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REPORT ON CADASTRAL SURVEYS IN MOROCCO  
(Submitted by the Government of Morocco)

## REPORT ON CADASTRAL SURVEYS IN MOROCCO

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A regular and accurate land plan is annexed to the land registers (livres fonciers) which constitute a veritable property registry office. 1/ Property in Morocco is daily increasing considerably in value, and the particularly rapid urban development and agricultural changes have altered the scale of values which could hitherto serve as a basis for estimating areas in connexion with the cost of topographical surveys. For these reasons, the limits of properties are defined accurately and the survey operations and calculations of areas are carried out exactly to make it possible at any period of time to determine with certainty on the ground, on the basis of titles to land and plans, the boundaries which would have disappeared or which would give rise to disputes and so that the areas indicated on the plans and titles do not have to be discussed.

The small size of properties in Morocco has led to the adoption of the calculated or numerical survey method because the graphical survey, which can in certain conditions represent the outline and area of properties with sufficient accuracy, is in many cases inadequate to describe them with the necessary precision.

Furthermore, guaranteed corrections of boundaries are the common distinctive feature of cadastres for judicial purposes which incorporate land registration in Morocco.

To carry out these cadastral plans, the technicians of the topographical service have to conform strictly with the technical regulations which lay down the methods to be used in plan surveys, the required degree of accuracy and the permitted tolerances:

- the instruction for carrying out work on demarcation and plans under the system of land registration (fundamental dahir of 12 August 1913), prepared jointly by the Chief of the Landed Property Conservation Service and the Chief of the Topographical Service;
- the joint regulations (1969 edition) relating to the execution of topographical operations subject to contracts to be entered into with the private enterprise, and which constitute all the technical rules governing the execution of cadastral surveys.

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1/ See "Note on the system of land registration in Morocco" by Mr. Fassi Fehri.

## A. DEMARCATION

In any demarcation operation the surveyor of the topographical service has to prepare a sketch which is to be attached to the report (procès-verbal). This sketch should be prepared on an adequate scale, in principle to the scale of the future land plan, i.e., in accordance with the following table:

Scale to be used in the report of plans

Properties	Plot comprising on average				
	less than 1 property per 100 ha	from 1 property per 100 ha to 1 property per 10 ha	from 1 property per 10 ha to 1 property per 2 ha	from 0.5 to 5 properties per hectare	more than 5 properties per hectare
	average area of properties over 100 ha	average area of properties between 10 and 100 ha	average area of properties between 2 and 10 ha	average area of properties between 2 and 10 ha	average area of properties under 2,000 sq. metres
Urban, built or for building, gardens, sub-urban, rural	1/5,000	1/2,000	1/1,000	1/500	1/200
		1/2,000	1/1,000	1/500	1/500

In the towns the application of the scale of 1/200 is not an absolute rule. The plan of very small properties of under 200 m<sup>2</sup>, particularly 100 m<sup>2</sup>, should be based on a larger scale (1/100 and even 1/50).

Generally speaking, the scale should be such that all the useful data and details are clearly visible. The sketch contains all the details which are to appear on the plan and all the features designated to appear on the plan: important features of the plot able to serve as permanent and characteristic marks: walls, fences, embankments, streams, communication routes, isolated trees, parcels in their respective situations, bases of servitudes, sections to clarify statements in the report (party walls, overprints, etc.).

These sketches are prepared as a rule on the plane table by means of a "Goulier" type telescopic alidade and a target levelling-rod.

They should be sufficiently accurate to make it possible to replace temporarily the regular plan when the demarcation of the property reveals numerous claims of a kind that lead one to assume that the perimeter boundaries as established at the time of demarcation will be substantially altered as a result of decisions taken in response to objections.

## B. PLAN SURVEYS

### (a) Preparation and presentation of plans - general rules

The plan survey to be annexed to the land registers only involves planimetry.

However, as it is important that the plans prepared and issued to private individuals correspond to the schedule of condition and that they constitute a faithful and accurate reproduction of it on the day of the survey, a survey is also made, in addition to the boundary signs (marks and natural boundaries) which are the most important part of the plan, of the lines which are obviously characteristic of the relief of the ground and the physical aspect of the properties: sudden changes in slopes, important thalwegs, clearly marked crest lines, peaks, cliffs, etc. They are plotted on the sheets of the plans by means of conventional signs and handwritten references, the slopes being represented by hachures without any altimetical indications.

