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LAND RELATED INFORMATION SYSTEMS

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1. Introduction

Canada is a federal state of 10 provinces and two Territories. At times the provinces, for developmental or economic reasons, set up regional agencies to attack common problems. This paper deals with such an agency and how it is handling problems on a regional basis. Our region is the "Maritime Region" - the Provinces of New Brunswick, Nova Scotia and Prince Edward Island in Atlantic Canada. The three provinces had a similar history, similar development patterns, and it should be noted that prior to the initiation of our program, the largest scale of topographic mapping was 1:50 000 and there was no cadastral office and no cadastral mapping comparable to that found in all European countries. There was also a willingness in the Maritimes to work together, coupled with a recognition that the three provinces together would probably save money in solving common problems by pooling their resources.

The Land Registration and Information Service (LRIS) has been in place for over six years, and we expect it to continue for many years to come, particularly in the production of surveying and mapping information. It may well be, though, that in other areas of the LRIS program (for example, in the administration of the Land Titles Act, or in the provision of automated information manipulation and retrieval systems), that the Maritime unit is too large a package. It could be found that provincial or even sub-provincial units would be more effective as an ongoing administrative unit but with coordination and development retained on a Maritime basis.

2. Objective

The objective of the program was first described in a proposal regarding a comprehensive Surveying, Mapping, Land Titles Registration and Land Statistics Program dated May, 1972, and, I quote: "to achieve satisfactory standards of land survey and mapping and the identifying, registering and cataloguing of land details and, in particular, to do so on a regional basis in the interests of economy and efficiency." If I were asked to state the objective today, it would simply be "A Land-Related Information System", and such a system would be defined as follows:

a) to provide a geographical referencing system by establishing a homogeneous positional base and a mapping base;

b) to define additional common elements, such as land tenure data, land appraisal data, soil survey data, micro-climatology data, political boundaries data, geological data, hydrological data and infrastructure and to set up or encourage provinces to establish data bases using these common elements;

c) to promote the coordination of file structures to assist the provinces in building their own land-related data bases, such as forestry, agriculture, environment, energy, and municipal services thus facilitating the transfer of information between data bases.

d) to assist in research and development of a functional design of an integrated network with high-speed communication lines linking compatible front end processors to enable the transfer of information between data bases.

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3. Basic Requirements for the Evolution of a Modern Land-Related Information System

We feel that there are five essentials needed in putting together a comprehensive land-related information system:

a) It has long been recognized in respect to surveying and mapping that the need for information is dependant on the will to make changes in land use; if there are no changes whatever to be made, there is a minimal need for surveys, mapping, and land-related information. If there is a will to make changes in land use and in the method of land administration, it must be apparent at the public (citizen) level, at the bureaucrat (senior civil service) level, and at the political (elected legislator) level.

b) There must be a consensus (preferably a formal agreement) on the designation of the agency which is to have a mandate to provide leadership in the evolution of a system.

c) The mechanism for an on-going dialogue among all agencies, who have or may have a significant role in collection and/or using land information, must be established.

d) An agreement as to which data files are basic to the system must be reached and the responsibilities for creating and maintaining these files must be clearly fixed. LRIS has proceeded on the basis that a control survey network, a topographic map base, a property map base, and a land titles system are basic and LRIS has accepted responsibity for them.

e) An R & D program is needed to develop methods for exploiting these basic data files in conjunction with various sectors, such as the infrastructure sector, the renewable resource sector, the land taxation, policy and planning sector, etc.

4. Program

Thus our program was initiated in four phases. Phase I consists of:

a) Establishing a secondary grid of control monuments at densities of 300 meters in urban areas, 800 meters in suburban areas, and 4000 meters in rural areas. This is 97 % completed.

b) Maintenance and densification of this grid. This is an ongoing project with an estimated annual emplacement of 3 % of the total.

c) Redefinition. This project was initiated to correct distortions in the secondary control network caused by tying to the distorted primary network. When the federal government decided to readjust the primary network as part of the North American Redefinition, the opportunity was seized as being ideal to improve our own calculated values, and to make the conversion to metric as well.

   This redefinition project began in 1976. All existing observations, over a million, were reprocessed and stored in computer-readable form. The direction observations at each station were adjusted (station adjustments) and every distance was instrument identified so that a variance (uncertainty) could be determined for the measurement.

   All data was reduced to the reference surface (ATS/77 Datum). When the readjustment was completed, all coordinates were then computed (transformed) to the coordinate system used in the individual provinces.

