PHOTOGRAMMETRIC CONTRIBUTION TO THE ROMANIAN CADASTRE DEVELOPMENT

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Since the second half of the last century the cadastre has been introduced in some zones of Romania. This task will be solved in the near future, for the whole country, only with photogrammetric contribution.

Method and equipment evolution, the results obtained, the actual development stage and the future trends are all presented in this paper.

Key Words: Cadastre, Mapping, Photogrammetry.

The early stage of the photogrammetric use within the cadastre has happened at the same moment with this technique introduction to the European country mapping. In 1924, the first photogrammetric works for the Romanian cadastre were carried out by the Aerial Cadastral Office within the Civil Aviation Department. During 1924-1926, both photomosaics and triangulation and ground control point pre-markings over some towns were made.

A 1:1,000 scale cadastral map has been compiled by the French Aerial Company using rectifying procedures over Bucharest Municipality, which good results have brought about an increased photogrammetric use within cadastral and urban planning fields of activity.

During 1926-1931, our specialists tried to persuade the decision-making authorities in the advantageous photogrammetric use for the cadastral mapping; but the private topographical surveying enterprises have strongly opposed that new approach.

In his paper "The Photogrammetry in Romania", published in 1933, the Manager of the Air Force Department stated among others : "The lack of confidence, which some members of our Cadastral Technical Committee have as against the aerial photogrammetry and other unknown reasons, has postponed the designed works to be carried out in Dobrudja, although the preliminary studies made by the General Cadastral Department and the cost tendered by the Air Force were a real pleading for aerial triangulation application, considering its advantages..."

In 1929, to better know the area covered by Ploieşti oil fields, Prahova district, the Photogrammetric Branch within the Mining Cadastral Department, the Ministry of Industry and Trade, as well as, the Aerial Photography Branch within the High Aeronautics Department, the Ministry of War, were established.

The Photogrammetric Branch had an airplane to take aerial photographs, aerial cameras, stereoplotters and photorectifiers at its disposal.

During 1929-1931, a 1:6,000 scale aerial photography over about a 200,000 ha area was taken for the mining cadastre. The aerial photographs, thus obtained, were used to compile 1:2,000 and 1:5,000 scale cadastral maps, using stereoplottings and a 1:5,000 scale photo sketch.(*)

At the same time, photoschemes and photomaps for cadastre and urban planning have been compiled over other zones.

The French Professor H.Rousille has greatly supported the photogrammetric applications in Romania. In 1929, he joined a Romanian commission to study the photogrammetric efficiency and its method expanding approaches aiming at the Romanian cadastre introduction,as soon as possible.

After the Second World War, a land registration of the lands, where no land cadastre was in existence, and topographical maps at appropriate scales have been obviously required. This has entailed the establishment of the Centre for Photogrammetry within The Ministry of Agriculture and Forestry.

The Centre for Photogrammetry establishment in 1958 and its continuous upgrading with the present-day equipment have promoted the increase of the topographical and cadastral mapping every year, reaching in 1965 at almost 90 per cent a rate,which is nowadays maintained.

That early stage requirement was to compile topographical map over the whole country territory in a short period of time, aiming at land registration, based only on planimetry; so, during 1958-1965, 1:10,000 and

(*) Since 1932, the rate accomplishing works for the mining cadastre has been greatly reduced, considering economic matters.

