities. These costs have been studied for Wisconsin.

The primary source of information is a report entitled "Land Records: The Cost to the Citizen - A Wisconsin Case Study."[2] The preparation of this report was conducted by individuals from the Wisconsin Department of Administration and the University of Wisconsin-Madison. Funds came from the Resource and Land Investigations Program (RALI) of the U.S. Geological Survey, Department of Interior. In addition to financial support from RALI, the following people have contributed to the design and completion of the Wisconsin study: Barbara Larsen and William Gulley of the Wisconsin Department of Administration, Professors James L. Clapp and Bernard J. Niemann Jr. of the University of Wisconsin, R. Steven Fratoni of the Institute for Environmental Studies, Arthur L. Ziegler, Wisconsin State Cartography and Allen H. Miller of the Wisconsin Office of Planning and Energy.

The study documents the minimum annual expenditure at all levels of government for compiling and maintaining land records in Wisconsin. It is the only known effort to determine these public costs.

Knowledge of these non-trivial public investments in important. Without this evidence, the executive and legislative branches of government are unlikely to move with sufficient momentum and with the necessary intensity to confront the land records problem. It is also important because the individual taxpayer can be told directly what it costs to operate the current system.

The study has also added to knowledge of the land records system in Wisconsin. The division of responsibility for these records among the various government levels is clearer as is the regional variation throughout the state.

The project started with a practical definition of land records that included criteria and examples. Working materials included interview guides for each level of government, logs for recording responses and expenditures, and several informational packages about the project. Introductory letters to governmental and utility company officials were prepared and sent to administrative and program managers, with follow-up telephone calls.

The terms land information system, geographical information systems, or resource information system are relatively new and often are used interchangeably with land records and multi-purpose cadastre. In this study, these terms are used interchangeably.

The term land records includes governmental data required, collected or maintained for real estate valuation and taxation, land

transfer, environmental protection, and land use and resource planning and management. Also included are some land record activities by utilities. The term documents refers to the form in which land-related data are most commonly used. These documents usually include the following types: maps, deeds and other title related material, plats, inventories, logs, microfilm, publications, field notes, magnetic tape reports and questionnaires.

Within this discussion land records exhibit government and citizen interest in the natural and cultural (including ownership) aspects of the land whether in, on, above, or under the surface of the earth.

Agencies and offices at various levels of government were contacted. The methods are briefly described:

a) State

A poll of all state agencies identified those having land records. Several interstate groups such as the Minnesota-Wisconsin Boundary Commission were contacted, with only Wisconsin costs being calculated. Agencies that contained the majority of land records were the State Department of Natural Resources, Transportation, Local Affairs and Development, Agriculture, Revenue and the University of Wisconsin System. In addition to on site interviews conducted by project analysts, budgets, program descriptions, and sample land records were examined. Related research papers and conference notes were examained and the authors contacted when possible.

Information was obtained for the fiscal year July 1, 1975-June 30, 1976. Any recently completed major projects or upcoming major projects outside of this sample year were briefly described, and a cost estimate attached.

b) Local

To derive a state total for local government expenditures would have required data from 71 counties, many municipalities, and more than 1200 civil towns. Rather, a sampling procedure was developed with the assistance of the State Cartographer's Office and the University of Wisconsin-Extension's Survey Research Laboratory. The sampling element consisted of the civil town, any village or city that fell within or abutted it, and costs from the county and regional planning agency in which the civil town was located. Land records expenditures by the county and regional planning agency were prorated to reflect only the civil town's portion of county and regional spending.

The state (excluding the Menominee Indian Reservation and the City of Milwaukee) was divided into eight parts of equal population and again into eight parts of equal area. The two independent samples included sixteen civil towns, six villages, three cities, fifteen counties, and eight regional planning commissions.

University of Wisconsin-Extension agents assisted in locating offices concerned with land records and in setting up interviews with local officials. Project analysts interviewed town, county, city, and village officials as well as regional planning commission staffs.

c) Federal

Federal agencies likely to have land records were identified. Previous studies and publications served as guides. The Project Advisory Committee supplied names of persons within federal agencies. These people were contacted by telephone before the detailed project materials were mailed. Telephone interviews supplemented correspondence and in some cases federal representatives in the state or in the federal region provided the needed information.

d) Utility

Four major electric and gas companies, one large power cooperative, and two major telephone companies were contacted by telephone with followup letters detailing what information was requested.

The project was carried out under several constraints. The definition of land records is supject to interpretation. While budgets for offices such as the Register of Deeds are well defined and all inclusive of land records, other budgets frequently do not contain categories for land information activities such as mapping charting, drafting, printing of maps, computer services or natural resource expenditures. These facts made it necessary to estimate expenditures. Program managers made estimates of percentage of staff time, administrative overhead, and direct costs attributed to land records.

The degree of confidence in the local cost figures is high since county and town budgets are relatively "tight" and are closely tied to identified responsibilities such as tax listing, tax assessing, registration of deeds, zoning, planning and surveying. Cooperation from

local officials was good. Though estimation was often necessary, cost figures from similar offices at different locations were reasonably consistent when compared with overall local budgets.

The degree of confidence in the state cost figures is moderate to high. However, problems of definition were greater and programs more complex with estimations often required. Federal spending, private sector contracting, and multi-year program made the task more difficult. Cooperation was good, and project researchers estimate that the state expenditure figures are within 20 percent of "actual" costs.

The level of confidence in the federal cost figures was lower than the confidence in local and state figures. Some federal agencies were able to provide the desired information; others were not able to identify and estimate costs of their land-related information. Separating expenditures for Wisconsin from total federal spending was a difficult task because few federal agencies publish activity reports by state. Project researchers followed with additional phone calls, but in a few cases were unable to obtain figures. One federal agency, the U.S. Army Corps of Engineers, declined to participate, stating in their letter that "it would cost $140,000 and six months to obtain the information you requested."

EXPENDITURES

a) State Expenditures

Total 1975-76 land records spending by each agency was divided by the state's January 1, 1976 population of 4,623,375. According to the

annual fiscal report for Fiscal Year 1975-1976, total state government expenditures for the sample year were $4,722,529,000. Approximately 10 percent of this amount ($472,523,000) went for environmental resources. State land records expenditures were estimated by the Land Records Project to be $11,582,818 for that year, or approximately two percent of the environmental resources spending. Agency estimates for land record expenditures follow:

Agency	Estimated FY 75-76 Land Records Spending	Per Wisconsin Citizen
Administration	$126,289	$.03
Agriculture	311,550	.07
Local Affairs	1,156,611	.25
Natural Resources	4,389,461	.95
Revenue	535,733	.12
Transportation	4,219,147	.91
University of Wisconsin System	576,455	.12
Other	267,572	.06
Total	$ 11,582,818	$ 2.51

b) Local and Regional Expenditures

The total estimated expenditures for land records by Wisconsin's local governments for 1976 is approximately $41,117,989, of $8.89 per resident. This is an estimate of the 1976 expenditures for land records by civil towns, municipalities, counties, and regional planning

commissions in Wisconsin, plus separately calculated expenditures for the City of Milwaukee. The sampling and statistical procedures used to derive this composite estimate are explained in Appendices to the study report.

c) Federal Expenditures

Federal agency expenditures usually were not organized by categories such as land records or by state. High and low estimates were cerived by project staff by supplementing agency-supplied data under this project with data from two related federal studies.

The estimating and averaging process used resulted in an approximate federal expenditure of $3.32 per citizen during Fiscal Year 1975-76 (July through June).

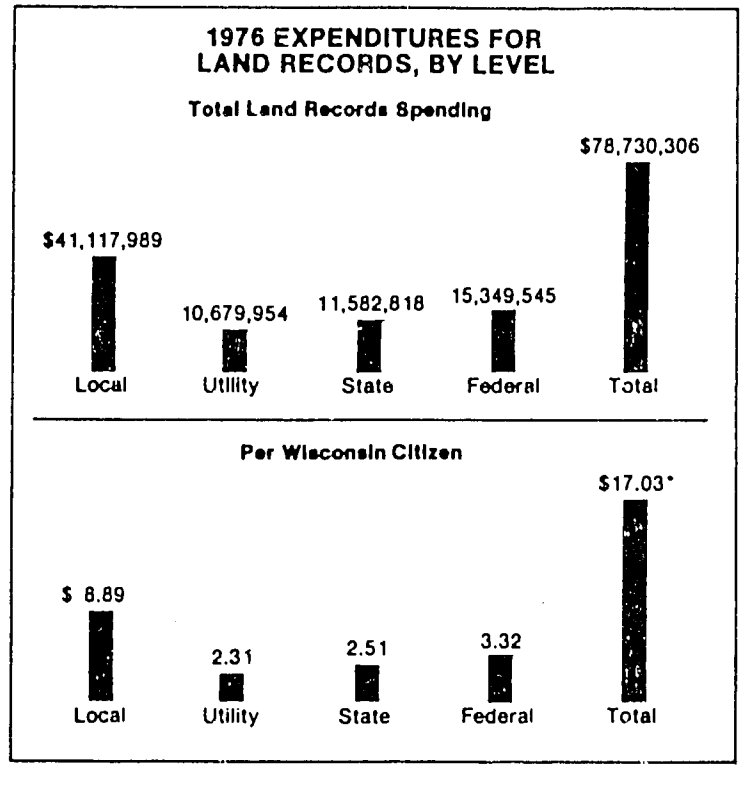
d) Utility Expenditures

As major users and producers of land-related information, those utilities contacted were well informed and concerned with governmental land records problems. Spending estimates for calendar year 1976 were obtained from one major telephone company and from two major gas and electric utilities. Expenditures estimates were divided by total population (not customers or households) in the utility's service area.

Company	Cost per Person		Estimated 1976 Land Records Expenditures
General Telephone	$ .83	.83	$ 734,476
Wisconsin Public Service Corp.	1.34	$1.48	939,000
Wisconsin Power & Light Co.	1.62		
Total		$2.31	$1,476,800

For comparison with government expenditures, the telephone utility's per capita expenditure was added to the average of the two power utilities per capita expenditures, for a single estimate of $2.31 per resident. This calculation was used to estimate an annual expenditure for land records by all utilities in Wisconsin as $10,679,954.

Total land record expenditure estimates by all levels of government come to a one-year total of $78,730 or $17.03 per Wisconsin citizen. Gross per capita utility estimates are included in the statewide figures, as shown below.



This graph illustrates the relationship among annual expenditures by governments at several levels (and by utilities) to collect, produce, and maintain land records. As a comparison, the total of approximately

$17 per Wisconsin citizen or $78 million, represents, for example, nearly two percent of the 1975-76 total Wisconsin state expenditures of about $4.7 billion.

PROBLEMS AND PROPOSALS

The 1978 report concluded that Wisconsin citizens are not getting their money's worth for their land record dollar. Seven basic problems were identified as: accessibility; availability; duplication; aggregation; integrability; confidentiality; institutional structure.

The 1978 study proposed several criteria for consideration in any systematic effort to improve the land records. These are: a standard geographical base; large scale maps; quality controls for data input; accessible and decentralized information; responsiveness to citizen needs; institutional visibility and stability; protection of confidentiality; incremental change.

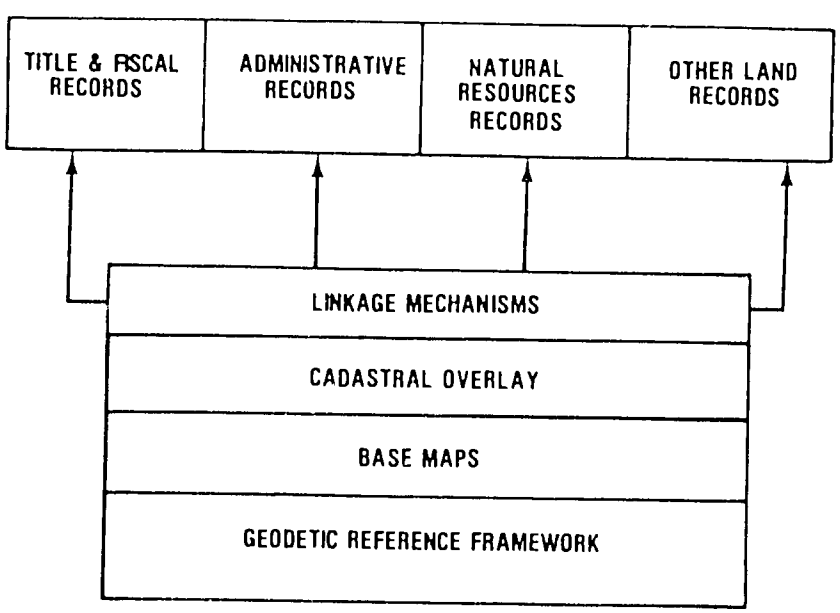
Recommendations included: data collection at the lowest possible government level with technical capability; actions by all governments to make data compatible; accessible government offices; a single governmental entity with land records management responsibility; establishment of a state office or council concerned with land information; emphasis on the local level of government as the citizen access and use point; federal standard setting and support.

It was noted that the American Bar Association had recently published the Uniform Simplification of Land Transfers Act which calls for a State Recording Officer to approve guidelines and local procedures for recording land related documents.[3]

The 1978 study described the need for a standard geographical base and large scale maps for natural and cultural features within a land records systems. These elements appear in recommendations for improvement in land information systems described in "Need for a Multipurpose Cadastre"[4] and "Procedures and Standards for a Multipurpose Cadastre."[5] The concept of the multipurpose cadastre is described as a framework that supports continuous readily available, and comprehensive land-related information at the parcel level. The components of a multipurpose cadastre are the following:

1. A reference frame consisting of a geodetic network;
2. A series of current, accurate large-scale maps;
3. A cadastral overlay delineating all cadastral parcels;
4. A unique identifying number assigned to each parcel that is used as a common index of all land records in information systems; and
5. A series of land data files, each including a parcel identifier for purposes of information retrieval and linking with information in other data files.

These components and their relationships are depicted as follows:[6]



Components of a multipurpose cadastre.

Establishment of a land records system based on the elements of a multipurpose by a local government is often difficult because of the initial investment in the geodetic reference framework (or geodetic control system) and the large scale base maps or digital products. These elements are essential because they provide the mechanism for creating files of compatible land data. Compatibility (to a measureable degree) for a variety of land data within a jurisdiction depends upon a geodetic control system across the spatial extent of that jurisdiction.

THE DEMAND FOR SPATIAL INFORMATION: THE RELATION TO A GEODETIC CONTROL SYSTEM

There is a universal demand for spatial information products for public and private land planning and development. This demand can be satisfied by existing files of land data whose accuracy and compatibility satisfy the planning and development community.

Compatibility is an attribute of the product which results from the merger of data from two or more independent files. It is a continuous rather than discrete characteristic of data files. Compatibility provides a quantitative measure of the quality that results from the merger of files of land data. It is an attribute of the data which can only be obtained from the use of a geodetic control system. A geodetic control system means compatibility, the compatibility of land data files.

Compatibility of land data requires a common spatial reference framework. In common vernacular, this means, for example, that all the

features of a map or of the base map elements must be referred with known accuracy to a geodetic control system. In order to achieve compatibility in any practical manner the geodetic control system must extend over an appropriately wide area and be of an appropriate density and accuracy. In other words, the control system must be "global" in the sense of extensive, rather than "local" or site specific.

The land planning and development process requires land data with the attribute of compatibility. This recognition alters the nature of the argument for investment in a geodetic control system. It directs attention from site specific needs for marked points to the demand for a spatially extensive geodetic control system. The demand is characterized as systematic rather than point specific.

This crucial issue is discussed below but can be illustrated here by an example. The example concerns the often heard statement that subdivision boundaries can be made more secure if their location is tied to a geodetic control system. However, for the purpose of increased boundary security, other less expensive means can be employed such as tying the locations to <u>any</u> reasonably permanent object.