   The Maritimes were split into twenty-four subnets ranging in size from 943 stations to 4.141. The observations were evaluated subnet by subnet and each subnet. The results were sewn together until a final network, containing the entire Maritime system, was developed and solved simultaneously. The final network contains 40.887 stations.

   The results of the redefinition project are now published in metric units and available to our users on COM. (Figure 1).

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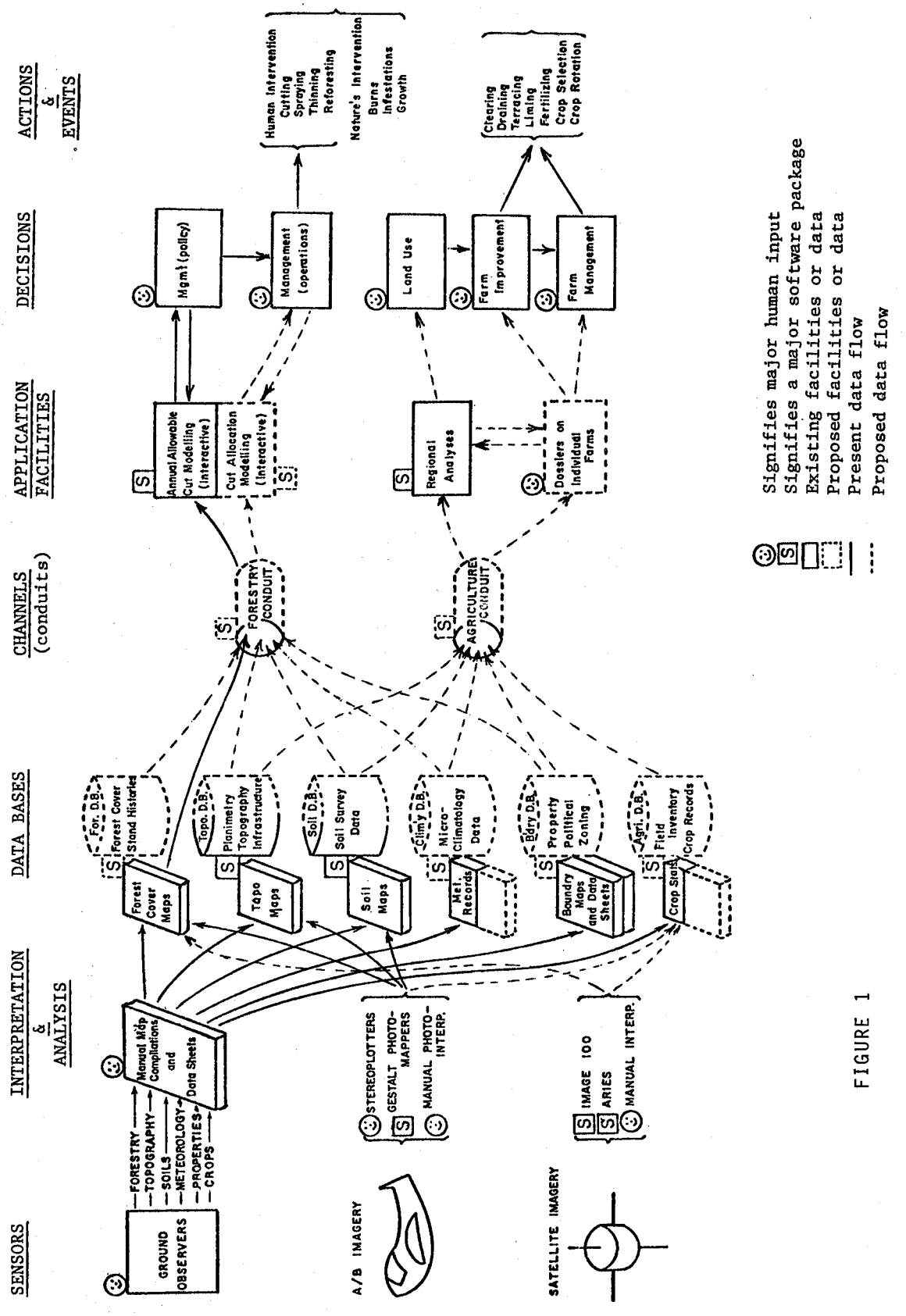

FIGURE 1

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With redefined values in hand (with associated confidence information) the survey engineer is now in a position that he can determine the accuracy of a boundary he has established at a specified confidence level.