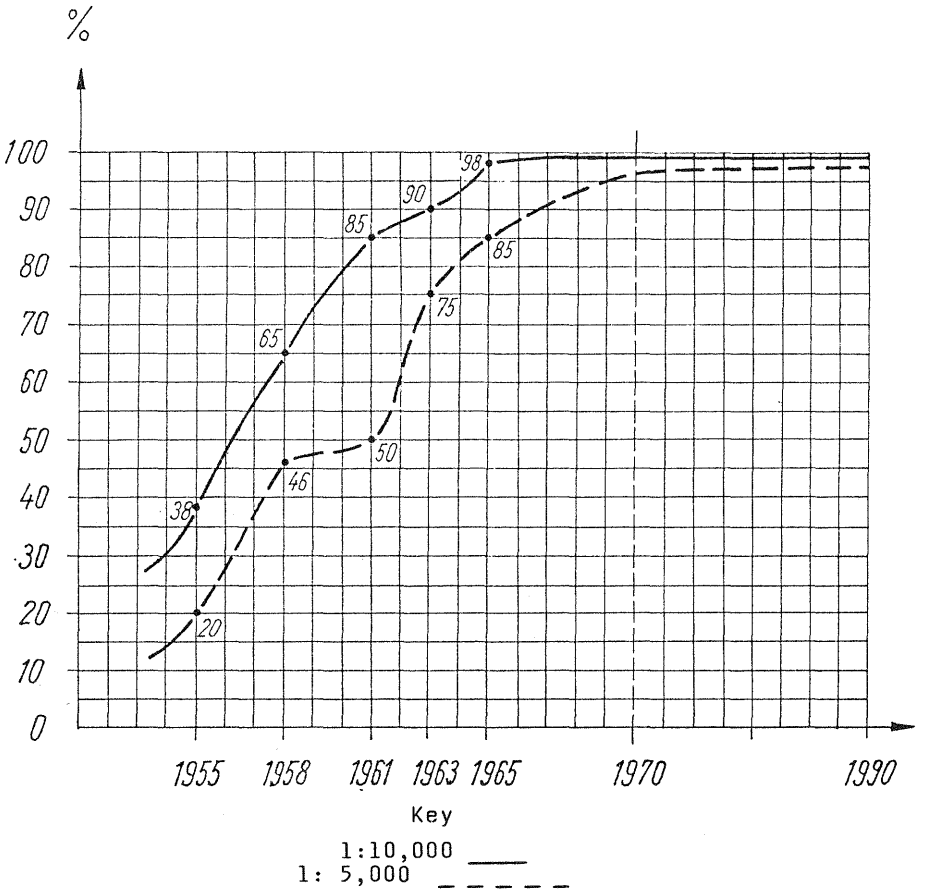

Figure 1. Topographical and Cadastral Map Capacity Using Photogrammetrical Methods as Against the Annual Complete Capacity Over the Whole Country, Using Various Methods.

1:5,000 scale topographical maps have been compiled, covering about 40 per cent of the whole country surface.

Since 1961, a 1:5,000 scale basic topographical map over the whole country surface has been compiled, using photogrammetrical procedures. The cadastral map has been derived from the above mentioned basic topographical map, as shown in Figure 2.

The scale of the basic topographical map has been chosen to answer the cadastral requirements. A 1:10,000 scale was considered too small and unproper for any zone of the country. So, all 1:10,000 scale topographical and cadastral maps have no more updated, but replaced by the 1:5,000 scale basic topographical and cadastral maps.

The main photogrammetric procedures were:
- Stereoplotting procedure.The stereoplotters, such as, Stereoplanigraphs, Stereometrographs, Autographs have been used to compile an analogical/graphic map showing planimetry, hydrography and relief;
- Mixed procedure. Various rectifiers producing photomaps further processed as graphical maps by cartographical procedures have been used for planimetry. The levelling has been made up in the field topographically.

This mixed procedure has been used only over plane and rather rough (undulating) ground.

Obviously, our country topography justifies the two photogrammetric procedure uses to compile both the 1:5,000 scale basic topographical map and the derived cadastral one. This scale is also too small for built-up surfaces showing many topographical details and having a high economic value, respectively.

Therefore, 1:2,000 and 1:1,000 scale topographical maps and the derived cadastral ones have been compiled over these highly densed surfaces, using the same technology given in Figure 2.

Surfaces requiring topographical and cadastral maps at scales larger than a 1:1,000 scale are not the subject of the general cadastre, but they are related to the specialized cadastre (mining cadastre, industrial site cadastre, a.s.o.).

Data on topographical and cadastral work capacity in Romania and the state-of-art at the end of 1991 are shown in Table 1, in a synthetical way.

As we have already mentioned, the 1:10,000 scale topographical and cadastral maps had been replaced by the 1:5,000 scale ones; this is the reason not to mention them in the below table.