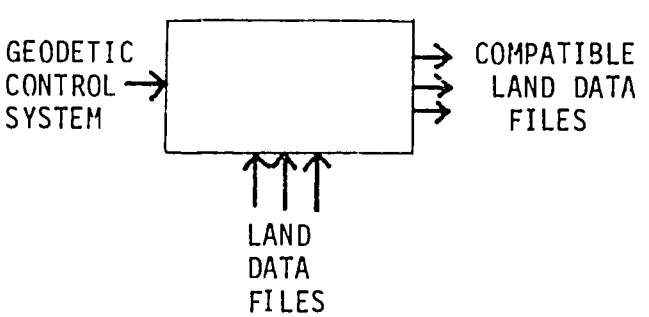
THE VALUE OF COMPATIBLE, CONTROL-DEPENDENT PRODUCTS

The ultimate value of all information and data used in planning is better decisionmaking about the environment. This value cannot be easily measured numerically. This difficulty is because environmental quality is not a commodity sold in the market and surrogates are needed for measurement purposes.

Managing the environment, including land planning and development, is a problem of risk management. The desire for compatible spatial information products is seen as the desire for knowledge that makes risk assessment possible.

It is possible to measure the value of an investment in a geodetic control system which is designed to provide existing, compatible data for land planning and development. An investment in a geodetic control system to satisfy this demand provides a specific benefit. When a decision is made which utilizes a product created because of the compatibility attributes of existing data files, a significant cost is avoided. This avoided cost is that of an ad hoc collection of the required information to make the files compatible. In some cases it is the cost of collecting the entire data ad hoc. The use of existing, compatible spatial data by a decisionmaker who finds them satisfactory for purposes of planning provides a stream of avoided costs which are the benefits from investment in a geodetic control system.

A systematic geodetic control system designed to produce compatible files of land data is represented as follows:



ATTRIBUTES OF THE GEODETIC CONTROL SYSTEM:

(1) SPATIAL EXTENT.

(2) DENSITY.

(3) ACCURACY.

(4) UTILIZATION OF A COMMON SPATIAL LANGUAGE.

ATTRIBUTES OF THE COMPATIBLE LAND DATA FILES:

(1) ANTICIPATED, FREQUENT DEMAND.

(2) SATISFY DECISIONMAKERS.

(3) EXPENSIVE AD HOC DATA COLLECTION.

It is possible to measure the avoided costs that occur when existing, compatible data files are used in a jurisdiction. The first task is to identify a jurisdiction with the following characteristics:

1. A geodetic control system exists over an extensive area of the jurisdiction.

2. The geodetic control system is the basis for a large set of existing compatible data files.

3. The compatible land data files and derived spatial information products are used for a wide variety of planners, developers and land use deicisionmakers.

It is not essential that such a jurisdiction be typical. The goal is to identify a jurisdiction which has a land information system with the proper characteristics. This jurisdiction provides a laboratory for measurement of investment in a geodetic control system. It provides an example of the benefits derived from investment in a geodetic control system.

It is possible to estimate the costs avoided when existing files of compatible data permit decision to be made without resorting to ad hoc field collection of data necessary to create compatibility.

This process begins with the identification of those decisions within a jurisdiction which are made from the combination of existing compatible data files. The ad hoc of creating the compatibility among the files that produce the spatial product will be estimated. This is the cost avoided because the geodetic control system has provided the compatibility. The sum of avoided costs throughout the jurisdiction is an estimate of the value of an investment in a geodetic control system.

These considerations are used to identify the appropriate jurisdictions. For such jurisdictions, data gathering will include the following:

1. The decision or risk assessment required. It is useful to know the source of the requirements (regulatory process, investment choice, etc.).

2. The data file or map which is the medium for decision-making. This file or product must come from the array of existing products provided by the investment in control. Each product consists of a set of compatible features essential to the decision.

3. The avoided cost because the decisionmaker felt confidence in the knowledge provided by the product and did not resort to ad hoc field measurements to obtain compatibility.

4. The cost of the geodetic control system and the other actions which were necessary to create and maintain the existing, compatible files.

Determination of the latter two items provide an indication of the cost-effectiveness of an investment in a system that provides files of information for planning and land related decisions.

The costs are for:

1. Geodetic control established systematically in a region.
2. Land data made compatible by reference to the geodetic control.
3. The medium that delivers the compatible data. The medium may be a map or a digitally-stored information product.

The benefit of the geodetic control system is the sum of the avoided costs of ad hoc field collection and assembly of information necessary to create compatibility.

The following specific items must be determined:

LAND PLANNING OR DEVELOPMENT PROJECT.

DECISION OR RISK ASSESSMENT.

LAND INFORMATION ITEMS OR FEATURES REQUIRED

(e.g. COMPATIBLE FEATURES REQUIRED).

PRODUCT QUALITY REQUIRED.

PRODUCT AVAILABLE FROM THE FILES OF EXISTING COMPATIBLE DATA?

IF YES, WHAT IS THE COST OF OBTAINING THE NECESSARY PRODUCT IN AN <u>AD HOC</u> FIELD INVESTIGATION?

SUMMARY

Land planning and development is a multipurpose phase process. This process uses and generates increasingly accurate spatial information which relates cultural and natural features. The products of this process are a part of the land tenure framework.

The existing system of land records in public agencies makes it difficult and costly to assemble the data needed for land development and decisionmaking. The existing system itself is costly.

Proposals for improvement in the land records focus on a geodetic control system and large scale maps or digital products. The benefits of an investment in a system of control and maps or digital products can be measured.

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AGENCY FOR INTERNATIONAL DEVELOPMENT

BUREAU FOR LATIN AMERICA

PROGRAM EVALUATION STUDIES

INTERCOUNTRY EVALUATION OF CADASTRAL PROGRAMS

Costa Rica
Guatemala
Nicaragua
Panama

by Bernice Goldstein

June 1974

A.I.D. Evaluation Studies represent the views of their authors and are not intended as statements of official policy.

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Foreword

The subject of this report is an evaluation undertaken from November 26 through December 14, 1973 in Costa Rica, Panama, Nicaragua and Guatemala of AID-supported cadastral programs. The report is in two sections: Part I--Overview; and Part II-Individual Country Programs.

First, a general observation. It seems to me that, while cadastral programs can contribute to fiscal improvement and land reform, they are not first requirements for the accomplishment of these objectives. Therefore, within the context of AID's current areas of concentration and limited resource availabilities, we should be satisfied, when making judgments about future proposals, that the cadastral project is more effective than alternative approaches in advancing our interests. If undertaken, the cadastral project should be an integral part of an overall program strategy in which the cadastral activity is related to, and reinforced by, other elements of the country program.

Specific observations with respect to characteristics of past programs, problems encountered, and possible future approaches follow:

1. Past programs have been characterized by the implicit expectation that a broad range of benefits would almost automatically result from carrying out a cadastral survey. If stated objectives were ambitious, and at times imprecise, project design frequently underestimated the complexity of the operations involved and often failed to provide for the linkages necessary to assure achievement of desired ends. The broad scope of some loans, particularly those that included natural resources inventories, severely strained host government support capabilities. In some cases, impact suffered because governments did not find it feasible to undertake requisite legal or administrative action.

All of which suggests the need for more precision in definition of purpose, a narrower "focus" for the activity, improved project design, integration into a comprehensive country program strategy, and the existence of necessary laws and regulations.

2. Concerning property tax improvement, our experience shows that while a cadastral program can improve property tax administration through the installation of an equitable and efficient property tax system, it cannot of itself bring about high levels of property tax revenues.

Past projects have encountered problems because

--they did not include all components--mapping, identification, valuation, collection--or cover a complete administrative unit;

--they underestimated the complexity of reconciling cadastral property tax records with existing records;

--budgetary support was insufficient;

--the host government did not find it feasible to take requisite legal or administrative action.

This suggests an approach which

--includes all essential components; extends over an entire administrative unit and inventories everything in the unit; and provides for maintenance of the system;

--is the "minimum" cadastre to serve the country's needs, in terms of cost and host government technical and administrative capability;

--is based on a determination, upon approval of the loan, that requisite laws and regulations either already exist or will be undertaken as a condition precedent to the loan.

3. Concerning land reform, experience shows that while the type of cadastral program AID has supported in the past can provide the basis for a modern land registry system and can provide the data useful for development in the rural sector, it cannot of itself bring about accelerated titling, improved distribution and utilization of lands, and other agricultural reform measures.

4. Concerning natural resources inventories, experience shows that while valuable data have been generated, their utilization appears limited relative to the cost of producing the data, suggesting the need to assess with care any future proposals. At the very least, such programs should, if undertaken at all, assure a close "match" between the generation of data and specific end-use of such data.

5. A "phased" approach. The evaluation revealed a sentiment among those associated with past cadastral programs in favor of a "phased" or "tranched" approach, under which the successful accomplishment of purpose in an initial scaled-down version of a complete program would be required before going on to a second and expanded phase.

Bernice Goldstein
February 1974

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AID Cadastral Programs
in Latin America

I. Overview

A. Background of Cadastral Programs

The term "cadastral survey", in the context of development assistance programs in Latin America, has largely lost its original meaning--that of a tax-mapping, property valuation program--and has been used to describe almost any kind of physical land survey, undertaken for any kind of public or private purpose. Furthermore, the word has been confused with the Spanish term "catastro", which refers to a survey made for land title purposes. The choice of descriptive term has thus led to a great deal of confusion and misunderstanding.

The programs undertaken in Central America in the mid-to-late 1960's reflect this confusion with respect to the nature of a cadastral program and what results could be expected from it. The programs had their origin in a SIECA[1]-sponsored activity which developed a broad plan for cadastral surveys and natural resources inventories; this plan was presented and approved by the Ministers of Economy of Central America and Panama in April, 1963 and in May, 1963, a revised set of loan criteria for a "Program of Investigation and Utilization of Natural Resources and Improvement of Real Property Tax Systems" was issued. Essentially, the criteria called for a three-pronged approach: (1) installation of modern real property tax systems to increase government revenues; (2) an inventory of natural resources; and (3) mapping to support the first two objectives. Subsequently, with the assistance of AID, a variety of "cadastral survey" programs were undertaken in Central America. However, although SIECA had

1/ Permanent Secretariat of Central American Economic Integration (SIECA)

promoted the use of so-called integral cadastral surveys,[1/] AID limited its offer to the financing of "fiscal" cadastres, in view of the latter's more immediate relation to property tax administration and the relatively lower cost and greater speed of such a cadastre. (In Panama and Nicaragua, the AID loan also included a natural resources inventory to which the greater part of loan funds was devoted.)

B. Summary of Implementation and Goal Accomplishment

Costa Rica - The AID cadastral loan to Costa Rica in 1964 was the first to get underway and, being the pioneer program in the region, ran into a number of unforeseen difficulties. The purpose of the loan (L-011) was to assist the Government of Costa Rica in "improving the administration of property taxes . . . and to provide information needed for land reform, land use planning, and public works" through a project of (a) tax mapping and tax appraisal and (b) acceleration

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1/ In his 1968 (Costa Rica) study, Legal Problems Presented by Use of Cadastral Property Records in the Present Tax System, Lorin S. Weisenfeld describes the two classes of cadastral surveys: "The broadest is a public record which identifies every property within a given region on a precise and specially prepared map, and attributes to that property a legal description of its boundaries, an enumeration of its physical and economic qualities, and an assessment of its value for tax purposes. This type of cadaster is called a complete cadaster or integral cadaster. It is premised on geometric mapping of the highest precision and is sufficiently accurate to serve as a basis for determining legal title. A fiscal cadaster serves the more limited function of identifying and evaluating properties for tax purposes only. It is designed merely to provide the base upon which property assessments can be uniformly and justly made. Although a fiscal cadastral survey is undertaken in the same manner as an integral cadastral survey, the more restricted uses to which the resultant maps will be put permit a less stringent surveying process. For this reason, it is considerably less expensive and more rapid than the integral cadastral study. It is often selected in preference to the integral cadaster by governmental entities which must choose between the eventual luxury of a definitive cadaster and the immediate necessity of improving property tax administration. The choice between the two types of cadastral surveys is not mutually exclusive, since a fiscal cadaster serves as the foundation upon which an integral cadaster can subsequently be built."

of the completion of topographic mapping. Problems of reconciling the cadastre-generated records with the existing property tax list and of maintaining the cadastre during conversion of the system seriously jeopardized operations and, in effect, significantly reduced anticipated revenue generation. Assessment of loan impact on land reform, land use planning, and public works planning, is more difficult. The project can be said to have had impact to the extent that data on cadastre property cards were utilized for planning purposes and to the extent that the L-011 loan helped to strengthen the Cadastral Office (in the Geographic Institute) which, in turn, is supporting current programs of IFAM (Municipal Development Institute) in municipal tax administration and ITCO (Land and Colonization Institute) in its land titling activity.

Panama - The stated purpose of the 1964 AID loan to Panama (L-007) was "to establish a basis for orderly land settlement, improved land use, land title registration, an evaluation of natural resources, establishment of an equitable and efficient rural land tax system, and other agricultural and land reform measures . . ."

Reportedly, project activities resulted in over 125,000 acres of agricultural lands previously under unknown or ill-defined tenure status being returned to the public domain for more productive use. On the other hand, land title registration effects of the project have been nominal. At the time of its completion in 1971, the cadastre had revalued most rural properties and the project consultant had made recommendations regarding land tax reform. However, no legal or administrative action has yet been taken to implement a reform of the land tax system.

The data resulting from the natural resources inventory component of the loan have been utilized by the National Planning Office and by the Ministry of Agriculture and the Agrarian Reform Commission. However, the information and data in the computerized cadastral register reportedly are not being fully utilized.

Nicaragua - The greater part of the 1966 AID Cadastral Survey Loan (L-012) to Nicaragua, as in the case of Panama, was devoted to a natural resources survey, with only about one third the total funds used for activities directly connected with improving property tax administration.

Nevertheless, the rising trend in property revenues, from 1970 through 1972, is attributable in large measure to the increased number of property taxpayers and increased valuation resulting from the cadastral

project. The impact of the L-012 loan on agrarian reform activities is more difficult to determine, since most of the current activities of the responsible government agency--the Agrarian Institute of Nicaragua (IAN)--are being undertaken outside of the geographic area of the L-012 project. Again, however, as in the case of Costa Rica, to the extent that any titling and colonization activities are being carried out in the project area or are drawing on a cadastral office capability which has been strengthened by the AID project , the AID loan can be considered to have made a contribution. There is evidence that the data generated by the natural resources inventory component of the loan are being used by Nicaraguan government agencies and that the data also served AID in the Agriculture Sector analysis and the AID-financed "Feasibility Studies and Surveys."

Guatemala - The most recent program among those reviewed is the Guatemala loan (L-014), undertaken in 1967 and followed up with a second loan in 1973 (L-023). The purpose of the loans is property tax improvement, through assistance in carrying out cadastral surveying, tax appraisal, tax notification and collection.

Although it is early to measure the effect of the program on property tax revenues (since the major impact is expected to result when cadastral records are substituted in their entirety for the outdated property tax list now in use), there is already evidence of improved property tax performance. Additionally, the project is furnishing cadastral records and maps to local municipal governments for use in local tax activities and to the Property Registry for use in establishment of an improved property title identification system.

C. Conclusions

A more complete and better informed assessment of program impact lies in the future--the Guatemala fiscal cadastre project is not yet completed; the Nicaraguan program has suffered the effects of the 1972 earthquake (although its cadastral activity seems resilient); and in all countries, it should be noted, the AID-supported cadastral programs represented only accelerated portions of longer range programs which the countries are still carrying out.

In recognition of the above, and within the limitations of time and available information under which this evaluation was carried out, some observations about past problems and possible future approaches can, nevertheless, be hazarded.

1. Major Problems of Past Programs - A reading of the stated loan purposes in the AID-supported cadastral programs in Costa Rica, Panama, Nicaragua, and Guatemala reveals the implicit

expectation that a broad range of benefits would almost automatically result from carrying out "cadastral surveys".

If some of the statements of purpose were ambitious, and at times imprecise, project designs frequently underestimated the complexity of the operations involved and often failed to provide for the linkages necessary to assure achievement of the desired ends; even where successfully implemented, project impact suffered because governments did not find it feasible to undertake the recommended legal or administrative action. The broad scope of some of the loans, particularly those that included natural resources inventories, severely strained host government support capabilities, in financial and manpower terms; and utilization of data for planning purposes, both that generated by the cadastral property records, as well as the data produced by the natural resources inventories, has been limited because adequate provision was not made to assure their dissemination.