Phase II consists of providing:

a) A uniform, high quality series of medium scale 1:10 000 orthophoto maps with complete regional coverage. The orthophoto-negatives are produced on a Gestalt Photomapper Model I (GPMI) while enhancement and contours are added by conventional analogue plotting machines.

b) A uniform, high quality series of large scale 1:1000 and 1:5000 line and topographic maps of urban areas of population of 300 and over. These maps are produced by conventional analogue methods.

Both series are 70 % completed.

In research and development, we have been investigating interactive mapping systems, analytical stereo-plotting systems, and related technological developments since 1976. Lately this problem has been compounded by the continued and accelerated proliferation of a variety of mini and micro computers with peripheral mass storage devices, each with different information handling conventions and characteristics.

Present digitizing techniques provide a series of record containing both the coordinates defining the alignment of a feature and a code for describing the feature, all arranged sequentially in order in which the features were digitized, and finally linked by features on a map basis. We feel a map data base should be structured so that any item or feature could be related to several others, thereby cutting across the present cartographic ordering. We have come to the conclusion that no single digital mapping product will satisfy all users and that the most that we can practically hope to provide is a topographic data base whose content will satisfy the majority of users. The onus must be placed on the user to develop interfaces to enable him to filter the digital topographic data revelant to his application.

Phase III consists of providing:

a) A property map which shows individual parcels of land, each of which is assigned a unique parcel identifier, and a computer file which contains ownership and descriptive information with respect to each parcel, and this information will be updated reflecting changes arising from instruments recorded in the registry office or through the collection of other pertinent information. To date, some 370 000 out of an estimated 800 000 parcels of land have had parcel identifiers assigned; and

b) to develop an improved system of land registration based on a land parcel index. To date, we have the legislation drafted; one province has passed the legislation but has not proclaimed it; in the other provinces, the legislation is being studied by legislative committees. We have consulted many authorities; we have welcomed visitors from many countries and my colleaques and I have presented many reports on our trials, tribulations and occasionally our progress in overcoming both technical and legislative hurdles. At this time, we are optimistic that we have developed a system that will be effective, modern, flexible, economically viable and legislatively acceptable; however, until the legislation is passed and proclaimed and the public has accepted it, our work is not completed.

In addition, we undertook to make the new system computer-oriented. This was done deliberately in order to make the land tenure data a key part of a comprehensive land information system. The land titles file will differ from the parcel file discussed above, in that the contents as well as the reference number of all the registered instruments pertaining to each parcel are included in the file, and only registered instruments are included. The volume in the file will be kept within reasonable bounds by the use of standard legal instruments such that only specifics (names, prices, etc.) and exceptions need to be spelled out; for example, the data on a mortgage

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would include only the number of the standard mortgage form, the names of the mortgagors and mortgagees, the principal amount, interest rate and repayment schedule. With this technique, the cost for sufficient computer memory to store all the active instruments relating to each parcel is not excessive. To prevent fraudulent entries such as a duplicate sale of a property, there will be a provision by which an "action pending" entry will be made immediately an instrument is presented for registration. Changes to the file will be made by what is called double-entry up-dating. New data will be coded and keyed by an operator who will not be allowed to enter the data into the file; the registrar or a deputy-restrar will verify the coding of the data and make the official entry (or deletion) to the file. As an additional safeguard, the person who will make the official entry will not be allowed to code or key the data; this is to minimize spur-of-the-moment corrections. One of the many advantages of this system is that the physical storage of documents is for archival purposes only.

This system was developed on a large main frame computer, using one of the well-known information management systems; it has proceeded to the demonstration stage, but has not been completely de-bugged. Development is being suspended until there is a decision to pass and proclaim the land titles legislation. Now that mini-computers are plentiful and available at reasonable cost, it is probable that when a decision is made to proceed, this software will be rewritten for use on a mini-computer.

Phase IV consists of R & C in the land related information field exploiting the capabilities available from the other program activities - positional data base, standardized base maps and land parcel data. We have looked at the infrastructure (power, communication, transportation) sector and we now have completed studies on the land assessment and land-related statistics sector. At present, the funding is extemely limited but, as there is a great deal of interest in the renewable resource (forestry, agriculture) sector, we anticipate a significant thrust in this direction, and a few man years of conceptual planning work is being carried out.