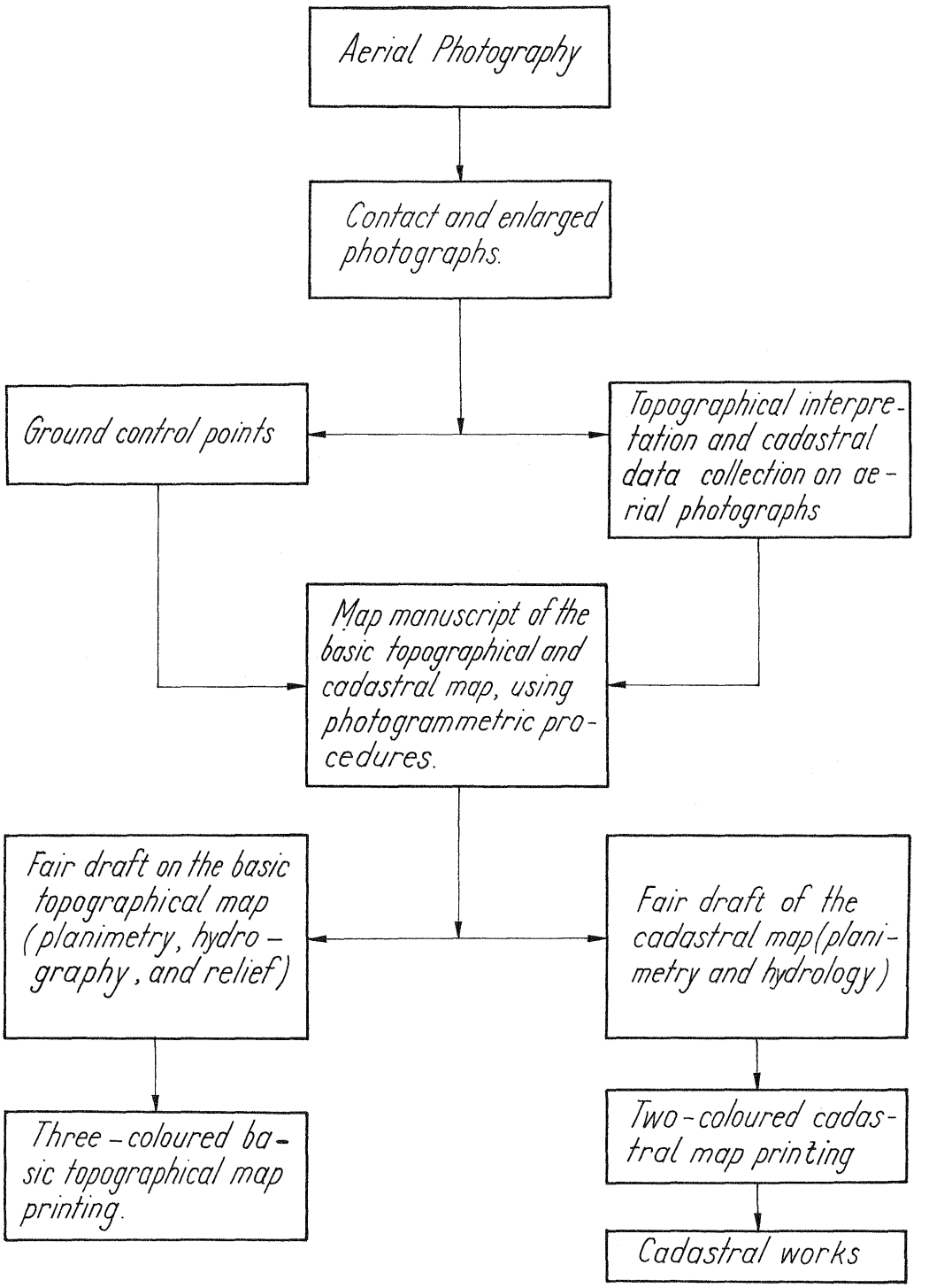

Figure 2. The Basic Topographical Mapping Technology, Using Photogrammetric Procedures and Cadastral Map Derivation Based on It.