In addition, all the natural and artificial permanent details which are recognizable on the ground and situated either on the peripheral boundary inside it or in proximity to it are surveyed and plotted over an area proportionate in width to the extent of the property and to the scale of the plan up to 100 metres.

These details include:

- (1) All constructions above ground, dwellings, farms and outbuildings, huts, "marabouts", surrounding walls, wells, troughs, reservoirs, tanks, norias;
- (2) Plantations and perennial crops such as forests, olive-trees, market and pleasure gardens, vineyards, cactus hedges and aloes, isolated trees;
- (3) Public works: paths and roads with embankments, ditches and kilometre markers, railways and their tracks, roadbeds, embankments, embankments, ditches, sign-posts, bridges, viaducts, aqueducts, culverts, telegraph poles and power transmission lines and posts;

- (4) Rivers with their thalwegs if they are usually dry or otherwise with the two banks, slopes with their crests and the feet of embankments, isolated rocks, springs, "seguias", "dayas", "merdjas", quarries, tracks and paths.

The whole length of permanent roads, ways, tracks and paths, public and private, through the property are surveyed.

The natural boundaries of properties are surveyed in every detail.

The boundary marks of already demarcated properties within a radius of 200 metres are also surveyed accurately and appear on the plan (tying). The plan also shows the nearest boundaries and indicates the direction of boundary marks too far away to be plotted; it also indicates the direction of particularly characteristic and very well known details even if they are some distance from the perimeter and cannot appear on the plan sheet.

The perimeter of demarcated claims is surveyed in the same way as the perimeter of the property.

The general provisions above for rural properties are applicable to urban properties, whether or not they are built on.

The plan of an urban property should represent all the planimetric details necessary for reconstruction of the boundaries of the real estate and for accurate representation of its composition.

In the case of urban and built-on properties, the surveyor outlines the projection on the ground of the perimeter lines as defined in the demarcation report. Apart from the perimeter contour, he also outlines by continuous lines the details visible to an observer looking at the real estate from above and by dotted lines the invisible details.

In relation to the boundaries which they define, the outside walls of the building and enclosing walls of the real estate or neighbouring real estates and the permanent external details (pavements, lamp-posts, man-holes, telegraph poles, fountains, wells, etc.) are surveyed over a width of approximately 10 metres.

The internal details of the properties, various structures, courtyards, gardens, etc., are surveyed by ordinary methods and plotted on the plan.

Sections should be prepared when necessary to facilitate reading of the title to land and explain certain servitudes and peculiarities of the state of important and complex localities which are difficult to describe.

They are indicated on the plan by the customary conventional signs.

(b) Execution of plans - technical rules

(1) Triangulation control network

The Army Geographical Service has adopted the system conforming with Lambert's projection for the map of Morocco (1/50,000 - 1/500,000 - 1/200,000).

The network of points of first, second and third order has been calculated with due consideration for the reduction formulae for angles and lengths.

As the sides of third order are assumed to have average lengths of 7 km, it can be assumed that the topographical operations involving triangulation of fourth order and the field surveying operations involved in the preparation of land plans are each carried out within a zone the extent of which (7 km) is such that these operations can be performed by quite simply using Lambert's co-ordinates and a simple regional factor of scale correction taken from a table. Measurements of angles, on the other hand, are not subject to any correction.

Morocco has thus been divided up into two zones in which Lambert's Northern Morocco system and Lambert's Southern Morocco system are applied with a zone of overlap of one grade in each of these zones, the maximum distortion of the lengths being 1/2,000.

(2) General conditions for carrying out surveys

The surveys must in a general way satisfy the general conditions set out below, it being understood that the regular plan annexed to the land register makes it possible to determine numerically the co-ordinates of the perimeter and the area of the property, apart from the scale chosen for plotting of the plan:

1. Being inspired by the accepted general principles of topography;
2. Adapting the most appropriate method among the methods and tolerances in use in the topographical service;
3. Applying correctly the chosen procedures and methods of operation;
4. Assuring the continuity of work by the permanent marking and fixing of polygonal points, survey marks and boundary marks;
5. Conforming with the regulations determining the form, keeping and presentation of the items in a survey file.