2. Possible Approaches

a. More Precise Definition of Objectives and Structuring of Project

Decide what is to be accomplished in the context of the overall program strategy and whether a cadastral project is more effective than alternative approaches in achieving our aim; limit the scope of the loan to that specific end (e.g., property tax improvement), avoiding overloading the system or dissipating efforts in an attempt to accomplish a broad range of objectives; integrate the project into the country program, relating the cadastral activity to other elements of that program.

1) If property tax improvement is purpose of loan,

-- determine what information is needed from the cadastre, how it will be used and maintained, and that the government will facilitate the effort.

-- carry the cadastral process through all stages--mapping, identification, valuation, collection--and extend it over an entire administrative unit, inventorying everything in the unit.

-- design the "minimum" cadastre to serve the country's needs in terms of cost and host government technical and administrative capability.

-- determine that the requisite laws and regulations to make the project "feasible", are either already in existence or will be undertaken as a condition precedent to the loan.

-- be realistic in expectations of returns; while a fiscal cadastre can contribute to the improvement of overall property tax administration through the establishment of an equitable and efficient system, it does not automatically result in high levels of property tax revenues (which are more a function of rate structure and the government will to enforce collections). In and of itself, the cadastre will make only a small direct contribution to revenue increase through identification and appraisal of properties that previously avoided the tax; through uniform and modern evaluations; and through the savings effected by streamlining the system.

2) If land reform (i.e. registry and titling improvement) is purpose of loan,

-- recognize that the issues and complexities of land titling are such that they should be addressed in a project specifically structured for that purpose, as a component of an integrated approach to the agricultural sector.

-- be mindful that while a fiscal cadastre can make a contribution as a foundation upon which an integral or complete cadastre can subsequently be built, and as a source of statistics on land use, its role is indirect at best, and ascribing a land reform goal to a fiscal cadastre project is not only unrealistic, but can jeopardize the accomplishment of property tax improvement objectives.

3) If a natural resources inventory is purpose of loan,

-- determine whether the loan can be justified in the context of current AID priorities and limited resources. While valuable data have been generated in past inventory programs, their utilization appears to be limited relative to the costs of producing the data, suggesting the need to assess with care any future proposals.

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-- one approach would be to build on the basic data generated by a fiscal cadastre (where one exists), elaborating the information on a selective basis, in the nature of a feasibility study, in those cases where there are specific possibilities for future projects, to be undertaken by AID or in collaboration with other donors.

-- as a minimum first step in the collection of data for planning purposes, every effort should be made, where there is a fiscal cadastral project, to assure utilization of the range of statistical information that can be culled from cadastre property cards for the surveyed area: the card is the source of important statistics on land use that can be employed by agencies of the government involved in general development planning, urban planning, and agrarian settlement or reform. Likewise, it is an adjunct to public works programming, providing basic maps and property values for compensation purposes.

b. A "Phased" Approach

The evaluation revealed a sentiment among those associated with past cadastral programs in favor of a "phased" or "tranched" approach, under which the successful accomplishment of purpose in an initial scaled-down version of a complete program would be required before going on to a second and expanded phase.

Unlike some so-called "pilot" or "demonstration" projects which have been undertaken in the past, however, the initial phase would be a reduced version of a complete program, planned and carried out in its entirety, including all processes, but confined to a limited administrative unit; (the problem of equity resulting from implementation of a property tax program on a unit-by-unit basis, does not seem to be insurmountable). The optimum scale of operations would, of course, have to take into account the overhead, and the fact that almost as much time, money, planning and control are involved for the first phase as for expanded operations.

Such a phased operation provides an opportunity on a limited, more manageable scale, for training, working out kinks, and getting the system well established. More importantly, it gives both parties an option with respect to extension of the program. A "first phase" operation that has accomplished its purpose can, by demonstrating its utility and potential benefits if extended, test the seriousness of host government support; on the other hand, if the project has encountered difficulties and is unable to accomplish its objectives, it can be terminated.

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II. Individual Country Programs

Costa Rica:	Cadastral Survey
Loan No:	L-011
Amount:	$1,600,000
Date of Loan:	October 19, 1964 (Agreement signed)
Terminal Disbursement Date:	August 31, 1971 (Revised)
Disbursed:	$1,451,681

A. Purpose

This loan was made to assist the Government of Costa Rica (GOCR) in "improving the administration of property taxes in Costa Rica, and to provide information needed for land reform, land use planning, and public works through assistance in financing a project consisting of (a) tax mapping and tax appraisal of land the value of which constitutes 90% or more of the taxable value of land in Costa Rica, and technical assistance related to the foregoing; and (b) acceleration of the completion of topographic mapping of Costa Rica."

The original objectives--to map, value, and tax an estimated 344,000 properties--were found to be unrealistic by GOCR consultants and the number was reduced to 177,000. These properties were located on the central plateau of Costa Rica and in the region near the city of Puntarenas, and represented about 6[illegible]% of the total land value of Costa Rica. The area to be covered by the cadastral survey amounted to some 3,200 square kilometers of Costa Rica's 52,000 square kilometers. It was assumed that a subsequent cadastral study would cover tax mapping in the remaining portion of the country.

The topographic mapping project was aimed at speeding the completion of a joint program, undertaken in 1964 by Costa Rica's Geographic Institute and the U.S. Inter-American Geodetic Survey. The basic topographic maps were to serve not only tax purposes, but also were to be used for planning land use and development projects. Additionally, it was anticipated that the network of official monuments which the Institute was establishing as a part of its normal activities would make title surveys less expensive than they had previously been, and would, in time, help to solve the problem of insecure land titles.

B. Implementation

Technical assistance, under a loan-financed contract, was provided by the consulting firm, J. L. Jacobs and Company, which committed itself to services including the development of appraisal standards, the

preparation of an appraisal manual, and the training of staff. With the Central American Bank for Economic Integration (CABEI) serving as regional technical adviser to the GOCR, responsibility for administration of the project was assigned to the GOCR's National Planning Office. At the termination of the consultant's contract in June 1968, project responsibility shifted from the National Planning Office to the Finance Ministry.

The GOCR considered all field work in the project to be completed as of June 30, 1968. At that time, 160,000 properties had been mapped in the field; 154,000 office evaluations had been made of land and buildings; and 149,000 appraisals had been made in the field.

However, the degree to which the field records could become the bases for assessments of the 149,000 properties for property tax purposes depended on whether they could be reconciled with the existing property tax records. (In Costa Rica the in personam property tax system and the progressive levy made records reconciliation a highly involved and necessary operation.) For reasons described below, this stage in the process proved to be a critical bottleneck and, according to latest estimates, only a little more than 60,000 new valuation assessments had been transmitted to the taxpayers because of the difficulties encountered in reconciling the two sets of records.

Upon termination of field and office work on a property, complete property cards were coded and key punched, as an intermediary step in adapting the cadastral records to tape in order to make them compatible with the computerized billing system used by the Property Tax Department. Because the Costa Rican Property Tax law requires that property tax bills be figured progressively on the sum of the assessments of an individual's taxable interests in the country, the accounts in the Tax Office are kept in the name of the property owner rather than in the number of his parcel. Thus, no parcel of land can be taxed unless it can be associated with a named party in interest. Moreover, elementary principles of fairness require that no parcel of land be taxed to one individual until it has been determined that there are not other parties in interest (i.e., co-owners or beneficial users) who have a legal obligation to share the tax burden.

The cadastral records could not be used directly from the tape because they were not correlated with the existing records of the Property Tax Office. Because the cadastral survey is property-oriented and not name-oriented, the problem was two-fold. First, every property identified in the cadastral survey had to be linked to a name in the Property Tax Office records. Secondly, every other party in interest connected with the property had to be accounted for and billed a proportionate share of the tax.

If the parcels identified by a cadastral survey had coincided perfectly with those on the Property Tax Office rolls, and if the names on the Property Office rolls were only those who, in fact, currently had a tax liability, it would not have been difficult to match a cadastral identity number with a finca number, and then establish the names of all who had tax liability in the property. Unfortunately, the state of the Property Tax Office records made a complete mechanical reconciliation of the two systems impossible. Property descriptions on file with the Property Office were approximate and haphazard, making it difficult or impossible in many cases to match them with the precise descriptions of the cadastre. Thus, while the cadastre identified all properties and their value, but not necessarily the owner or taxpayer, the records of the Property Tax Office identified the taxpayer, but not necessarily taxpayers for all properties.

With the assistance of an IRS[1/] advisor, a computer program was formulated to see how close to the goal of 85% matching against the cadastral records the machine process could come. However, the pilot machine matching study (the Belen Experiment) produced only a 30% reconciliation, and the GOCR abandoned the machine matching plan in favor of manual reconciliation.

The logical solution to the complex problem of reconciling current information with past records would be to double check the new information, publicize it in the area being surveyed and registered, adopt the new records as they exist, at least for tax purposes, and file the old records. The Government of Costa Rica, however, opted for the record reconciliation route, and thus, after four years of cadastral work, approximately half the assessments made during the cadastral project have been reconciled and are in force. (A new Cadastral law, presently before Congress, would require a cadastral certificate before recording in the public land registry and registering in the Central Tax Office. The passage of this law should contribute significantly to ordering the present confusion regarding land ownership and should also improve the administration of the property tax.)

Mention should be made of some activities that were an adjunct to the cadastral project. For example, during the course of 1968, grant funded technical assistance was provided by a legal advisor to the project who was to analyze the legal problems of using the fiscal cadastral records within the Costa Rican <u>in personam</u> tax law. The legal advisor was to (1) review the progress in legislative improvement, including the final draft of legislation to correct problems encountered; (2) review and make recommendations on the reconciliation then underway between the cadastral and the tax records with special emphasis on potential legal problems; (3) recommend a revised organization of the Property Tax Office to two alternatives--(a) implementation of new legislation, and (b) continuation of reconciliation work without the new legislation.

1/ U. S. Internal Revenue Service

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During 1968, limited funds under the loan were made available to support a juridical or "integral" cadastre. This undertaking by the GOCR, also assisted by a German Technical Mission, was directed toward the modernization of the Public Registry. Work on the integral cadastre was to make full use of the fiscal cadastral investigations and maps.

Legal and economic research in rural property problems was undertaken in 1969, in the context of the University of Costa Rica Agrarian Law Project, jointly financed by the University of Costa Rica, the Costa Rican Government, the International Legal Center and AID. The purpose of the Law Project was to examine the role which Costa Rican law and legal institutions play in the development process, particularly agricultural development. The Project compared the Civil Code and other legislation, and examined the way in which the written law has been interpreted by the courts. In addition, field studies and personal interviews were used to identify customary or unwritten law, so that later it could be compared with formal written law. Where feasible, the operation of both written and customary law was evaluated in economic terms. In addition to preparing research reports of the various problems studied, the Law Project used the data obtained from field research for the preparation of case-textbooks on notarial, registry, property and agrarian law that will be used in teaching these subjects at the University of Costa Rica Law School.

A final activity which can be cited was the assistance in collecting property taxes (including delinquent accounts) provided through an arrangement worked out by a member of the Law Project, who worked closely with the Municipal Development and Training Institute (IFAM)[1/]; under this arrangement, ten employees of IFAM were assigned to the Property Tax Office, from October 1971 through 1972. As reflected in the table in Section C, this assistance, plus five quarterly billings in 1971, contributed to a rather substantial increase in collections that year.

The problem of maintenance caused another complication for the project. The loan agreement did not provide for maintenance of the system while it was being developed. As a consequence, the cadastral records were becoming obsolete over the three year period, due to a high rate of property "rights" changes (because of the exemption system, every "right" or "interest" in the property must be recorded).

In addition to the difficulty of reconciling the cadastral records with the existing tax records, and the problem of maintaining the cadastre during conversion of the system, the utility of the new cadastral records was further limited because legislation to change the basis of the property tax from in personam to in rem which had been anticipated when the project was undertaken never materialized.

1/ Established by AID loan L-023, Municipal Development

C. Accomplishment of Project Goals

Because of the difficulties described above, the project has had limited impact on property taxes.

The data[1/] show the following property tax collections:

1961	C.14,200,000	
1966	24,627,000	(reflects first reconciliation)
1967	33,797,000	(25% surcharge)
1968	33,164,000)	
1969	32,820,000)	reconciliation "bottleneck"
1970	36,000,000)	
1971	46,000,000	(reflecting five quarterly billings plus work of Administrative Collection Dept.)
1972	N/A	(preliminary estimates indicate a decline reflecting in part advanced payments in late 1971 which would normally have been made in 1972)

As of August 1971, the accumulative addition since the beginning of the program in increased value to the tax rolls was estimated to total $173 million. Because the rate of tax is low, the additional tax yield was about $750,000 per year. Delinquent billings were estimated to be over 10,000 in number and rising.

With responsibility for implementation of the fiscal cadastre now in the Tax Office, little if any use of the data is being made by other government agencies. However, mapping and cadastral work continue--the National Geographic Institute (IGN) is working with both the Municipal Development and Training Institute (IFAM) and the Land and Colonization Institute (ITCO)--in new activities essentially outside the geographic area of the L-011 project: the IGN is working with IFAM in assisting municipalities in the implementation of new fiscal cadastres; and the IGN is working with ITCO in photogrammetric and cadastral work in support of the Land Tenure Project of the Agricultural Sector Loan (L-022).

A final note in this connection concerns proposals for reform of the agrarian taxation structure in general, presented in a study[2/] undertaken in 1972, under the aegis of the earlier mentioned AID-supported Law Project. Decisions on reform of land taxation still lie in the future.

1/ Robert C. Wells, Rural Land Taxation in Costa Rica, A Legal and Economic Analysis (Costa Rica, 1972), p. 7. (IMF data show C.37.3 million for 1971 and an estimated C.37.5 million for 1972.)

2/ Ibid. p. 15-20.

Panama:	Cadastral Survey and Natural Resources Evaluation and Tax Administration
Loan No.:	L-007 and L-007/A
Amount:	$2,730,000 (amended total)
Date of Loan:	August 6, 1964 (Agreement signed)
Amendment No. 1:	September 26, 1968
Terminal Disbursement Date:	May 31, 1971 (Revised)
Disbursed:	$2,627,517

NOTE: The evaluation in Panama was carried out under certain limitations, being based exclusively on reading of AID Mission files and discussions with Mission staff and without access to Panamanian officials.

A. Purpose

The stated purpose of the loan was "to establish a basis for orderly land settlement, improved land use, land title registration, an evaluation of natural resources, establishment of an equitable and efficient rural land tax system, and other agricultural and land reform measures ..."

This purpose was to be accomplished through the following activities:

(a) the survey and study of present land use and natural resources capability, including collection and study of data with respect to soil capability and fertility, groundwater, drainage, erosion, geomorphology, geology, and economic and locational factors bearing on land utilization and valuation;

(b) a rural cadastral survey including definition and mapping of property boundaries and land ownership, development of land valuation formulae, and the assessment of rural land values;

(c) the cataloging, collation and analysis of data collected in the foregoing surveys and of existing data, and establishment of a land capability classification system;

(d) training of technical personnel to carry out the Project and to maintain and continue the surveys on completion of the Project;

(e) assistance to the Ministry of Finance in improving the administration and organization of rural property taxation;

(f) procurement of equipment and supplies for the foregoing purposes, and

(g) such other Activities to which the Borrower and A.I.D. may agree in writing.

B. Implementation

Project operations began December 1, 1964 with technical assistance provided under a loan-financed contract with a consortium of three U.S. firms. The survey was concentrated in the metropolitan region of Panama (except for the Panama City and Colon urban areas), the Central Region and the Chiriqui Region--about 35,000 square kilometers (13,500 square miles) or 46% of the national territory. Together, these areas contain about 90% of the rural population and the greatest agricultural activity. (It was anticipated that upon completion of the rural cadastral program, a similar tax mapping and tax appraisal program, covering at least the major cities, would be undertaken.)

The original work plan of property identification and valuation was based on a volume of 90,000 rural properties as indicated by the 1960 census data. In April-May 1967, when 100% of the properties in several districts had been identified, it was found that actual numbers varied greatly from the recorded census data. On the basis of the data gathered, it was estimated that the rural properties in the project area totaled 120,000, or approximately one-third more than originally projected. Based on the discovery of approximately 30,000 additional properties to be surveyed and evaluated, plus a need to refine certain data of the national resources survey, the AID loan was amended on September 26, 1968 to provide for an increase of $330,000 to the original and an extension of two years.

