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REPORT ON MAPPING THE FORESTS OF LEBANON
at 1:50,000 (1963 - 1965)

الجمهورية اللبنانية
مكتب وزير الدولة لشؤون التنمية الإدارية
مركز مشاريع ودراسات القطاع العام

REPORT ON MAPPING THE FORESTS OF LEBANON
at 1:50,000 (1963 - 1965)

by

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Beirut, May 1966

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A C K N O W L E D G M E N T S

The writer takes pleasure in acknowledging the assistance and co-operation of his Lebanese colleague, now of the Plan Vert, M. K. El Husseini, with the photo-interpretation and mapping and during many sorties into the mountains of Lebanon.

The ready co-operation and technical advice of Messrs. Aero-Procisa, Photogrammetric Engineers of Beirut, was vital to the succeful production of the Forest Map of Lebanon and is gratefully noted here, as is the co-operation of the Direction des Affaires Geographiques of the Lebanese Army, who printed the map.

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S U M M A R Y

Using the existing 1:50,000 map series as a base, the present natural forest cover of Lebanon was mapped by photo-interpretation of 1:25,000 aerial photography taken in 1962, supported by extensive checking in the field. The forests were mapped mainly by species and density classes and occasionally by age classes, down to a size limit of about 6 ha.

The interpreted detail was transferred from the photos, for printing on to the map sheets, by 3rd order photogrammetry. The final map, covering 24 sheets, was produced in November 1965. This showed the forest areas in green, with symbols denoting species and density classes. A punched card index of all forest stands was also initiated.

The area of forest was measured from the map. This showed some 67,000 ha with a density equivalent to more than 10% ground cover and another 66,000 ha of the same species with a density of less than 10%.

Of the first category, some 48,000 ha (ca 70%) consists of oak coppice, mainly Quercus calliprinos Webbe and Q. infectoria Oliv., or Juniper, mainly Juniperus excelsa M.B., stands, mostly degraded. In addition there are 1750 ha (ca 2.5%) of extremely degraded fir forest, Abies cilicica Carr, with abundant juniper; 2,000 ha (ca 3%) of cedar, Cedrus libani Loud., mostly degraded and often with a strong admixture of fir and juniper, or oak; and finally come 15,000 ha (ca 22%) of pine forests, divided more or less equally between Pinus brutia Ten. and Pinus pinea L., with a negligible amount of P. halepensis L. and Cupressus sempervirens L.

Of the other 66,000 ha of land carrying the same species at a very low density, about 57,000 ha (ca 86%) are covered with extremely degraded oak or juniper; under 400 ha with cedar and the remaining 9,000 ha with pine.

Altogether, out of about 133,000 ha mapped as carrying forest vegetation, only about 10,000 ha represent anything approaching high forest. About 70% of this latter area carries stands of P. pinea, protected and to some extent managed for the production of the edible seeds.

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The inescapable conclusion from these figures, already well known if not previously so precisely substantiated, was that the once extensive forests of Lebanon have been disappearing and are being degraded and destroyed at a very rapid rate. This is supported by the very fragmented nature of the forests, which appears from the map.

With less than 7% of the land area covered with forest, even when this term embraces stands of down to 10% density, it is evident that any policy of national land use will require extensive afforestation and the urgent protection and improvement of the remaining forests.

For the execution of such a policy it is recommended that the Forest Map could be used immediately 1. To determine and record the ownership category of all forest; 2. To analyse the distribution of the forest by administrative areas and their human and livestock population densities; 3. To analyse the limiting ecological factors determining the natural distribution of the different forest types.

It is also recommended that the application of air photo-interpretation and simple photogrammetry to all aspects of natural resources development in Lebanon should be rapidly expanded. Initially this may be done by establishing a section devoted to such work in the Plan Vert, on the basis of the work and training already carried out by this Project.

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Extensive field checking was nevertheless imperative, and at least 80% of the stands mapped were inspected on the ground. For purely mapping purposes this would have been a quite uneconomic procedure, but was in fact undertaken largely in the course of other work and also enabled the necessary study of the present condition and ecology of the forests to be made.

2.4 On the completion of the classification and delimitation of the forest stands on the aerial photographs, the limits were transferred to the 1:50,000 map sheets by third order photogrammetry, using a Zeiss Stereotope. This work was put out to contract, for a price of L.L. 10.90 per stereo-pair ($3.60). A copy of the contract specifications is attached as Appendix No. 1.

This method was resorted to after it became evident that the high degree of image distortion due to the extremely broken terrain made it impossible to carry out the transfer satisfactorily by the simpler Stetchmaster (in this case Stereosketch) technique.

2.5 Using modern scribing techniques, the Contractor also produced final films for over-printing on each map sheet, with the stand boundaries, serial numbers and forest type symbol.

2.6 The Direction des Affaires Géographiques (D.A.G.) of the Lebanese Army printed 50 copies of each of the 24 map sheets on which forest occurred, without the green colour by which the undefined and undifferentiated forest was originally denoted. The D.A.G. then used the films prepared from the interpreted aerial photographs to overprint these maps with the results of the forest mapping.