We are intrigued by the challenge of collaborating on the development of an information system that can respond to the needs of this sector because the data in this sector is never static. As illustrated in Figure 1*), we see a cyclic sequence: data collection, interpretation and analysis, data bases (storage), data merging, applications (synthesis and modelling), decision-making, actions and events, data collection, etc. A brief commentary on each step in the cycle follows:

a) Data Collection - There are now, and there will continue to be for the foreseeable future, basically three methods of data collection; ground observation, air-borne sensing and satellite sensing. Everyone is familiar with the air photograph taken from an airplane. It is the sensor that has contributed the bulk of the data that we now have in our maps, charts, files and data sheets.

b) Interpretation and Analysis - To date, most of the interpretation and analysis of the data from sensors has been done by a skilled photo-interpreter using a stereo-viewer. For many purposes, there is no foreseeable replacement to the skilled interpreter: only the human eye can effectively cope with subtle variations in shape and texture. There are, however, some tasks which are yielding to automated processes. In general, however, a judicious combination of automated techniques and human interpreters is desirable.

*) Remote Sensing for Renewable Resource Monitoring in the Maritime Provinces (Figure 8) by Angus C. Hamilton, Chairman, Dept. of Surveying Engineering, University of New Brunswick.

c) Data Bases - Following an extensive search of literature and consultation with several authorities, we could arrive at no consensus on a definitive definition for the term "data base". In recent practice and in our subsequent discussion, the term "data base" is being used to described any sizeable well-structured file of data; although it is generally understood that at least some of the data will be in computer-compatible format, this is not necessarily the case.

d) Data Merging (Data Conduits) - The idea of a data conduit is being introduced in place of the data bank concept that has been prevalent in syntheses of this type. This is visualized as a much more realistic approach to the merging of data than the creation of a great monster data bank in which all data of every sort, type and description would be stored. By thinking of data "flowing" from place to place, we will begin to break out of the log-jam that we are in with respect to merging, synthesising and effectively utilizing data. In this approach, there would be a conduit designed specifically for each application facility; for example, there would be one for forestry information, another for agriculture information, and so on.

e) Applications Facilities - Under this general heading, there are two types of facilities: the first type is the modelling program at the macro level in which data selected from one or more data bases can be used for modelling and for developing scenarios and alternatives in preparation for management decisions; the other type of facility is at the micro level - the pulling together of all the relevant information with respect to one particular site - for example, all the relevant information with respect to one farm.

f) Decision Making - The decision-maker is the key element in the system. If he is not included or if he is not interested, then the system is doomed to fail. It must be recognized that the entire system cannot be made available immediately, however. Some applications, such as the Annual Allowable Cut modelling programs for forestry, are being introduced using rather primitive data. If decision-makers are not interested and do not use the capability of the system at an early stage of development, there will be a loss of momentum. Conversely, if decision-makers try to replace their largely intuitive methods by reliance on modelling prematurely, there will be misunderstanding and failures. Thus it bears repeating that the attitude of decision makers is vital to the success of the system.

It is implicit in the Figure and in the preceding discussion that for the system to be fully effective, much of the data must be in a computer compatible format. However, as yet, no decisions have been taken as to the extent or the tempo of compiling map data in digital format. There are obviously many problems to be resolved before this will become a routine production procedure. However, in view of the fact that digital map data is essential for the modelling application, there is a sound rationale for proceeding quickly with this development.

5. Reflections on the Evolution of a Land Related Information System

Because, in general, land-related data can only be comprehended when it is in a graphic or map format, and because use of the computer is the only way to maintain up-to-date files from which any selected combination of data can be rapidly retrieved, it is obvious that our progress in land information systems is dependent on the rate at which we build up digital map files.

Digitizing existing maps is a costly process and one that in the normal course of events is not done. Digitizing new mapping has not yet been shown to be cost effective from a production point of view, but it may be cost effective if there is a spin-off benefit. All of us who are managing mapping programs are faced with the question of when to start digitizing and how rapidly to proceed after we have started. These are important decisions because this will dictate the rate at which land information systems will become effective in the next couple of decades.

At the technical operations level, one of the problems currently of concern is to develop an economic procedure for field digitization of data; this must provide input directly into the system and yet be simple and portable. This way, errors could be minimized and the field staff would feel that they were an integral part of the system.

Another current problem is the lack of compatibility of software and hardware in the collection, handling, storing and dissemination of information. During the past 15 years, some attempts have been made to standardize hardware. Software standardization has also been attempted through the use of universal programming languages and the development of data base management packages but invariably the only answer to achieving results when combining computer outputs is still reprogramming. This problem is being compounded by the continued and accelerated proliferation of a variety of mini- and micro-computers with interactive graphics and modelling capabilities, each with different information handling conventions and characteristics.

6. Reflections on the Role of Photogrammetry

There are three major contributions from photogrammetry to our system:

a) The block adjustment methodology in providing control for both resource and urban mapping.

b) The Gestalt photomapper in providing good quality photo maps.

c) The conventional stereo-plotters for urban mapping and enhancement of the orthophoto maps.