The accuracy required in determining survey data is laid down for each category of operation in a table of tolerances. Furthermore, in any property survey the following rules must be obeyed:

- (a) Achieving a rational sequence of operations in order to minimize and dissipate the effect of operational errors;
- (b) Supervising any measurement through independent measurement of the former (self-checking by the operator).

The general principle of topographical operations may thus be summarized as follows: any measurement carried out on the ground must be accompanied by proof of its accuracy. Thus any direction will be observed at least twice from different origins (reiteration), each length will be measured twice either by the same method or different methods, and the co-ordinates of property boundaries will be obtained by two different means (e.g., double bearing and distance):

- (c) Compensating for errors in accordance with the established principles of topography. Thus, in the case of traverses compensation will be applied in accordance with the method of parallel and proportional distribution.

IT GOES WITHOUT SAYING THAT THE LINKING OF SURVEYS TO LAMBERT'S SYSTEM OF CO-ORDINATES IS THE ABSOLUTE RULE WHICH ALONE ENSURES THAT THE WORK IS CO-ORDINATED AND HOMOGENEOUS AND THAT CADASTRAL MAPS ARE COMPILED PROGRESSIVELY AND SYSTEMATICALLY.

The general method adopted by the topographical service is that of the survey by traversing and by bearing and distance. However, the final, detailed phase of a survey is flexible and adapted to the particular conditions of the piece of ground. Thus other methods may be needed, such as alignments and intersections in the chain for detail surveys.

Furthermore, the technical documents where the measurements of length and angular observations are filled in are completed directly on the ground, the special forms of the topographical service being used, in indelible ink without erasures or interlineations. The technical documents are authenticated by the chief of the topographical team upon completion of the operations in the field.

Field surveying calculations involve all measurements of angles and distances made in the field and are intended to:

1. Determine the exact position of the points surveyed in order to obtain the necessary co-ordinates for the plan report;
2. To determine how accurate the measurements are.

Cadastral surveys involve calculations which may be grouped in three categories:

(a) Preliminary and auxiliary calculations

Calculation of the reduction of distances generally effected on the survey document; calculation of triangles;

Calculation of grid bearings and distances;

Calculation of intersections of lines and curves.

(b) Computation of proper co-ordinates

Calculation of traverses, alignments and bearings and distances making it possible to obtain the co-ordinates of perimeter limits and certain sensibly chosen points of detail.

The results obtained must fall within the required tolerances and satisfy the checking calculations carried out simultaneously.

Some checking calculations are carried out automatically such as those which concern distances between boundary marks and bearing points and the checks on alignments; others are left to the checker to confirm or alter when there is a risk of error in the computation of co-ordinates.

(c) Calculation of areas

The area of properties which are the object of a land plan will in general be calculated by the numerical method and checked by means of a graphical or calculation by machine.

The numerical method involves one of the following two procedures:

(a) Analytical calculation based on the rectangular co-ordinates;

(b) Geometrical or trigonometrical calculation based on the elements measured on the ground or calculated on the basis of the latter.

Graphical calculation uses the elements measured in accordance with the scale on the field sheet.

Calculation by machine involves the use of a planimeter and nomograms.

When necessary, a combination of these different methods will be applied.

The methods are classified as follows, in order of decreasing value and accuracy:

1. Analytical calculation by means of co-ordinates;
2. Numerical calculation based on the survey elements;
3. Graphical calculation together with calculation by machine.

The choice between the latter two methods depends on the nature of the work, the form of the plots, the scale of the plan, etc.

Any calculation of area must be checked by a second calculation independently of the first calculation.

If the two calculations are of a similar nature, the mean of the findings is adopted.

If the two calculations are of a different nature, the more accurate calculation is adopted and the other is used as a check.

The discrepancy between the two calculations must not exceed the tolerance indicated in the tables used by the topographical service.

The property plan is usually reduced to the scale of 1/20,000 or 1/2,000 so as to appear in the registration plans of rural or urban properties prepared to these scales and on which appear all the properties which have already been registered or are awaiting registration.

#### Tolerances applicable to large-scale cadastral surveys

The system of tolerances used by the topographical service is intended not only to assign limiting values to the deviations established, but also to make it possible to assess the quality of the work objectively by distributing the deviations in relation to the theoretical distribution.