Also, in early 1969, a property tax administration component was added to the consultants' contract, to establish a methodology for integrating the new rural property maps, property records and valuations, generated by the rural cadastre, into the existing property tax system.

The project involved, in various times and places, some 300 Panamanians and 40 personnel from the U.S. Overall responsibility for the project within the Panamanian Government was assigned to the Agrarian Reform Commission (Comision de Reforma Agraria); additionally the Planning Office and agencies of the Ministries of Agriculture and Finance cooperated in the Cadastral project.

The Consultants "CATAPAN" consisted of a joint venture of three U.S. consulting firms. The sponsor and manager of the CATAPAN consortium had been responsible for producing the General Work Plan in 1963, which was the principal document by which the Government of Panama (GOP) requested and received USAID financing for the project, and also was in charge of producing the 1964 Detailed Work Plan.

The study produced at the completion of the project supplemented more than 5,000 separate maps, covering a project area of more than 3,600,000 hectares from the standpoints of some fifteen distinct technical

components. The consultants' final report indicated that, as a result of the loan activity, "the project area is covered by a mass of basic terrain, natural resources, and ownership data that is probably unparalleled in any other country except in some restricted areas of the United States, England and Germany."

Information about maintenance of the cadastre is very fragmentary. An internal AID memorandum of August 1969 reports that during the course of the project no provision was made for keeping the property inventory up to date, but that efforts were under way to keep the inventory of titled properties current and that this should not be a problem in the future. However, the untitled properties, which comprised some 75% of the total number of rural properties, presented an as yet unsolved maintenance problem. It was anticipated, however, that the new law permitting the issuance of valid titles on the basis of controlled photo-map description (map number-parcel number) would contribute to the acceleration of titling and thereby help reduce and ultimately eliminate the problem of untitled properties. It was also observed that the Fiscal Cadastre Office was sufficiently well organized and the staff sufficiently well trained that it could not only finish the work remaining to be done to complete the cadastre without further outside technical assistance, but should also be able to develop and carry out a successful cadastral maintenance program on its own. With respect to urban cadastral surveys, a major cadastral survey assessing real property values for Panama City and Colon was completed in 1970.

C. Accomplishment of Project Goals

1. Agrarian Reform - The rural cadastre was designed to produce a register of rural property ownership, establish the valuation on each property and provide the additional identification data and property maps required to accelerate the land titling process as well as to facilitate the implementation of an equitable and efficient rural property tax program.

a. Land Titling - The loan completion review and report of January 1972 estimates that, based on project activities, over 125,000 acres of agricultural lands previously under unknown or ill-defined tenure status had been returned to the public domain for more productive use. Land title registration has been nominal, however. Although the rate at which titles to land were being issued by the Agrarian Reform Commission rose threefold in the years from 1969 to 1972 compared to the annual rate of the preceding six years, only about 2,000 new titles have been issued in each of the last two full years.

It has been estimated that at this rate, it would take 35 years to catch up with the apparent 1970 backlog. The GOP's current rural development strategy, however, seems to place emphasis on group settlements (with plans for ultimate tenure arrangements as yet unclear), rather than facilitating individual titlings for the small farmer.

b. Rural Land Tax System - Pursuant to Subsection 3.1(h) of the Loan Agreement, the GOP in 1964 submitted a plan and schedule of proposed taxation and property registration improvements to be effected. Although revisions in property tax legislation were achieved in the fall of 1964, the proposed major reorganization of the rural land tax collection and enforcement division was not effected and only minor administrative changes took place. Further legislative and administrative changes needed to improve significantly the property tax and property registration programs were subsequently put off in view of pending national elections in 1968. At the time of its completion in 1971, the cadastre had revalued most rural properties. At that time, also, the project consultant made recommendations regarding land tax reform. However, no legal or administrative action has yet been taken to implement a reform of the land tax system. Because of the GOP's decision to continue applying an automatic valuation of ₱/30 per hectare to all rural land, the valuation of rural properties has had virtually no impact on the rural property tax.

2. Natural Resources Inventory Data - The natural resources survey was designed to indicate the agricultural, water, and mineral potential as well as the complementary data required for the valuation process. The initial components included soils, land use, surface geology and a groundwater survey with the subsequent addition of construction materials and fertilizer/non-metallic components.

The natural resources studies generated by the loan project reportedly have been utilized by the National Planning Office and, in connection with land settlement and titling activities, by the Ministry of Agriculture and the Agrarian Reform Commission. They are known to have been drawn on in the recently completed Agriculture Sector Study, conducted under the aegis of the Sector Study Commission of the National Planning Office.

There is less encouraging information, however, about the current use of the data in the computerized cadastral register. Reportedly,

owing to lack of liaison with the agriculture and planning authorities, no use is being made of this data, and the cadastral administration does not feel that it has access to Ministry of Finance computer time for other than tax purposes.

In sum, then, with respect to accomplishment of project goals, the loan has not brought about the implementation of an equitable and efficient rural property tax program and the reorganization of the system of property title registration; and there are only indefinite and generalized indications that the natural resources inventory data are being utilized.

Nicaragua:	Tax Improvement and Natural Resources Inventory
Loan No.:	L-01[illegible]
Amount:	$5,4[illegible],000
Date of Loan:	February 28, 1966 (Agreement signed)
Amendment No. 1:	August 27, 1970
Terminal Disbursement Date:	March 31, 1972
Disbursed:	$5,397,000

A. Purpose

The purpose of the loan was to assist the Government of Nicaragua (GON) in "carrying out a project which was the three-year accelerated portion of a ten year program to evaluate natural resources and establish a basis for orderly land settlement, improve land use, land title registration and the identification of other development projects and programs in the fields of agriculture, industry and land reform, and to improve the tax system related to property taxes . . ."

This purpose was to be accomplished through:

(a) an integrated natural resources survey including studies of geology and geomorphology, soils, present land use, forestry and ecology, range capability, meteorology and climatology, ground water, surface water and other factors bearing on land utilization and valuation;

(b) the development of a land capability classification system;

(c) acceleration of basic mapping and special purpose large scale mapping;

(d) creation of effective property tax administration and collection capability;

(e) delineation of urban and rural properties; development of property ownership maps and property identification numbering system including map indices; development of modern mass appraisal capabilities along with the appraisal of urban and rural properties and the plotting of land valuations on a set of land valuation maps;

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(f) processing, analysis and dissemination of the foregoing data;

(g) construction of two buildings to house the Geologic and Cartographic departments;

(h) training of technical and managerial personnel to carry out the Project and to maintain and continue the surveys for the completion of the Program;

(i) procurement of equipment and supplies to carry out the Project; and

(j) such other Activities to which the Borrower and A.I.D. may agree in writing.

B. Implementation

The Capital Assistance Paper established the basic goals of completion of all activities over 35,000 square kilometers of the Pacific Area, estimated to contain 200,000 properties. The original Detailed Work Plan set as goals the 35,000 square kilometer area for natural resource studies and 40,000 square kilometers for property mapping and valuation of an estimated 270,000 properties, 50% urban, 50% rural during a three year operations period. The final Detailed Work Plan, as amended, set as goals the 35,000 square kilometer area for natural resources studies and the property mapping and valuation of all urban properties within the 35,000 square kilometer area estimated at 100,000 properties and the property mapping and valuation of 62,500 rural properties in an area of 25,000 square kilometers during a period of three years and nine months.

Responsibility for organizing, directing, coordinating and supervising the execution of all activities of the overall Cadastral Program (i.e. the GON's ten year Program) was with the Executive Director's Office, established as a separate agency under the Ministry of Economy.

The Executive Director was assisted by a joint venture consisting of Development and Resources Corporation and Clapp and Mayne, Inc., as Executive Advisors to the Project; the Executive Advisors were responsible for preparation of the Detailed Work Plan and Valuation Manuals during the pre-implementation stage and for expert advice and evaluation during the implementation and operations phases of the Project. The Operations Consultant Group, consisting of a joint venture made up of Parsons Corporation, International Aero Service and Marshall and Stevens Inc., provided expert consulting for carrying out the work of each of the activities of the Project.

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Ten GON agencies were involved in carrying out the activities, involving an estimated 737 GON personnel at the peak of the Project. Additionally, there were inputs to the overall Program from a German Technical Mission, the Inter-American Geodetic Survey, the Central American Bank for Economic Integration (CABEI) and the UN. Coordination of activities and maintenance of a balanced approach to an integrated program was, therefore, extremely difficult.

At the completion of the Project, the GON had substantially completed the requirements of the Project as set forth in the Loan Agreement and the Detailed Work Plan and, at the same time, created a cadre of trained technicians to carry out the work in the rest of the country.

At Project completion, the data indicated that 175,000 properties had been delivered from the mapping activity to the property valuation activity and that 154,000 properties had been valuated. At the same time, only 63,000 property ownerships had been verified and only 52,000 properties had been forwarded to the Tax Collection Office. Moreover, of the 52,000 properties forwarded, only 36,000 had been processed on to the tax rolls. Procedural changes to remedy the inefficient processes being used to verify property ownership had been recommended.

By the conclusion of the Project, the natural resources inventory component of the loan had produced valuable data, collected over the developed area of 35,000 square kilometers of the Pacific Coast; integrated analysis of these data had been initiated, and the data were being disseminated. Also, a channel had been established by law whereby the analyzed data and recommendations for implementation of identified development projects and programs are to be considered by the GON's planning officials.

The Cadastral Office is continuing its work of surveying the entire Program area. However, the pace of implementation has been slowed by insufficient government budgetary appropriations and the loss of trained staff to the higher salaried private sector.

C. Accomplishment of Project Goals

Any assessment of the impact of the AID loan on land reform, tax reform and utilization of natural resources data must take into account the emergency nature of the GON's planning program of 1973, resulting from the earthquake and drought suffered in 1972. The full extent to which Project goals are accomplished will have to await effective completion of the overall Cadastral Program by the GON, the utilization by official and private groups of the data produced by the Cadastral Survey, and

further evidence of Government performance in titling and taxation. Nevertheless, there are some indications of the Project's accomplishments.

1. Agrarian Reform - Determining the impact of L-012 on agrarian reform activities is difficult, since much of the current program of the Agrarian Institute of Nicaragua (IAN)--the agency established in 1964 with responsibility for land titles, settlement, rural training, land expropriation and development of new areas--is being undertaken outside of the loan project area. However, to the extent that the land registry and land titling system has benefited from L-012 and that the current titling and colonization activities are drawing on a Cadastral office capability which has been strengthened by the AID project, L-012 can be considered to have made a contribution. It is also known that the agricultural sector analysis, currently under way, has drawn heavily on the natural resources inventory produced by the AID loan (see below).

2. Tax Improvement - The increased number of property taxpayers and increased valuations resulting from the Cadastral Project are credited (along with more vigorous tax collection procedures, as well as the imposition of a new sales tax) with contributing to the improved overall Central Government revenue picture in 1970. Gains in property tax collections were also registered in 1971 and 1972; at the same time, according to the estimate in the loan completion report, the tax potential of the properties mapped as of mid-1972 amounted to $16 million, or about three times the amount actually collected that year. It was anticipated at that time that procedural changes to be implemented in 1972 would increase the efficiency of the operations and result in increased revenues in the future. As a consequence of the earthquake disaster, real estate taxes will experience a major reduction in 1973--preliminary estimates through September indicate more than a 15% decline over 1972 levels.

The Project's contributions to tax improvement may still lie in the future. Most immediately, it is believed that the Project's valuation activity in Managua may play an important role in any indemnification program undertaken by the Government in the reconstruction of Managua. For the longer range, there are implications for the Cadastral Project in new proposals for fiscal reform, such as have been advanced by the Advisory Center of the Central American Institute of Business Administration (INCAE). Among the Center's recommendations is one calling for increased property taxes; the Center has also recommended certain administrative measures, including a change in the nature of the property tax to *in rem* instead of *in personam*. Additionally, the Center is giving increasing attention to issues concerned with the strengthening of local governments, including local taxing authority. This may give some impetus to the activity contemplated in the Covenant, Section 6.5 of the Loan Agreement which had to do with restructuring the municipal tax system.

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3. Natural Resources Inventory - One Loan Covenant (Section 6.9) provides for use of data for development projects. As mentioned earlier, under the Project a channel was established by law whereby the analyzed data and recommendations for implementation of identified development projects and programs were to be considered by the GON's planning officials. At the Project's conclusion, the analysis and recommendations of one region had been completed and were ready for presentation. The disposition of the first report is not known; however, because of the restructuring of the GON's institutional framework for development planning (consequent to the earthquake disaster), new procedures will have to be established for considering future projects identified on the basis of Project data. In the meantime, there is evidence of continuing demand for the data. During the operational period banks, consulting firms, drilling companies, international agencies, local industries, national development agencies and others requested information on soils, land use, hydrogeology, geology, land values, surface water, climatology. More recently, as mentioned above, the data served the Agriculture Sector Analysis and also were drawn on in the AID-financed "Feasibility Studies and Surveys". Future use of the data is anticipated when an OAS Regional Development Program gets under way, sometime in 1974.

Guatemala:	Property Tax Development Loan I and II
I. Loan No.:	L-014
Amount:	$2,200,000
Date of Loan:	July 10, 1967 (Agreement signed)
Terminal Disbursement Date:	September 30, 1973 (revised)
Disbursed:	$2,186,000
II. Loan No.:	L-023
Amount:	$1,250,000
Date of Loan:	February 28, 1973 (Agreement signed)
Terminal Disbursement Date:	December 31, 1976

A. Purpose

The primary purpose of L-014 (Phase I) was to achieve an "increase in property tax revenue of the GOG[1/] through modernization of the tax base (property identification and appraisal) and improvement of tax collections through increased public acceptance and more efficient enforcement. The next most important objective of the project was the development within the Internal Revenue Service of the capability to continue the program after completion of the project. Another objective was the establishment of a modern property identification system to replace the obsolete land registry system and to serve as the base for a formal legal cadastre."

The purpose of L-014 was to be achieved through (1) the mapping and appraisal for property tax collection of the project area which covered approximately 12,000 square kilometers on the south coast and twenty-seven urban centers and (2) improvement of property tax assessment and collections.

The purpose of L-023 (Phase II) was to solidify the institutional process established in the first loan and to extend the system over a broader geographic area.

B. Implementation

Project funds were apportioned between two GOG agencies: The National Geographic Institute (IGN) of the Ministry of Communications and Public Works, and the Internal Revenue Service, a department of the Ministry of

1/ Government of Guatemala (GOG)

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Finance. The activities of these two agencies were coordinated and supervised by a Project Administrator and assisted by a consulting group (the J. L. Jacobs Co., Inc.).

Although it is considered that L-014 obtained good results within its limited scope, it was necessary to follow up the loan with a second phase loan, L-023, in order to solidify the institutional process of cadastral surveying, tax assessment, tax notification and tax collection and to extend the system into the Department of Guatemala and certain areas of South coast Departments not covered by Phase I.

The first phase had provided for cadastral records of taxable properties based on cartographic feasibility and not according to fiscal requirements. It covered a swath of the more prosperous southern section of the country without regard to political divisions and thus did not provide cadastral records for all properties in any one Department, the political subdivision for taxing units. This created a major problem because without the cadastral records for an entire Department, the records must be tax implemented on a property-by-property substitution basis in order to register them into the obsolete tax list called the "Matricula".

The tax office, using manual methods, encountered serious difficulties in registering the vast amount of new records that were furnished to it by the cadastral project. Because of this situation, it was not possible for any one of the Departments to institute an overall reform. Phase II will correct this deficiency by photo-mapping an additional 8,000 square kilometers, containing an estimated 230,000 properties. With the completion of both phases, the new record system will cover up to 90% of the property tax base of the country as compared to the 20% covered by the first phase.

The new loan will provide for the completion of the implementation and administrative stages for the cadastre records that were developed under the original project through notifications and inscriptions, and as political units are completed, through billing. As Departmental areas are completed, a total cadastre record system will be substituted in place of the outdated matricula presently in use.