There are still some potential applications for photogrammetry:

a) The potential for low cost methodology in boundary surveys on low value land parcels.

b) Low cost equipment for interactive or online editing of data that is being encoded by stereo-plotters.

c) Low cost method for identifying changes and for updating medium scale resource maps.

Let me hasten to point out that I am well aware of the high precision attainable with aerial triangulation; the interactive editing equipment that is on the market; the sophisticated capabilities of remote sensing; however, problems remaining are not "how it can be done", but rather "can it be done economically".

7. Final Comment

As you move into land-related fields, you will find that, in addition to design problems, you will experience many jurisdictional and institutional problems which, together with the lack of proven concepts, leads to difficulty in obtaining commitments from senior officials and anticipated users. However, a step-by-step approach to a series of well-defined goals is worth striving for wherever the need exists. As H.G. Jerie, ITC (Enschede), Holland, described so well in his paper, "Integrated Collection and Recording of Regional Planning Data", I quote: "The degree of comprehensiveness required of a system depends on the level of activity of the area, the resources available to develop a system, and the commitment of the potential users to an improved system."

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Abstract

The maritime provinces of Canada initiated their land related information system (LRIS) in 1973. Its main components are: secondary geodetic networks, medium and large scale maps, property maps and land titles, and additional land based information. They are intercombined to form a comprehensive information system.

The system has been on its way for about 6 years. The various phases have reached different states of completion.

In the presentation the approach and special considerations are explained. Also the technical, administrative and economic aspects are reviewed, and some of the encountered problems are discussed. Summarizing the available experience a preliminary assessment of the system is given.

Das landbezogene Informationssystem der atlantischen Provinzen Kanadas

Zusammenfassung

Die atlantischen Provinzen Kanadas haben 1973 mit der Einführung eines landbezogenen Informationssystems (LRIS) begonnen. Seine Hauptkomponenten sind: Geodätische Netze 2. Ordnung, topographische Karten mittlerer und kleiner Maßstäbe, Liegenschaftskarten und Eigentumsrechte, sowie zusätzliche landbezogene Informationen. Sie sind zu einem echten Informationssystem verbunden.

Das System ist seit 6 Jahren im Aufbau. Die einzelnen Teile befinden sich in verschiedenen Phasen der Vollendung.

In dem Vortrag werden die Grundkonzeption und die besonderen Bedingungen erläutert. Es wird eine Übersicht über die technischen, wirtschaftlichen und Verwaltungsgesichtspunkte gegeben. Schließlich wird nach der Diskussion einiger Probleme versucht, die gemachten Erfahrungen zu würdigen und das System zusammenfassend zu beurteilen.

Système d'information sur la structure foncière des provinces maritimes du Canada

Résumé

Les provinces atlantiques du Canada ont commencé en 1973 à mettre sur pied un système d'information sur l'aménagement foncier (LRIS, Land-Related Information System). Les composantes principales de ce système sont: des réseaux géodésiques de second ordre, des cartes topographiques à petites et à moyennes échelles, des cartes de bien-fonds et de droits de propriété ainsi que des informations supplémentaires concernant le sol. Cet ensemble forme un véritable système d'information.

Les travaux durent depuis six ans déjà. Les différentes phases sont plus ou moins proches de l'achèvement.

Nous expliquons dans notre conférence la conception qui a été à la base de cette réalisation et commentons les différents aspects techniques, économiques et administratifs. Nous aimerions ensuite discuter de certains problèmes pour essayer d'apprécier les expériences qui ont été faites et de formuler un jugement préliminaire sur le système en question.

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El sistema de información sobre el uso de las tierras de las Provincias Marítimas del Canadá

Resumen

Las provincias atlánticas del Canadá comenzaron en 1973 con la introducción de un sistema de información sobre el terreno (LRIS). Sus componentes principales son los siguientes: Redes geodésicas de segundo orden, mapas topográficos a escalas medianas y pequeñas, mapas catastrales y derechos de propiedad, así como informaciones adicionales sobre el terreno. Están combinados en un verdadero sistema de información.

El sistema se encuentra en ejecución desde hace seis años. Sus distinatas partes están en fases diferentes de terminación.

La conferencia explica el concepto básico y las condiciones especiales. Se da una vista de conjunto de los aspectos técnicos, económicos y administrativos. Después de discutir algunos problemas, se trata de apreciar las experiencias hechas y de juzgar el sistema en conjunto.

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