In the check the work is classified "very good", "good", "fair", "bad" or "rejected" according to the percentages of deviations in relation to the number of classified errors.

Under this system self-checking by the surveyor, rational checking and objective evaluation of the quality of the work are possible.

#### Habitual characteristic errors

Designation	Probability of excess
Probable error      pe	1/2
Standard error      se	1/3
Maximum error or tolerance      T	1/100

I. GENERAL CONTROL NETWORK

A. Triangulation

The observations and calculations should comply with the following tolerances (in decimilligrades):

- (a) Maximum dispersion of the values obtained for each direction after reduction to the reference..... T = 50"
- (b) Misclosure of a round of angles ..... T = 30"
- (c) Tolerable deviation on a direction ..... T = 30"
- (d) Mean radius of indecision ..... 16 cm
- (e) Maximum deviation on the formation of  $Vz_m$  ..... T = 100"

B. Minor control of accuracy

The minor control points of accuracy are obligatorily linked to the points of the general control network.

The tolerances below apply to traverses whose sides are measured by a parallactic method, the angles being measured in two series for the polygonal angles and in four series for the parallactic angles by means of an instrument which enables the required degree of accuracy to be obtained by triangulation.

Lengths established for traverse sides:

- 1. Monostatic method : 80 to 100 m
- 2. Bistatic method (auxiliary base at end) L = 400 m with a base B such as  $B = \sqrt{2 L}$

(a) Angular closures

$$T \text{ in decimilligrades} = \sqrt{6,500 + 625 (n + 1)}$$

n being the number of summits

(b) Tolerances relating to closures in length (T L) and in direction (T D)

$$T L = \sqrt{450 + 0.4 L + 0.0027 L + 15 \text{ cm}}$$

$$T D = 0.0012 L + 25 \text{ cm}$$

L is expressed in metres.

## II. SURVEY TRAVERSING

The tolerances below apply to the traverses surveyed by the following method of operation:

- angular measurements in two series with reversal of the telescope;
- linear measurements on the tape or equivalent method.

1. Angular closure

$$\text{Tolerance: } T = 0.01 \sqrt{310,500 + 32,400 (n + 1)} \text{ centigrades}$$

n being the number of summits

$$\text{(usual formula - } T = 3' \sqrt{n} \text{)}$$

2. Tolerances relating to closures in length (T L) and in direction (T D)

$$T L = \sqrt{648 + 0.9 L + 0.042 L} \text{ cm}$$

$$T D = 25 + 0.009 L \text{ cm}$$

Other usual formulae linked to the component in dx and dy:

$$(1) \text{ Rural surveys: } 1/1000^L + 10 \text{ cm}$$

$$(2) \text{ Urban surveys: } 1/2000^L + 0.05$$

3. Double bearings and distances

Between 2 bearings and distances of length D and d

$$T = \sqrt{648 + 0.9 \frac{(D + d)}{\text{cm}} + 0.042 \frac{(D + d)}{\text{cm}}}$$

Other usual formulae linked to the component in dx and in dy:

$$(a) \text{ Rural surveys } T = 1/1000 (D + d)^m + 0^m 10$$

$$(b) \text{ Urban surveys } T = 1/2000 (D + d) + 0^m 05$$

4. Detailed survey

Deviation between a measurement of length and a measurement of verification:

$$\text{Tolerance} = 1.24 \sqrt{L + 0.0084 L} \text{ cm}$$

5. Determination of areas

Tolerance T relating to the difference between a numerical determination and a graphical determination:

Extract from the tolerance tables in use in the topographical service

Surface	Scale		Surface	Scale	
	1/2000	1/5000		1/2000	1/5000
1a 00ca	11 ca	28 ca	4ha 00a 00ca	229 ca	570 ca
10a 00ca	36 ca	90 ca	10ha 00a 00ca	367 ca	903 ca
15a 00ca	44 ca	110 ca	15ha 00a 00ca	453 ca	1107 ca
50a 00ca	81 ca	201 ca	20ha 00a 00ca	528 ca	1280 ca
1ha00a 00ca	114 ca	285 ca	50ha 00a 00ca	879 ca	2043 ca
2ha00a 00ca	162 ca	403 ca	100ha 00a 00ca	1340 ca	2932 ca

In addition, each land plan must, before it is transmitted to the land conservation service, be checked. It is only and obligatorily following this check made on the basic data for survey calculation and sometimes on the land itself that the property plan is designated "Approved plan" and can be transmitted to the land conservation service for "closure".