Under Phase II, a property tax system will be designed to be computerized by arrangement with the Ministry of Finance, including the functions of calculating property assessments, filing records on tape, preparing tax bills and recording collections and delinquency accounts. The loan will also provide for a special study to determine the need, if any, for legislative reform as the new cadastral record system is applied to the Departments. And, finally, under the loan, provision is made to furnish the cadastral record listings and property maps to various local municipal governments having the authority to levy local property taxes, as well as to furnish advice and assistance to local municipal governments in property tax administration.

C. Accomplishment of Project Goals

1. Property Tax Improvement - Until the cadastral records are completed for an entire Department (it is expected that the first of these--Escuintla-- will be completed by the end of March 1974), implementation continues on the cadastral records under the original Project Plan, that is, on an individual basis using a special computer program designed for that purpose. Even under these circumstances, tax revenue performance has improved: according to the latest data available, property tax collections for the entire country (based on the new records) for the first ten months of 1973 amounted to about $6 million, compared with $5.4 million for the comparable ten-month period in 1972. These data reflect approximately 15,000 new accounts (inscribed in the billing system), representing increases in value of roughly $75.6 million. At the prevailing rate this base increase of $75.6 million is estimated to generate $350,000 a year in additional revenue. It is also estimated that current collections represent about one half of potential revenues.

Expectations are for rather significant progress in improving the tax system and revenue within two years, by giving immediate priority to working in the Municipality of Guatemala (which represents an estimated 80% of the revenue producing properties in the entire country).

2. Titling - Although improved titling was not the primary goal of the project, it was expected that the project would indirectly contribute to the establishment of a modern property identification system. In furtherance of this expectation, the project is providing cadastral maps and computerized listings to the Property Registry to act as an initial start in its improvement.

3. Use of Cadastral Data - In addition to providing a property map system to the Property Registry, the project is furnishing cadastral record listings and property maps to the various local municipal governments having the authority to levy property taxes for local improvements.

Additionally, Mission personnel as well as relevant GOG agencies have been informed of the availability of data on the cadastral property card that can contribute importantly to development planning in the rural sector.

HOUSE REGISTRATION HANDBOOK

A Manual for Registering Houses and Plots in Unplanned Settlements

SAAD YAHYA

URBAN DEVELOPMENT DEPARTMENT

The World Bank
Washington, D.C.

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PART 1

IS IT WORTHWHILE?

Half the urban population in developing countries lives in slums and unplanned settlements. In these settlements not only is shelter inadequate but many of the basic necessities and desirable conveniences are lacking. Clean water is available to only some of the residents. Facilities for the disposal of human waste are even scarcer. Education, health care and recreation facilities are grossly inadequate. It is estimated that some 400 million people in Africa, Asia, and Latin America live under such conditions. Their numbers are swelled by additional millions every year. Although these settlements are situated in the middle or at the edge of sophisticated and well-managed cities--Bombay, Buenos Aires, Calcutta, Manila, Mexico City, Nairobi and Seoul, to name but a few--little is known about them. They still need to be discovered in the sense that information about the inhabitants and their surroundings has to be collected and documented, maps prepared, plans for development formulated. The inhabitants, though they work and live in the city, have no recognized and accessible residential address, since their dwellings are illegal, and the land they occupy belongs to someone else. It would be helpful to know who lives where and what belongs to whom. That then is the purpose of house and plot registration. It is to survey and register household and plot characteristics. The resulting information forms a useful basis for planning and designing slum upgrading projects, improving delivery of municipal services, and granting proper titles to houseowners.

Registration information can therefore be useful to a variety of agencies and individuals. Among the primary or major users are metropolitan governments, municipalities, provincial and state governments, and central government ministries and departments. The types of agency using registration information, and the use to which it is put, are summarized in Table 1. Utility companies supplying urban services such as water, power, and telephones make use of registration information in distributing their product and invoicing the consumer: water or electricity is supplied to a specific address whose occupants must pay for the services rendered. Delivering mail from door to door is easier for the postman if each house has a specific number on a named street or block.

The secondary or minor users of registration data would include private commercial agencies, businesses and professionals. For instance, the marketing of a new product is facilitated by the presence of comprehensive data on ownership and occupancy of dwellings in a neighborhood, and by the improved access to individual families resulting from an efficient address system. Property identification makes real estate transactions easier to execute, so that not only do the plot owners benefit but associated industries such as estate agents, lawyers and financiers are likely to benefit from the results of a registration effort. A whole spectrum of small-scale and informal suppliers will find the improved access and house identification system an asset to their day-to-day operations; for instance taxi-drivers, door-to-door salesmen, ambulance drivers, rent collectors, bailiffs, community nurses, midwives and drivers of delivery vans.

Pages 2 & 3 Are Photographs and were not copied.

Table 1: PLOT REGISTRATION USES BY VARIOUS AGENCIES

	Municipality/Local Government	Metro. Government	Provincial/Regional/ State Administration	Central Government	Parastatals/Utilities	Private Companies & Individuals	Political Parties	Household
General Urban Administration	O	O	-	X	-	-	-	-
Delivery of Social Services	O	O	O	O	-	-	-	X
Health Services Delivery	O	O	O	O	-	-	-	-
Censuses	-	-	-	O	-	-	-	-
Cost Recovery	O	O	X	X	O	-	-	-
Property Taxation	O	O	-	X	-	-	-	-
House Improvement Loans	X	X	-	-	-	X	-	-
Forward Planning	O	O	X	X	O	-	-	-
Land Acquisition	X	X	X	X	X	-	-	-
Land Use Analysis	X	X	X	-	-	-	-	-
Household Surveys for Socioeconomic & Transportation Planning	X	X	-	X	-	-	-	-
Granting Property Titles	O	O	-	O	-	-	-	-
Monitoring, Evaluation & Impact Analyses	X	X	-	-	-	-	-	-
Marketing	-	-	-	-	X	O	-	-
Political Organization	-	-	-	-	-	-	O	-
Giving the House a Specific Address & Identity	-	-	-	-	-	-	-	O
Property Transactions	X	X	X	O	-	-	-	O

Note: O = major use; X = minor use.

Each of the users mentioned above would have his own objectives and requirements. Therefore the type of information to be collected and recorded will depend on who is going to use it and for what purpose. Whereas a planning authority would want only physical and qualitative data portraying broad patterns and trends on which forecasts for the future would be prepared, a land administration department would be more interested in precise details of ownership, tenure and physical boundaries. The water and electricity supply authorities would be interested in the plot number, location and name and address of the consumer. In upgrading projects it is important that bona fide residents and original structures are inventoried before project implementation, and a census executed at the right time can solve a lot of problems later when it comes to demolition, resettlement, and granting of title. In most cases the user is merely interested in where a certain household lives. Which means that the identity of the plot and family or families living on it are the basic components of a registration system.

The requirements of an appropriate registration system in relation to the expectations of various users are discussed in the following sections.

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PART 2

PUTTING RESOURCES TOGETHER

A. Requirements of an Appropriate Registration System

Whereas the basic objective of house and plot registration is to record household and property information in the form of registers, rolls and maps, the detailed content of these documents will depend on the purpose for which they are to be used. The ultimate aim and desired result is to facilitate economic, social and political transactions in the community. 1/ There is no point for example in installing a complex computerized information system in a small municipality without staff to operate it and where the local populace will have no access to the information. At the same time short-term requirements specific to a particular project, e.g. a squatter upgrading project, may be initially paramount but they should not be allowed to prejudice long-term objectives.

For a registration system to meet community needs it must satisfy the following requirements:

(a) Local relevance: content, format and presentation should follow local custom and tradition. Care should be exercised in the use of words such as plot, lot, site, house and structure, since they have different meanings in different countries. The use of measuring units, e.g. acre or hectare has to be locally relevant rather than in accordance with international practice. Descriptions of properties where given should pay due respect of people's homes: it would be wrong to describe a house as a "hut" or "shanty" just because it is built of inexpensive or traditional materials.

(b) Ease of execution and administration: feasibility of a new system needs to be carefully evaluated especially as regards the time and resources needed to install it. It is tempting, while conducting a household survey, to collect as much information as possible. But this temptation must be resisted since superfluous data will not only cause unnecessary expense, but it will also increase the likelihood of inaccuracies in the final presentation. And inaccuracies in some documents, e.g. tax rolls may have legal import and expensive consequences. Complex, detailed maps may need to be printed in several colors, a process not available in some developing countries.

1/ These transactions can be divided into: (a) Deliveries (water, electricity, mail, passengers); (b) Collections (refuse, sewerage, rent, taxes, sick persons); and (c) Transfers and Exchange (property sales, political participation).

(c) Use of available skills: the process of collecting information and documenting it should consume as little as possible of scarce professional manpower. Generally, emphasis should be placed on designing and implementing a simple system that can be easily executed by skilled and semi-skilled staff with the minimum of supervision. Planning and engineering departments in medium-size and large municipalities, and of course in central government ministries, would have their own social interviewers, planning technicians, surveyors and valuation assistants. With proper guidance such staff are capable of doing the necessary field surveys and documentation. Additional temporary staff could be hired if necessary. The use of consultants should be the last resort after attempts to find adequate in-house staff have failed. The two case-studies presented at the end of this manual show how consulting firms were used; in one case (Dar es Salaam) to carry out the whole registration exercise including field surveys, interviews, maps and registers, and in the other (Manila) cadastral surveys and deed plans only. In both cases it was not so much the lack of in-house skills that led to the employment of consulting firms but the shortage of staff and the urgency in which that particular task had to be done within the context of project implementation.

(d) Simplicity: by simplicity we mean brevity, precision and comprehensibility. A simple information system may be difficult to design initially, but it is less expensive to install and use in the long run. Experts and laymen can use it. Simplicity is an essential requirement for the final product and for the process itself; field questionnaires and survey equipment should be as simple as possible. There have been cases where complex survey equipment has frightened the residents of unplanned settlements, with catastrophic consequences for the surveyor. 1/

For fiscal and estate management functions, the only information needed would be plot identification, name and address of the owner, plot, house, or area, and use and assessment of land rent due. For town planning purposes more detailed information on the plot and its occupants may be needed, e.g. on soil conditions, drainage, availability of services, household size, number of rooms, floor area, household income, employment, place of work, and car ownership (quite relevant in some uncontrolled settlements). It is seldom

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1/ A surveyor was recently beaten to death by residents in an East African slum because the people mistook his theodolite for an instrument that sucks human blood for consumption by a mythical religious sect.

possible, however, unless a computerized system is used, to have a combined register suitable for all functions. It may be desirable therefore to have a simple register and, if deemed necesssary, a set of maps for day-to-day managerial purposes and a more complex data file to be used by planners as an when required, which should not be often.

Another differentiation could occur on a geographical basis in that a simple register and dossier of maps may be adequate for a homogenous unplanned residential area but a more sophisticated set of documents would be required for those parts of the central business district where there is a mixture of the more formal commercial development with settlement by squatters, a situation to be found in cities such as Addis Ababa or Lagos.

(e) Accuracy and reliability: in official documents accuracy is essential. Precision must be paid for, although for some purposes a high degree of accuracy is unnecessary. For example, maps and plans used for fiscal purposes need not be as accurate as those used for granting title deeds. Whereas a valuer (appraiser) can use plans, or even prepare his own, based on approximate measurements taken with a linen tape, a deed plan must be prepared with a high degree of accuracy, with an acceptable margin of error. On the other hand the tax collector will need precise details of plot particulars and owner's name and address. That register or roll must be error free. Registers and maps containing too many errors, either arithmetical or typographical will cause unnecessary confusion, delays, or even litigation.

The standard of precision needed and achievable must be determined before the registration operation begins. Where there is no previous experience, a pilot survey (see Part 3, Section C) will be useful. It is also necessary to differentiate between working documents for internal use and official documents available for public use and scrutiny; the former need not be as accurate as the latter.

(f) Efficient storage and retrieval: when information has been collected from the field it needs to be collated and recorded in a manner that makes it useful to potential users. It should be available when required. The particulars of any one plot, house or household should be available within a few minutes of an enquiry being made by an officer or a member of the public. A good test is whether the required information can be obtained by phoning the relevant office. To this end registers, rolls and maps must be kept in an accessible but safe place where no unauthorized person can interfere with the records.

(g) Ease of review and updating: as properties change hands, households move house, changes of use take place and subdivisions occur, it is obvious that after a while the records will be out of date unless revisions are made continually. A good system is one which allows the officers responsible to make such revisions administratively without having to get the whole document approved by the municipal council or minister. For instance tax rolls in many developing countries can be amended administratively in the interim period between complete revaluations.

The need for review and updating is a factor to be borne in mind when deciding on the format of presentation. Also, when a new system is introduced it should be compatible with existing systems as far as possible.

(h) Capacity for technical improvement: where a basic or rudimentary system is employed to start with it makes sense to allow for its improvement on a step-by-step basis as funds become available. Many modern computer systems can be designed along those lines. When it comes to title surveys, some countries allow the use of a "temporary survey" where the boundaries are marked by wooden stakes rather than by concrete beacons, thus allowing construction to take place before a proper title survey can be conducted. This system saves a lot of time where there is a shortage of registered surveyors. Another example is the tagging or labeling of houses with a temporary number written with chalk or painted on the front door while waiting for proper number plates to be manufactured. That approach has been used in Dar es Salaam, Tanzania.

(i) Accessibility to the public: information on plots, houses and ownership should be made available for use by members of the public. Registers, rolls and maps should be public documents accessible during office hours either at the town hall or site office. Where staff has to be employed to assist members of the public or to prepare written extracts, a nominal fee--called search fee--may be charged. A fee may also be charged for copies of maps and plans.

Accessibility is related to simplicity. An unsophisticated clientele will benefit more from a simple listing showing the main items of information in the local language rather than a foreign official language. At the same time survey beacons and monuments should be placed on site in such a manner that they are easily identifiable by non-surveyors.

(j) Equity: presentation of technical information and format of documents should not show bias toward a particular group or groups of people. For example, it would be ethically wrong to categorize entries in a register according to race, tribe or religion. Maps too should show all houses or structures, not just the "permanent" ones. It would also be wrong to omit showing premises on a map because they belong to an unpopular religious sect or a person with unorthodox political views.

(k) Cost effectiveness: a registration system must pay for itself, in economic and social terms. That is why the type of system used and the level of sophistication and precision need to be carefully evaluated and weighed against the benefits to be derived. A costly cadastral survey and titling operation may not be justifiable where land is publicly owned as in Tanzania, or Mozambique. On the other hand a sophisticated computerized system would be superfluous if its only use would be for collecting land rent. Costing aspects are discussed in detail in the next section.

It is evident from the above discussion that appropriateness is relative and community-specific in that what is appropriate in a particular situation or country may be totally irrelevant in another.

B. Costs and Benefits of House and Plot Registration

The benefits of a registration system should accrue to the public sector, the community at large and the individual households. It will be seen that the cost of a properly conceived system is relatively small and easily recoverable. For example, the cost of preparing a new tax assessment roll would be recoverable through increased tax revenues. On the other hand, a titling operation executed as part of a squatter upgrading project provides an opportunity for the cost to be recouped through the normal machinery for recovering project costs, i.e. initial payments and subsequent plot rents and charges, in addition to the property tax arrangements. It would be difficult to convince houseowners to pay for a survey just because the authorities want an up-to-date data base. Whatever expenditure is incurred must be seen to yield substantial benefits for the local populace.

Cost and Complexity

The actual expenditure that may have to be borne by the household will depend on a number of factors, chief among which being the amount of information to be collected and recorded, and the degree of accuracy required. In Tanzania, for example, a register of squatter houses and accompanying maps

based on aerial photographs was prepared in 1980 at a cost of about US$4 per house. In Manzini, Swaziland, it was estimated in 1979 that a full title survey of the squatter areas on the outskirts of the capital city could be prepared for between US$40 and US$50 per plot. In Metro Manila the surveying and monumenting of plots in the ZIP Program (see Case Study 2) is being carried out at between US$30 and US$45 per plot depending on site conditions.