Topographical and Cadastral Work Capacity
(1991)

Table 1

The country surface (ha)	Usual scales for cadastral maps 1:	Surfaces for which cadastral maps are compiled at these scales (ha)	No.of the map sheets	No.of the map sheets compiled till the end of 1991
23,750,000	5,000	23,750,000	41,984	33,700
	2,000	1,133,400	8,300	5,000
	1,000	157,000	4,600	2,600

All sheets of the topographical maps at 1:2,000 and 1:1,000 scales are reduced to a 1:5,000 one to finally cover the whole country surface by such basic maps.

When the general cadastre introduction is to be taken place, the complex matters of the in-town surfaces and those ones having a high economic potential should be considered as against surveying and cadastral documentation completions.

Dense topographical details and small sized parcels over the respective zones are requiring 1:2,000 or 1:1,000 scale topographical and cadastral mapping, as we have already mentioned.

To compile small scale topographical and cadastral maps the possibilities, which photogrammetric procedures give, considering the respective zone feautures, have been studied (Zegheru, 1970; Zegheru,1986). The proper photogrammetric procedure related to those peculiarities is established. Early 1960, the first analytical aerial photograph plottings were made, based on some former studies and investigations.

Since then, the photogrammetric digital measuring and data collecting equipment have been ceaselessly improved, computer capacity and speed have been increased, operation means, data and information storage and display supports have been also improved, and various plotters for automatic mapping have been developed all over the world.

During 1981-1985, all these impressive offsprings brought about a new technological flowline, measuring, processing and mapping photogrammetric data automatically, using analytical aerial photograph plotting (Zegheru,1982); its improved configuration is also used, nowadays, to compile 1:2,000 scale cadastral maps over rural settlements.

A Photogrammetric System for Automatic Cadastral Mapping (SFAIPLAC) has been developed within The Institute for Geodesy, Photogrammetry, Cartography, and Land Management (I.G.F.C.O.T.) consisting of several measuring stations, each of them having a precision Stereocomparator,i.e. a Stecometer or a Dicometer, and a minicomputer (PC). All these measuring stations are linked together to a micro-computer (host computer), facilitating a further connection to a plotter (Figure 3).

(1) All points to be measured and linked to each other as against the topographical and cadastral configurations are marked and numbered on the enlarged aerial photographs considering the cadastral map compilation scale; the proper conventional sign codes to represent them on a plotter are also written. Toponimy and administrative names, land-use categories and other cadastral data are written, as well. The above mentioned data, written on aerial photographs, as well as, other input data and information, i.e. cartographic grid data, are processed and input, according to the technological flowline presented in (2), (3) and (4).

(2) xf;yf coordinates and parallaxes are measured on the first aerial photographs and slides as stereo pairs, to find :
- aerial photograph indices of a stereo pair;
- aerial triangulation points;
- points establishing topographical details and cadastral map contents.

(3) The following computations and operations are made up for each stereopair:
- internal orientation;
- relative stereo pair orientation (stochastic terrain model) ;
- relative coordinates of the measured points.

The respective stereo pair measurements are displayed to analyse their completeness and to add other necessary ones, which have been omitted. Data, which all measuring stations have captured, are input into a mini-computer.

(4) Data captured by all measuring stations (2) are used, to :
- compute the aerial triangulation point coordinates on blocks of aerial photograhs;
- compute each stereo pair absolute orientation;
- compute the measured point coordinates on each stereo pair;
- compute the polygon line intersections with the sheet cartographic grid.