The check made on the survey work is to ensure that the control networks serving as a basis for the surveys are of a homogeneous nature and that the work is well carried out technically so that it can be used by all surveyors both in the administration and the private sector.

At the regional level, the topographical service has set up cadastral offices comprising eleven officials responsible for demarcation, topographical plan surveys of registered properties and of properties to be registered, and the archives of cadastral surveys.

Each cadastral office contains:

- (1) A list of triangulation survey marks of all orders classified by 1/20,000 reference field sheets and comprising:
  - their designation;
  - their planimetric and altimetric co-ordinates, if necessary;
  - their nature and silhouette, if necessary.

- (2) A set of rural cadastral plans to the scale of 1/20,000 and urban ones to the scale of 1/2,000; depending on the density of the property, the plans may be prepared to a larger scale.
- (3) The survey files of each property which has been registered or is in the process of being registered.

All these documents may be consulted by the public on payment of a research fee.

In conclusion, the registration of landed properties helps the gradual establishment of a legally-based cadastre which offers complete security to the owners.

However, many obstacles are delaying the completion of such a cadastre:

- firstly, the registration procedure, by very reason of its accompanying guarantees, is very lengthy and expensive;
- secondly, as the registration is optional, its application is dependent on the goodwill of those concerned; the geographical dispersion of requests, despite the efforts of the topographical service to group them, affects the conduct of demarcation and topographical survey operations which have a low rate of productivity and are expensive.

To help remedy this state of affairs and to support the dahir of 25 July 1969 which formed a code of agricultural investments, a dahir of the same date instituted general registration of rural properties in selected areas at the instigation of the topographical service and in accordance with the owners' wishes.

The general registration, which, it should be noted, is free, makes it possible to increase at least tenfold the present rate of productivity of optional land registration. Indeed, the photogrammetric methods used enable topographical operations to be carried out with the maximum speed, productivity and economy, and the topographical service has very modern photogrammetric equipment which is at present sufficient to deal with all the new tasks resulting from general registration.

Nevertheless, general registration, in view of certain needs, has not been fast enough.

Thus the needs of economic and social development necessitate a scope and urgency which cannot brook indefinite delays. To stick to essentials, the study and execution of projects of national interest affecting irrigation and land redistribution, the building of roads and dams, the development of ports and airports, the exploitation of mineral and forest riches, the development of tourism and the quest for an equitable basis for property tax are activities which involve a methodical and thorough knowledge of housing stock.

Hence it is necessary to concentrate on an interim solution which, if it is not registration, nevertheless constitutes a very important stage and at least has the advantage of providing, within reasonable periods of time and at minimum expense, documents which can be used in the various public and private economic sectors.

This was the aim of the dahir of 19 July 1962 relating to the establishment and maintenance of the Cadastre National.

The dahir provides, in the case of each property and with due regard for existing instructions concerning registered properties, for establishment of the boundaries of each property, its area, the nature of its soil and the types of activities practised there, and of the owners and apparent holders of real rights.

In each commune the owners and communal councillors take part in cadastral surveys. These operations are ratified by a commission de cadastre national which is presided over by the administrative authority of the commune (the caïd) and consists of communal councillors.

In each commune the following are prepared:

- a plan showing parcels and parcel register in which the properties are indicated with their topographical characteristics;
- an original of land tax register on which the real estates are grouped by owners' accounts.

The plan showing parcels is prepared by modern photogrammetric methods whereby the scale and degree of accuracy of the parcel plan and the value of each category of land can be flexibly adopted.

Thanks to information science, all the data collected in the field will be fed into computers which can provide at any time, in addition to the parcel registers and original of land tax register, any economic and statistical information required, e.g., thematic maps, distribution of a property, etc.

The cadastre thus prepared will satisfactorily ensure the physical definition of landed properties and the identification of apparent owners.

This cadastre, prepared at reasonable cost and within reasonable periods of time, will, moreover, constitute an important stepping-stone to registration and the legally-based cadastre.