It is clear then that a full title survey complete with deed plan and plot description is the most expensive option, while the least costly is a simple list of houses and owners/users with a set of maps drawn more or less to scale but showing clearly each structure and the main topographical features. Between these two extremes there is a range of alternatives arranged below in order of complexity and costliness:

Plots/Structures	Owners/Users
Total quantity	Total number
Quantity by subarea	List of names
List and approximate maps	Names and addresses
List and aerial photos	Owners and renters' particulars
List and precise maps	Detailed household information
Tagging without title survey	Letter of offer/allocation
Plot description	
Temporary title survey	Certificate of title/rights
Full title survey	Title deed
Full title survey including buildings	
Mapping of land, buildings and other qualities, e.g. floor areas, condition, type of materials	

Bearing in mind that the problem is to find suitable identification for the property (structure or plot) on the one hand, and for the owner on the other, the alternatives listed above offer a number of permutations that would be applied to suit a particular situation.

Cost Determinants

Apart from the level and type of information required, as outlined above, the cost of registration is likely to be influenced by a number of factors of which the principal are:

(a) Location: the location of a squatter settlement in relation to the rest of the city and the operation headquarters is relevant in that transportation is a major item of expenditure while carrying out a survey.

(b) Size: a small settlement is easier to survey and prepare records for, and it may be even less expensive where simple techniques can be used. However, it is uneconomical to fly over a small area of, say, a few hectares for the purpose of aerial survey. Where consultants are employed, a cheaper fee, hectare for hectare, may be negotiated if the areas involved are fairly large.

(c) Topography and climate: undertaking a cadastral survey on steep sites is more difficult than on level terrain. It takes longer and costs more. Climate is important because aerial photographs using traditional methods cannot be taken during the rainy season--which may last for half the year in some countries--or when it is overcast. Moreover, field staff, be they social interviewers or survey technicians, work best when climatic conditions are good. Ideally, fieldwork should be planned for the appropriate season.

(d) Density: survey work is more complex where buildings are closely packed than when densities are low, and there is plenty of room for the land surveyors to work in. There is a wide variation in plot sizes and the number of dwellings per hectare, with the lowest densities to be found generally in African cities and the highest in Asian.

(e) Pattern: the pattern of existing development may seriously hinder survey work, e.g. where plots are irregular in shape, where buildings abut, or where buildings are under multiple ownership with various families each owning a room or an apartment.

(f) Activity: the maps and register must show the structures on the ground at a specific date. There is normally constant activity in the form of new construction, extension and demolition. It is otherwise expensive to keep amending the records to reflect changes on the ground.

(g) Legal requirements: statutory requirements relating to title registration procedures and the attendant fees will vary from country to country, or even city to city within a country.

The above factors must be taken into account when estimating the cost of implementing a registration system.

Estimating Methods

It is often useful to have an appropriate cost ceiling or cost yardstick before detailed estimates are prepared. This cost ceiling would be calculated on the basis of so much per plot or per hectare. Such figures may be obtained by analyzing past projects, either in the country, or if that should not be possible, in similar circumstances elsewhere. Care must be taken to make sure that the same type of information and recording is being considered. In the case of squatter upgrading projects, registration and titling can be calculated as a percentage of total on-site infrastructure cost, and a comparison made between different projects. For example, in Manila survey and monumenting accounted on the average for 5% of the total on-site infrastructure cost.

An example of how to estimate fieldwork and recording costs is given in Table 2 of Case Study 1. In that particular case fairly up-to-date aerial photographs were already available and no title surveys were required; in such a case the type and quantity of input has to be estimated within the context of that particular job. The cost of aerial photography is not included in this discussion since aerial photographs have to be taken for infrastructure planning and design and their use for registration purposes is often incidental. Maps can be complicated to make, are not easily updated, and should be included in a basic registration package only when necessary.

The main items of expenditure involved are:

(a) Labor: manpower costs will depend on whether the work is to be done by in-house staff, by specially recruited staff hired on a temporary basis, by consultants, or by a mixture of the three options. Wage rates will be different for each type of personnel. Personnel on the regular payroll, since they are paid on a regular basis, may in some cases be excluded from the estimates of financial requirements. It is important to differentiate between estimates of project costs and a budget or financing plan showing how the money will be raised.

Estimates of productivity may be based either on previous experience on similar operations, or on the results of a pilot survey. When estimating the number of man-days or man-weeks needed to do the fieldwork, allowance must be made for time likely to be lost because of bad weather, transport breakdowns and other unforeseen circumstances. It would be risky to plan on the basis of a five-and-a-half-day-week for long periods. It may also be advisable to allow for some overtime to be authorized at the discretion of the field supervisor.

(b) Materials: the type and quantity of materials to be consumed depend on the nature of the registration operation. Materials needed would include:

- aerial photographs
- maps
- drawing materials, i.e. instruments, paper, inks, colors, erasers, etc.
- photographic materials
- stationery
- tags or number plates

Availability of materials should not be assumed. Before the work starts it is necessary to check whether each material is readily available locally, and to list the suppliers. Government departments and municipalities would have their own established procedures for purchasing supplies, and these should be followed whenever possible.

(c) Transport: the distance between the office and site is important not only because of transport costs but also because of time lost while staff is traveling. Site offices should therefore be established whenever possible. Estimates of transport costs can be made on the basis of projected mileage at so much per mile or kilometer. This approach assumes that vehicles are available in the first place, either in the office car pool or belonging to individual officers. Where the position is otherwise, provision must be made for purchasing suitable field vehicles and for subsequent operating costs. Guidelines on mileage rates to be used may be obtained from schedules of official rates payable to staff traveling on municipal or government business, and from car hire firms.

(d) Printing: the final approved version of the maps and registers must be produced to a high standard. They may therefore have to be printed by specialist firms, in which case appropriate financial provisions should be made. In the smaller developing countries facilities for printing maps may not be available and suitable arrangements have to be made overseas.

(e) Office expenses/overheads: again, if the job is undertaken in-house, such items as rent, telephone calls, postage and secretarial services would be covered by the general office budget and no separate estimates would normally be required. Items such as the photocopying of applicants' documents can be costly, and a decision has to be made on whether to charge the applicants an application fee at the rate of so much per page copied.

(f) Contingencies: in order to allow for unforeseen difficulties a contingency sum of between 5% and, say, 10% should

be included in the cost estimates. If the job is likely to take a long time, an additional allowance for inflation and cost escalation should be made.

While preparing the estimates one must endeavor to be as accurate as possible while erring on the safe side. At the end of the day it is easier to explain underexpenditure than overexpenditure. It should also be remembered that once money is budgeted for a particular financial year, it must be spent in that year since most public agencies would not allow excess funds to be carried forward to the next year.

The Comprehensive Resource Inventory and Evaluation System (CRIES) Project's Phase I & II

of the

Jamaican Resource Assessment

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Introduction

Methods, approaches and procedures of land classification have changed over time, only the problems have not. Early classification methods were extremely time consuming and if implemented today would be prohibited by cost factors. The development of more expedient methods and means have helped to greatly reduce the time and costs associated with large scale land classification projects. The Comprehensive Resource Inventory and Evaluation System (CRIES) Project is attempting to utilize these methods and means to limit cost and time overruns in a large scale land classification project in Jamaica.

The CRIES Project

The Comprehensive Resource Inventory and Evaluation System (CRIES) project was formulated in 1976 as a jointly funded and developed project by the U.S. Agency for International Development, the United State Department of Agriculture, and Michigan State University. The project has been involved in the Dominican Republic, Costa Rica, Nicaragua, Syria, Honduras, Kenya and Jamaica. In addition, CRIES is also involved in assessing the physical and economic constraints to the production of irrigated vegetables in Traverse County, Michigan.

CRIES methods are based on using a core multidisciplinary team that has strong interdisciplinary ties to:

(1) "Assit developing nations to analyze their agricultural production potentials;

(2) Enhance their institutional capabilities for analysis of rural development planning and policy design." (Schultink, 1983 p.1)

Jamaican Resource Assessment Phase I

During October of 1981, the CRIES Project initiated Phase I of the Jamaican Resource Assessment. The primary purpose of the assessment was to create a nationally consistent natural resource data base from which regional, and national level agricultural planning decisions could be based.

Land Cover/Use

The only complete set of photography available to document current landcover/use patterns was imaged during December of 1979 and January-February 1980, at a scale of 1:50,000. These photographs, over 200 stereo-pairs, were used to interpret 26 categories of landcover/use patterns through out the island (Appendix I).

Mirror stereo scopes were used and delineation made on clear 10"^{2} squared acetate overlay. The smallest feature mapped (type size)

was 8 hectare. Three field trips were made to document interpreted landcover/use patterns using both ground and light aircraft transportation.

Once the final field work and corrections were made and all side-lap and end-lap problems corrected each of the 200+ sheets of interpretations were transferred to a set of stable based mylar maps using a zoom-transfer scope. When the interpretations were registered to the map they were transferred onto a sheet of pin-registered frosted mylar.

From these frosted mylar sheets final inked maps were produced and stable photographic black and clear base maps prepared. The black and clear mylars were then digitized and became one layer in the geographic information system. (GIS)

Soils

The primary source of soils information was the "Soil and Land-Use Surveys" of the 13 Jamaican parishes (Schultink, et. al., 1982). These surveys began in 1958 and were completed in 1970. The soil maps produced during the survey were at a scale of 1:12,500 with 546 different soil categories.

Three primary problems had to be solved before the information could be merged into the GIS. The first was to convert existing soil classification and descriptions into those used in the U.S. Soils Taxonomy.

Second, there was a concern that soil boundaries and descriptions may not be consistent from one parish to the next as a number of surveyors were involved over the 12 year period of the original survey. The third problem was one of aggregating 546 detailed categories into a form and intensity level suitable for a regional assessment.

Initially, soil delineations were aggregated according to the dominant soil type and characteristic. For example, 31 map units were originally classified as being dominately Bonnygate strony loam, these were aggregated into one category. Classification descriptions were modified according to U.S. Soil Taxonomy and boundaries were field checked. Final field checking left 197 individual classifications. These classifications were transferred to the pin-registered stable base mylars maps and photographic black and clears were once again produced and digitized.

Production Potentials

The 197 soil units were grouped into 24 "Crop Potential Groups" based on texture, depth, drainage, slope, established cropping patterns and moisture availability (Appendix II). Each grouping was based on a section of the original soils work entitled 'Recommended Crops for Soils' for the 13 parishes. Groupings are

then rated as either high, medium or low for the potential production of sugar cane, bananas, food crops, vegetables, improved pasture, tobacco, pineapples, citrus, coconuts, coffee, cocoa, food trees, timber, natural forest, and rice. Tables were than developed for each parish showing the crop potential group by soil unit and its associated acreage (Appendix III).

Utilization of the GIS Phase I

The GIS created was used to produce cross tabulations of political unit by soil type, by soil grouping, by land cover/use, and by specialty crops. Perhaps the best utilizations of this GIS has to answer the question "what can be grown and where." Prime examples are areas for banana and coffee production, where only lands that were not currently being used for those crops or in a conflicting use such as urban were considered.

The CRIES-GIS software system was installed (at the end of Phase I) on a IBM mainframe computer. It allows the user to systematically store, retrieve, update and analyze resource information relative to the extent and quality of resource attributes (e.g. soils, climate, topography, hydrology) and the current land use or productivity of natural resources.

The system consists of two major software components, GEOMAST and GEORAP* The GEOMAST routines are mainly used to create, update and verify the resource data base, whereas GEORAP supports interactive data processing and anlysis. Typical system outputs include computer printer maps (e.g. crop suitabilities), cross tabulations, histograms, overlay analysis, re-scaled map products, etc.

The CRIES-GIS was installed at the Ministry of Public Service Central Data Processing Unit (CDPU). Two workshops were conducted at CDPU in 1982. The first, in March, was attended by five computer specialists; a second held in August was attended by potential users from a variety of Jamaican governmental agencies. Documentations of the GIS and training modules were studied and distributed along with the source code for the GIS. Three copies of the source code are being stored at CDPU, Data Bank, and Rural Physical Planning (RPPU), respectively. The GIS is currently fully operational.

Phase II - Refinement of the Physical Production Base

Phase II is designed to be a 4.5 year project emphasizing both regional and national level economic development for planning (Figure I). A first priority of the project is to install a micro-computer based G.I.S. and digitizing system within the Rural Physical Planning Unit (RPU) of the Ministry of

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*CRIES. User's Guide to the CRIES Geographic Information and Analytical System and Training Modules - CRIES Geographic Information and Analytical System. CRIES. 1982.

Agriculture (MOA). The system will play two roles. First, it will allow direct implementation of analysis software from the CRIES project to MOA. Second, the additional physical data required for potential crop yield analysis can be collected and entered into the system in Jamaica without the delay of bringing it back to Michigan State and shipping it back to Jamaica.

Physical data requirements during Phase II will be broken down under four (4) sub-headings: Land cover/use, soils, soil moisture availability and ground-water (FigureII). This work will parallel the economic development for the first three parishes. This work, however, is planned to precede the economic activities as much as possible during the first three years of the Project to avoid delaying any of the economic analysis requiring the physical data.

Land Cover/Use

Current land cover/use maps and data base reflect conditions as portraited on the 1979-1980 black and white photographs used during the Phase I inventory. Also, portions of St. Thomas parishes land cover/use information date back to the mid 1960's because of cloud cover problems in the more recent photography.

Where more recent photographs exists, as in parts of St. Catherine and Clarendon (1:25,000 black and white) updates of the existing data base can be made. Another potential updating source is the space shuttle mission scheduled for June, 1984. The shuttle will be carrying a Large Format Camera (LFC). The LFC will be used to image large sections of the Caribbean at a scale of 1:50,000. If the mission proceeds as planned and cloud cover does not pose as a major obstacle, this photography should be available by late 1984.

The only other potential data source, other than flying new photography, is the Thematic Mapper (TM) aboard Landsat IV. The TM scanner will capture data with a 30 meter resolution. The new micro-computer based G.I.S. to be installed at the Rural Physical Planning Division Unit will be able to process the digital TM data with minor software modification. Reflectance signatures can be aggregated to 16 hectare cells the existing 1:50,000 landcover/use data file can be used to establish classification criteria.

Soils

During Phase II of the Assessment a more extensive grouping of soils will be made into 'Agro-Ecological Zones' based on soiltexture, moisture availability and vegetative cover. The agro-ecological zones will represent homogenious units for potential crop production. Each zone will then be assessed and ranked according to its potential for export, import substitution and subsistance crop production yield potentials for each of the major crops.