(5) The cadastral map manuscript is drawn,

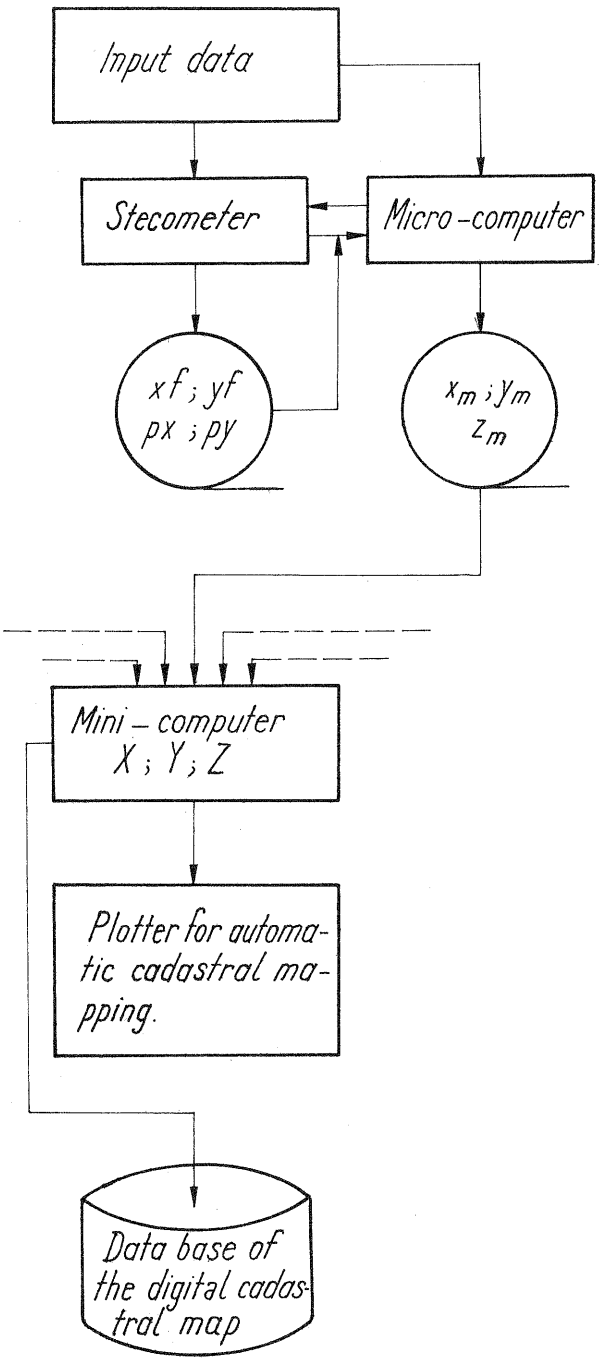

Figure 3. System to Compile Digital Cadastral Map, Using Analytical Aerial Photograph Plotting.

using geodetical coordinates of the measured cadastral points (4), drawing codes and semantic data proper to the cadastral map, as well as, each sheet cadastral data input to (1) and other data.

(6) All digital map data computed by the system mini-computer (5) are stored in the data base to be used later on.

The digital cadastral maps are quite useful especially during the subsequent processing stages, such as: area computations, lottings, land redistribution, boundary rectification, and computer-assisted processing (Zegheru, 1973).

The cadastre is one of the fields of activity requiring digital maps. Therefore, the whole cadastral maps compiled photogrammetrically, covering more than 85 per cent of our country surface with 1:5,000 and/or 1:2,000 and 1:1,000 scale maps, as we have already mentioned, are to be digitized to complete a Land Information System, in real time (Figure 4).

Today, a land reform entering into possession the former owners is under development; so, the existing topographical and cadastral maps are a self-evident importance.

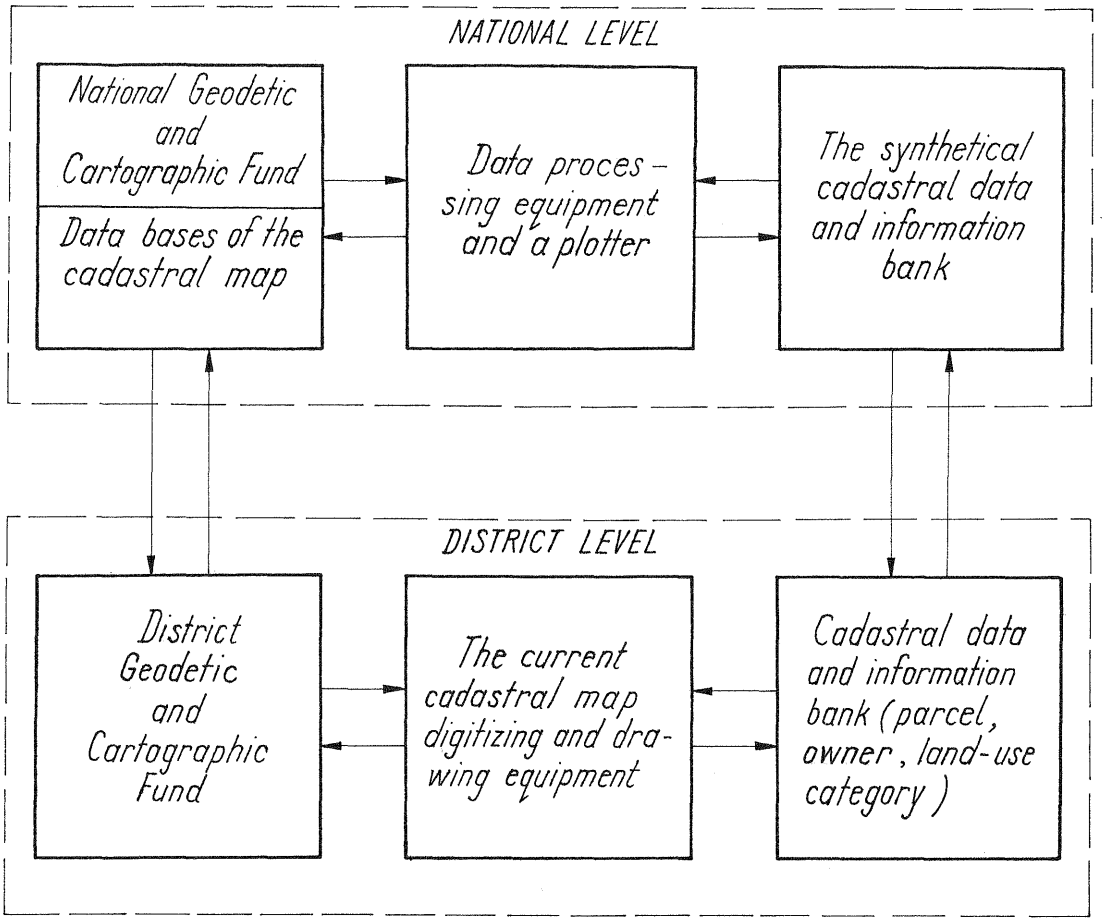

Figure 4. The Land Information System Based on The Land Cadastre

The great many works and the social phenomenon complexity can hardly be estimated. About 6.3 M land owners must enter into their former land ownership rights considering an almost 8 M ha. surface, totalizing about 25 M parcels, a great majority on their former locations.

Some data on the Romanian land reforms, in their succession, are given below, just to make a comparison.

Data on The Romanian Land Reforms

Table 2

Year	Surface (ha)	No.of owners	Duration	Remarks
1864	1,810,311	511,896	1864-1881	The date of its completion is unsure.
1921	6,120,000	1,393,353	1920-1926	At the moment it ceased to be in existence 612,124 families were not given lands.
1945	1,468,000	900,000	1945-1949	
1990	9,000,000	6,250,000	1990-	

Considering the land owner numbers, the total surface and the parcel numbers being the subject of the present-day land reform, practically, all the works equal the former land reforms altogether.

While the former land reforms aimed to give the peasants the new lands, the present-day reform is to re-establish the former land ownership rights.

Obviously, to accomplish that complex and extensive land reform, the 1:5,000; 1:2,000 and/or 1:1,000 scale topographical and cadastral maps compiled photogrammetrically over about 85 per cent of our country territory are of a real importance.

Nowadays, aerial photographs and other old photogrammetric products, carried out before the respective zones being featured by the compulsorily-developed cooperative farms, are a real help to re-establish the private ownership on their former locations.

Entering into possession the land owners is based on the updating cadastral maps used to make land division into parcels; the current topographical equipment and the so-called total stations are used to mark parcels on the field.

After that land reform has been completed, and the ownership titles have been given, all the works carried out should be integrated into the general cadastre, based on all the documentation required. Just a mention: when that land reform comes to an end, using all the equipment we have at our disposal, new cadastral surveyings are to be approached. We have in view to employ both digital photogrammetrical procedures and topographical ones, using total stations, which precision will be proper to a 1:2,000 scale replacing the 1:5,000 scale in the course of time.

There will be a lapse of time, maybe a decade, to develop the Land (cadastral) Information System, owing to our last land reform.

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