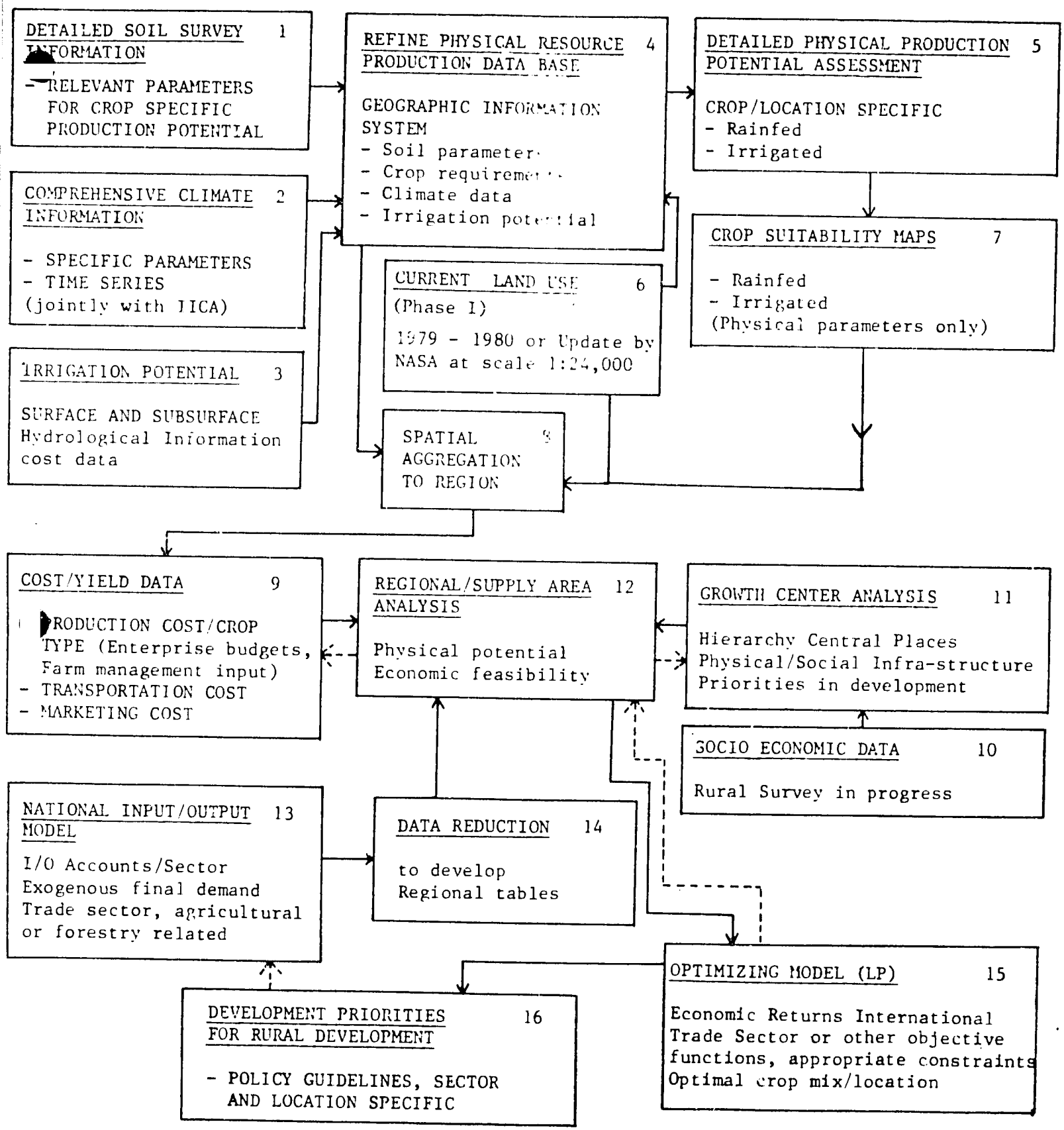
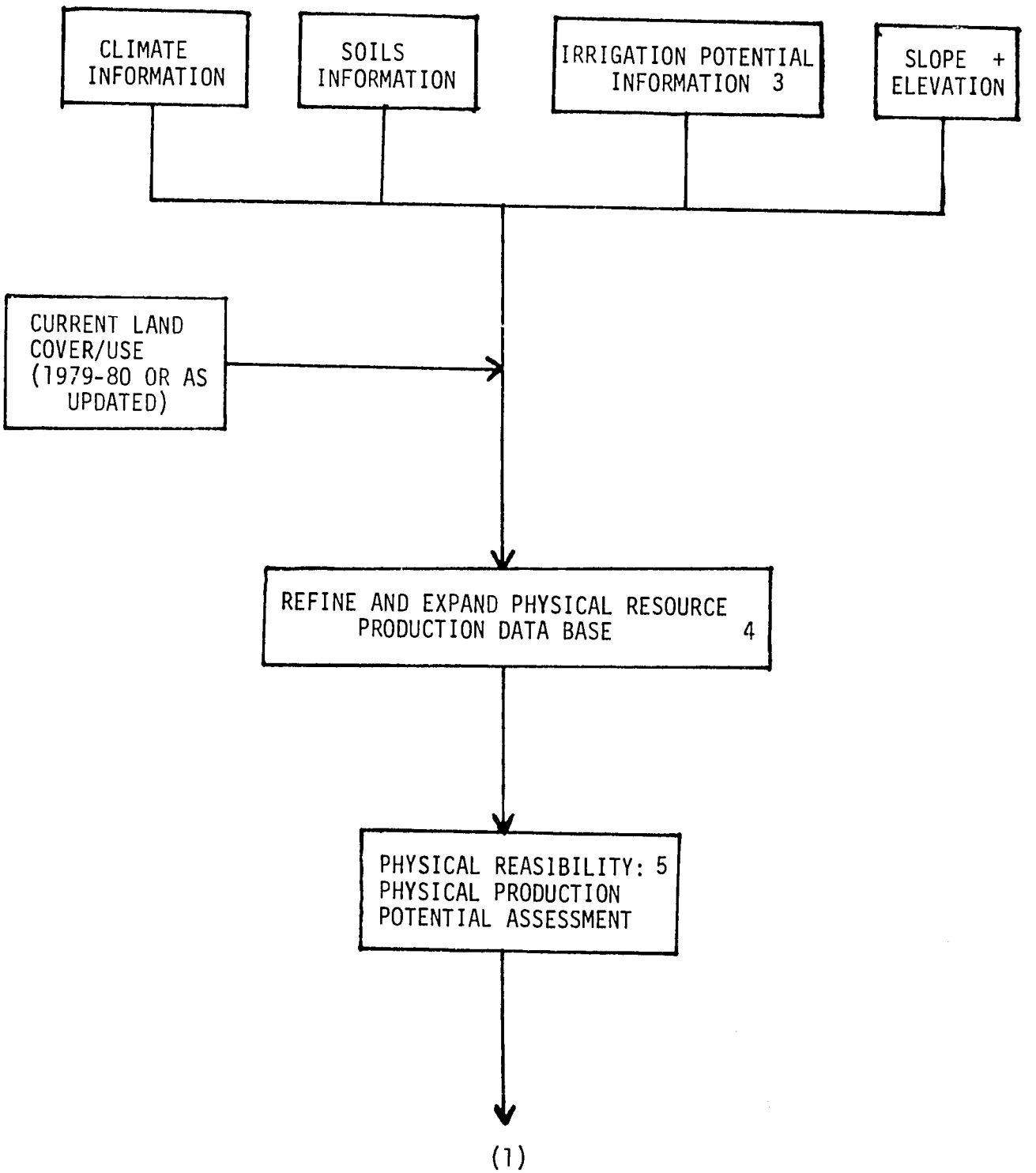


Figure 1 GROSS FLOWCHART PROJECT COMPONENTS
JAMAICAN RESOURCE ASSESSMENT PROJECT, PHASE II

FIGURE II

PHYSICAL FEASIBILITY COMPONENT



Soil Moisture Availability

Soil moisture modeling will be used to establish potential moisture availability for crop growth throughout the year. Wherever possible long-term records (30 years) will be used to document fluctuations in local climate conditions.

Evapotranspiration estimates will be derived using the Penman equation (for order stations) and tempered by lysimeter data where possible. Several water budgeting techniques will be compared, Thornthwaite, Blaney-Criddle, and S.C.S., plus Markov Chain analysis to determine the most representative estimate of actual conditions. Estimates will be made on a parish by parish basis. The model will be altered where necessary to provide the best estimate of actual field conditions.

Contouring-routines will be used for estimates of soil moisture availability over each parish. These estimates will be further modified by using sloping routines and existing wind data. Once the most appropriate countours are established they will be entered into the integrated data base system.

Goundwater

Existing well log data will be compiled and plotted on a parish map. Each well site will be given a set of descriptors indicating well depth, diameter and geological profile. Contouring routines will again be used to delimit areas with similar well depths. This information will be used to estimate potential costs of drilling wells for irrigation. This information in turn will be added to the information system.

Existing streamflow data will also be analyzed during this portion of the Project. Hydrographs will be compared with water balance graphs and precipitation occurence records. This information will be used to estimate the contribution of run-off versus ground-water flow under various soil moisture field capacity conditions. This information will also be used as indicators and weighting factors for moisture infiltration rates within various agro-ecological zones.

Production Potential and Suitability Assessment

Under this work component the refined physical data base will be used to establish crop production potentials using a suitability assessment for each agro-ecological zone. The suitability assessment will be carried out for major export, import substitution and subsistance crops by zone.

Potential yield estimates will be derived for each type of cropping group utilizing a regionalized yield model, as adapted from the model YIELD (Hayes, et. al., 1982). A flowchart of the model is included as Appendix IV. Subroutines will be developed to incorporate the crops from each group. Consequently, each parish will be divided into agro-ecological zones that can be

ranked by their potential yields of export, import substitution and subsistance crops.

Once the physical parameters have been assessed to determine crop suitability by parish by agro-ecological zone, the next step will be to determine the economic feasibility of producing these crops.

Structure of the Analytical System*

It is expected that the model for each region (i.e., parish) will be constructed by considering the crop suitability zone as homogenious and using the enterprise budget appropriate to each region for agricultural and forestry enterprises. The enterprise budget will help to determine the optimal resource mix for each region. Such solutions may or may not be best for individual farmers. It may be that the optimizing model for this part of the analysis will have a linear programming structure. The principal type of constraint will be land resource types, although other inputs may also be constraining (e.g. capital). It is recognized that profitable enterprises that are labor intensive are likely to have high priority because of the country's serious unemployment problem.

The optimal mix of crops will undoubtedly be highly dependent on distances to markets and prices applicable to those markets (Figure II). In view of this influence, the transportation system (all modes) will be entered into the information system. Using the market price and the cost of producing (using best recommended practices), plus moving commodities to markets, it is possible (using the linear programming transportation algorithm) to determine which crop can be economically produced among the crops suitability zones. Areas found to be potentially economical will be considered potential supply areas for various crops. The volume of commodities to be transported out of the crop production zone will depend on the output indicated as potential given current land use information (1979-80). The amount of each crop to be delivered to markets will be dependent on forecasted requirements for each demand region (including exports via ports). Locations of processing plants for agricultural and forestry commodities must be delineated within the information system as they constitute markets for the commodity produces.

Urban centers that constitute markets for crops will be depicted within the information system. The analysis will determine optimal flows of crops to the urban centers, given the existing transportation system. It is then proposed that a growth center analysis be carried out to determine which urban centers have the highest potential for economic growth and what measures need to

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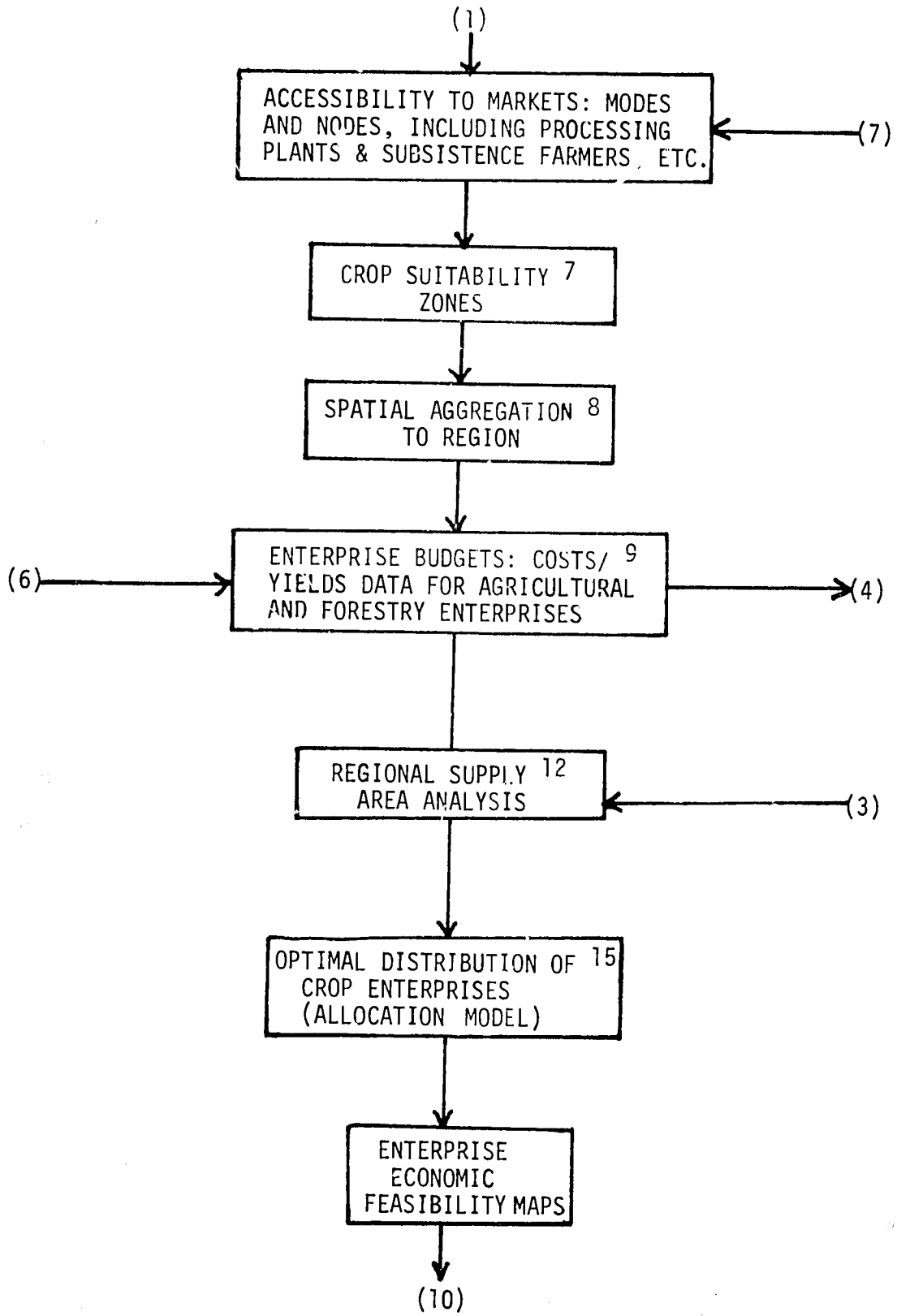
* From Schultink, Chappelle, and Witter. Phase II Project Proposal of Jamaican Resource Assessment, 1983.

FIGURE II

AGRICULTURAL AND FORESTRY ENTERPRISES COMPONENT



be taken in order to realize potential economic growth. This analysis should provide the analytical basis for allocating public funds to improve local infrastructure and provide guidelines to the private sector as to which locations are likely to be most profitable as enterprise sites. In so far, as changes in crops mix are identified, this analysis can provide clues as to what type of public and private investments are possible and necessary.

It has not been decided at this time as to how subsistance agricultural enterprise will be handled in the analytical system. It is clear, however, that they are very important and must be explicitly recognized. Guidelines drawn from the analysis will be helpful to subsistance farmers, if the information can be conveyed by extension workers to them and they are willing to adapt the recommendations. If this happens, it may be possible for subsistance farmers to progress to commercial farmers or at the very least, be able to subsist a a higher level than in the past. However, it should be reiterated at this point that, the smallest unit of analysis is not the individual farmer, but rather the crop homogeneous suitability zone.

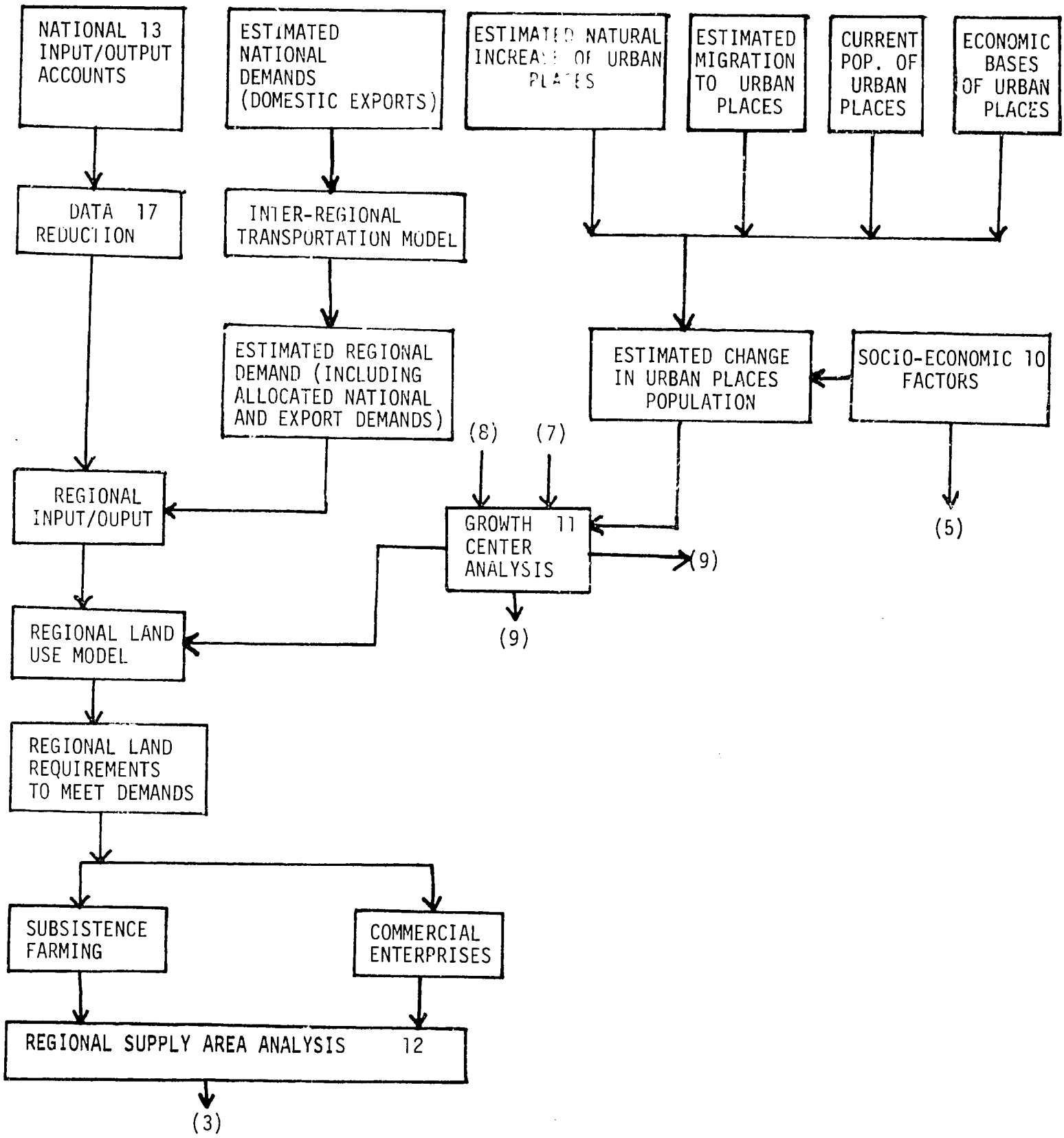
A major problem which will have to be overcome later is how to link this analysis to the national economy (Figure III). An obvious way to handle this matter is to enter the enterprise budgets used in the allocation model into a mathematical programming model built around input/output accounts for the regions. However, no such input-output accounts exist and it will not be possible to construct them as a part of this project. On the other hand, a set of national input-output accounts have been constructed. It may be possible to utilize data reduction techniques and supplementary regional economic information to develop the needed regional accounts. It is unlikely, however, that enough inter-regional trade data exists to build a full inter-regional economic model. The most that can be promised at this time, therefore, is that the study team will go as far as possible given the data that are available at that time.

Another major problem area the study team will have to contend with has to do with the export sector. There is no question but that the mix of enterprises in Jamaica is heavily influenced by the export market. In fact, there is considerable merit in having the economic model be export-driven and take per-capita consumption of goods and services as given. If this course is taken - the major question is to what extent can we accurately forecast the export market? If accurate forecasts can be developed and such markets were to be stabilized, then it should be expected that following the guidelines of the analytical system will provide higher levels of economic growth. If, however, export markets cannot be accurately forecasted and/or they continue to be unstable (in terms of quantity or prices), then it is not to be expected that study results will necessarily result in improved performance of regional and national

economies. In this case the major gains may be to improve the situation of subsistence farmers.

FIGURE III

NATIONAL AND REGIONAL ECONOMIC COMPONENT



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APPENDIX I

Land Cover/Use Classification Legend for the Jamaican National Resource Assessment Project

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1. Urban and Built-Up Areas

11 - Urban Residential - Parish capitals.
12 - Rural Residential - All other cities, villages or towns that have a total area equal to or greater than eight hectares.
13 - Industrial, Commercial and Institutional - These include bauxite processing plants plus commercial and institutional land uses found in parish capitals with total areas equal to or greater than eight hectares.
14 - Resort Development - Coastal strip development made up primarily of large hotels and associated facilities.

2. Crops

21 - Sugar Cane - Fields in sugar cane with a total area greater than or equal to sixteen hectares.
22 - Bananas - Predominantly mono-cultivation of bananas in fields equal to or greater than sixteen hectares in total area.
23 - Coconuts - Predominantly mono-cultivation of coconuts in fields equal to or greater than sixteen hectares in total area.
23A- Mixed Bananas and Coconuts - Mixed stands of bananas and coconuts. These fields are equal to or greater than sixteen hectares in total area.
24 - Orchards - All types of fruits and nut orchards that are in stands equal to or greater than sixteen hectares in total area.
25 - Tobacco - Tobacco production in fields that are equal to or greater than sixteen hectares in total area.
26 - Mixed Coconuts and Forest - Stands of coconuts and forest (deciduous) mixed together with no clear dominance in areas equal to or greater than sixteen hectares in total area.
27 - Mixed Bananas and Forest - Stands of bananas and forest (deciduous) mixed together with no clear dominance in areas equal to or greater than sixteen hectares in total area.
28 - Intensive Mixed - Areas, not less than eight hectares, with numerous small fields of onions. cabbage, tomatoes, peppers, pumpkins, citrus, bananas, pasture, etc. At least 60% of these lands are devoted to crop production, part of which may be fallow.*
29 - Extensive Mixed - Areas, not less than eight hectares, with numerous small fields of onions, cabbage, tomatoes, peppers, pumpkins, citrus, bananas, pasture, etc. Crop production will dominate between 15-60% of the total area.*

3. Pasture

31 - Improved Pasture - Areas that have been cleared and developed primarily for grazing. These areas are normally fenced and do not

have more than 15% crop production within any one delineation. The smallest area delineated is eight hectares.

32 - Unimproved Pasture - Areas that may have been cleared for cropping or grazing at one time, but have not been maintained for either. These areas are normally not fenced and have brush and forest pockets within them. Unimproved pasture delineations contain no more than 15% crop production and are equal to or greater than eight hectares in total area.

33 - Unimproved Pasture Limited by Slope - Areas that may have been cleared for cropping or grazing at one time, but have not been maintained for either. These areas are limited because of the extreme slopes, approximately 45° or greater. Limited pasture delineations contain no more than 15% crop production and are equal to or greater than eight hectares in total area.

4. Forest

41 - Coniferous - Forest stands including both coniferous and broad-leaved evergreens. The coniferous evergreens are commonly referred to as softwoods. These forests must have a 75% or more crown closure and be in stands of at least sixteen hectares or more.**

42 - Deciduous - Forest stands made of a mixture of various broadleaf species. The deciduous forest types must have a 75% or more crown closure and be in stands of at least sixteen hectares or more.**

43 - Brush - These areas are made up of low grazing deciduous type trees. Normally, these types of trees have little or no commercial value for lumber even at maturity. Brush delineations must have a 75% crown closure and be in stands of at least sixteen hectares or more.**

5. Water

51 - Lakes - Naturally enclosed bodies of water or man-made enclosures, including regulated natural lakes and reservoirs. These delineations reflect the amount of water that is present during the imaging of the 1979-1980 black and white photography used for this study. Lakes were mapped if their total area was equal to or exceeded eight hectares.

52 - Rivers - Rivers include creeks, canals, and other linear bodies of water. These bodies were not mapped unless they were equal to or exceeded four kilometers in length and could be distinguished on the photography.

53 - Wetlands Coastal - Marshes or swamps that are directly connected with the sea. Wetlands are frequently associated with low areas where the aquatic or hydrophytic vegetation is a result of the high water table. These delineations must be at least eight hectares or more in total area.

54 - Wetlands Noncoastal - Fresh water marshes or swamps that are not directly connected with the sea. Examples may include marshes, mudflats, and swamps located around lakes, ponds, rivers or man-made impoundments. These delineations must be at least eight hectares or more in total area.

6. Extractive

61 - Surface Mining - Areas equal to or larger than eight hectares, where vegetative cover and overburden are removed to expose limestone, bauxite, etc.

7. Barren Land

71 - Bare Sand or Rock - These areas are void of vegetation and are equal to or greater than eight hectares in total area. The category does not include any strip mined areas.

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* The percentages used as cutoffs for the Intensive and Extensive categories were adopted from those used by the Data Bank and Evaluation Division, Ministry of Agriculture, Kingston, Jamaica.

** The crown closure of 75% was established to eliminate possible confusion between Mixed Bananas and Forest (27), Improved Pasture (31), Unimproved Pasture (32), and Unimproved Pasture Limited by Slope (33). The density of forest in each of these categories varies enough that if a 25% crown enclosure (FAO's) was used a considerable underestimation, especially of the various pasture categories, would result. Forest patterns within these delineations were separately mapped whenever they were equal to or exceeded eight hectares in total area.

Production Potential Rating and National Area Totals for 15 Traditional Crops by Crop Potential Group
(See text for factors considered in the rating; High (H), Medium (M), and Low (L) rating indicated)

Crop Potential Group	Cane	Bananas	Food Crops	Vegetables	Improved Pasture	Tobacco	Pineapples	Citrus	Coconut	Coffee	Cacao	Food Trees	Timber	Natural Forest	Rice	National Totals: Hectares of Soils in Crop Potential Group
1	M	L	M	L	H	M	M	H	L	L	L	H	L	L	L	2,380
2	H	L	M	L	H	L	L	L	L	L	L	M	L	L	H	62,220
3	H	H	H	H	M	M	L	H	H	M	L	H	H	L	L	34,916
4	H	L	H	H	H	L	L	M	L	L	L	H	L	L	L	39,532
5	M	L	M	L	H	L	M	M	L	H	M	H	M	L	L	166,776
6	L	L	L	L	H	L	L	L	L	L	L	M	M	L	L	2,956
7	H	M	H	L	M	M	H	M	M	M	H	H	M	L	L	9,284
8	L	L	M	L	H	L	L	M	L	M	L	H	M	L	L	42,392
9	L	L	L	L	L	L	L	L	L	M	L	M	H	H	L	485,764
10	L	L	M	M	H	L	M	H	L	M	L	M	M	L	L	86,584
11	L	L	M	M	H	L	L	L	L	M	L	M	M	L	L	51,720
12	M	L	M	L	H	M	L	L	L	L	L	L	L	L	L	[illegible]
13	M	L	L	L	M	L	L	L	L	L	L	L	M	L	H	704
14	L	L	L	L	M	L	L	L	H	L	L	M	L	L	L	2,072
15	L	L	L	M	M	L	L	L	M	M	M	H	M	L	L	38,088
16	L	L	M	L	H	L	L	L	L	H	L	H	M	L	L	1,608
17	L	L	L	L	M	L	L	L	M	M	L	M	H	H	L	1,276
18	H	L	M	L	H	L	L	H	L	L	H	M	L	L	L	6,088
19	L	M	H	H	H	L	L	L	L	M	L	M	M	L	L	232
20	L	L	M	L	M	L	L	M	L	H	H	H	H	H	L	5,676
21	H	L	L	L	H	L	L	L	L	L	L	L	L	L	L	896
22	L	L	L	L	M	L	L	H	L	H	M	H	H	M	L	516
23	L	L	L	H	L	L	L	L	L	L	L	L	L	L	M	1,576
24	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	4,508

APPENDIX III

Portland Parish

Soil Group Digitized	Soil Group Map Symbol*	Crop Potential Group	Total Hectares Digitized	Total Hectares Normalized	Percentage of Total
2	32	5	76	77	.09
4		3	16	16	.02
5		2	40	41	.05
20		4	192	195	24
21		3	8	8	.01
23		3	444	451	55
24		3	324	329	.40
25		3	260	264	.32
27		3	184	187	.23
28		2	172	175	.21
29		14	76	77	.09
30		4	116	118	.14
34		5	3,452	3,510	4.31
38		5	8,752	8,898	10.93
41		15	2,968	3,018	3.71
43		4	44	45	.05
44		8	48	49	.06
46		5	7,712	7,841	9.63
49		8	36	37	.04
50		5	728	740	.91
52		5	608	618	.76
72	128	3	64	65	.08
73		10	32	33	.04
74		4	628	638	.78
75		8	660	671	.82
76	114	2	548	557	.68
77		9	12,824	13,038	16.02
78		10	132	134	.16
79		4	12	12	.01
91		8	948	964	1.18
92		2	16	16	.02
93		11	72	73	.09
94		11	9,548	9,707	11.92
95		5	1,984	2,017	2.48
98		4	48	49	.06
99		2	412	419	.51
103		3	1,136	1,155	1.42
107		3	20	20	.02
110	300	9	5,832	5,929	7.28
120		5	400	407	.50
121		5	32	33	.04
122		2	448	455	.56
123		3	96	98	.12
131		5	92	94	.11

* If not listed, map symbol identical to digitized value (see also Appendix H).

Portland Parish (cont'd)

Soil Group		Crop Potential Group	Total Hectares		Percentage of Total
Digitized	Map Symbol*		Digitized	Normalized	
136	301	5	2,328	2,367	2.91
137	302	5	168	171	.21
138	303	5	11,296	11,485	14.11
140		15	1,644	1,671	2.05
142	305	5	824	838	1.03
143	306	5	248	252	.31
147	RW	-	684	695	.85
149	SW	-	124	126	.15
155	MA	-	44	45	.05
157	V	-	268	272	.33
159	M	-	4	4	.00
161	BS	-	24	24	.03
167		4	8	8	.01
207		18	168	171	.21

* If not listed, map symbol identical to digitized value (see also Appendix H).

APPENDIX IV

INPUT

Climatological
- Maximum Daily Temperature
- Minimum Daily Temperature
- Maximum Daily Relative Humdity
- Minimum Daily Relative Humidity
- Total Daily Solar Radiation
- Daily Wind Speed
- Monthly Precipitation
- Precipitation Days
- Monthly Cloud Density
- Day/Night Wind Ratio

Agricultural
- Albedo
- Field Size
- Degree Day Base Temperature/Crop
- Field Slope Scenarios
- Irrigation Efficiency Scenarios
- Root Depth/Crop
- Growth Stage Crop Coefficients per Crop and Latitude
- Irrigation Critical Soil Moisture
- Maximum Tolerable Soil Salinity/Crop
- Electrical Conductivity/Crop

Crops Used

Spring Wheat	Rice
Winter Wheat	Rice
Spring Barley	Grain Corn
Winter Barley	Early Potatoes
Spring Rye	Late Potatoes
Winter Rye	Alfalfa

Pedological-Hydrological
- Soil Scenarios
- Leaching Efficiency Scenarios
- Leaching Requirement Scenarios
- Groundwater Table Scenarios
- Irrigation Water Electrical Conduction Scenarios
- Readily Available Soil Water
- Percolation Water Loss Rates/Soil

Station Information, Miscellaneous
- Latitude
- Longitude
- Elevation
- Time Step Size

↓

Data Interpolation

↓

CROP 1 Evapotranspiration
Reference Crop

↓

CROP 2 Evapotranspiration
Wind Adjustment

↓

CROP 3 Evapotranspiration
Crop Coefficients
12 Crops, 4 Growth Stages

↓

CROP 4 Evapotranspiration
Clothes Line and
Oasis Effect

↓

CROP 5 Evapotranspiration
Effective Precipitation
Groundwater
Percolation
Irrigation Efficiency
Leaching Requirements
Soil Water Potential
Soil Water Status

↓

OUTPUT

Crop Related

Crop Specific:
- Cumulative Evapotranspiration CROP 1
- Cumulative Evapotranspiration CROP 2
- Cumulative Evapotranspiration CROP 3
- Cumulative Evapotranspiration CROP 4
- Cumulative Evapotranspiration CROP 5
- Sowing Dates
- Cumulative Degree Days
- Irrigation Water Added to Root Zone
- Cumulative Irrigation Need
- Length of Growing Season Information

Multiple Growing Season Information

Actual Evapotranspiration/Maximum Potential Evapotranspiration

Soil Water Related

Crop Specific:
- Total Available Soil Moisture
- Groundwater Contribution to Root Zone
- Soil Moisture Storage Changes
- Runoff
- Percolation Water Loss

Source: Hayes, et. al., 1982.