2.7 In its final form, produced in November 1965, the new Forest Type Map of Lebanon at 1:50,000 comprised 24 sheets, listed in Appendix No. 2, with the forest areas printed in green and the boundary, serial number and Forest Type symbol for each stand printed in black. Each sheet also carries a legend on which the symbols are explained in Arabic and English. A copy of the legend is shown in Appendix No. 3.

2.8 The extent of each forest type was obtained by measuring the area of each stand from the map, using a polar planimeter. This work was also done on contract.

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The results are accurate to within 1%. They are shown in Appendix No. 4, which lists the forest area, by stands, on each map sheet and also the area of all stands in numerical order.

3. PROCEDURE

3.1 In order to arrive at a suitable classification of the forests these were initially inspected in all parts of the country. As the D.A.G. made aerial photographs available, these were used at the same time to correlate the different forest types with their appearance on the photographs.

3.2 Systematic and intensive photo-interpretation gradually developed out of these preliminary studies and was constantly accompanied by the inspection of forests on the ground.

To facilitate mapping from the photographs, delimitation was confined to the central portion common to the two adjacent photographs, where image distortion due to differences in altitude was at a minimum. This portion was bounded by two lines drawn on the photograph, one line half way between the principal and a conjugate principal point; the other line drawn on the stereoscopic image of such a line previously drawn on an adjacent photograph. The fact that principal and conjugate principal points had been marked on the photographs also reduced the cost of mapping the detail by contract.

3.3 For the examination of the photographs it was found essential to have the enlargement given by a pocket stereoscope, (Cassella, x 2), given the scale and quality of the photographs used.

3.4 In detail, procedure was to lay out the aerial photographs for a given region (in the absence of any mosaics or photo-assemblies) to obtain a general idea of the type and distribution of forest. The region was then located on the topographic, geological and rainfall maps, to obtain the available indirect evidence for the type of forest likely or unlikely to occur.

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3.5 As a rule, roughly rectangular areas of forest were delimited down to a size of 1 cm^2, representing 6.25 ha at 1:25,000. On the 1:50,000 maps this would appear as 1/4 cm^2 and smaller areas would have been impracticable to label with the appropriate symbol. Furthermore the time required to classify, record and map smaller areas would not have been justified by their importance. From similar consideration boundaries on the photographs were not drawn less than 4 mm apart.

Deviations from these guide lines were made in the sense that in areas of abundant and extensive forest, areas slightly exceeding 1 cm^2 were sometimes not mapped, when they could obviously contribute nothing substantial in the way of production, nor be readily incorporated in any management. On the other hand, areas smaller than the limits mentioned above were recorded in regions where forest was scarce, or where the forest type in question was not otherwise represented. An extreme example of this is the forest type Cypress, which is very scattered and never extensive and for which the occurrence of very small groups was mapped, to obtain a comprehensive picture of its distribution.

3.6 The serial number of each stand was noted on the aerial photographs. Simultaneously with the delimitation on the photographs a separate Stand Index was compiled, showing Stand number, Aerial Photograph number, Name of Map Sheet, Forest Type, and when the information became available, Total Area and Forest Area.

An expanded version of this Index, with notes on many of the stands and photographs of stands representative of various forms of the Forest Types will eventually be produced to accompany the Forest Type Map.

3.7 The forests are for the most part extremely fragmented and even in the more extensive stands there are non-forest areas of cultivated or rocky land. For the most part it was impracticable to delimit frequent small occurrences of non-forest within a stand boundary. In the course of delimitation the non-forest area was estimated and noted in the Index, in terms of tenths of the total area. Total area within a boundary could therefore readily be converted to forest area, once the area measurements were made.

3.8 After the completion of photo-interpretation, field checking and final delimitation of all forest stands on the aerial photographs, standard photogrammetric and map printing procedures were followed to produce the final maps.

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4. CLASSIFICATION OF FOREST TYPES

4.1 As appears from the present project of preparing the first Forest Map of Lebanon, the practice of forestry in Lebanon has not so far been, nor will immediately become, highly intensive. Consequently, for the initial stages of planning forest development, only a broad classification of forest types, species or groups of species; by wide density classes and where relevant by age classes, was required. At the same time this is all that was possible, given the scale and quality of the aerial photographs available and the fact that a two-man team was undertaking this task for an entire country. The classification used is set out in Table 1 below. The species included in each forest type are listed in the map legend, Appendix No. 3.

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TABLE: 1

CLASSIFICATION OF FOREST TYPES FOR THE 1:50,000 FOREST TYPE MAP OF LEBANON

SPECIES	CROWN % CLOSURE	DENSITY CLASS	AGE CLASS
OAK COPPICE	Over 30	1	
	10 - 30	2	
	Below 10	3	
OAK STANDARDS	Over 30	1	
	10 - 30	2	
	Below 10	3	
JUNIPER	Over 30	1	
	10 - 30	2	
	Below 10	3	
CEDAR	Over 40	1	
	10 - 40	2	
	Below 10	3	
FIR	Over 40	1	
	10 - 40	2	
	Below 10	3	
PINUS BRUTIA	Over 40	1	REGENERATION
	10 - 40	2	OR POLE STANDS
	Below 10	3	OLDER STANDS
PINUS PINEA	Over 40	1	REGENERATION
	10 - 40	2	OR POLOE STANDS
	Below 10	3	OLDER STANDS
CYPRESS			

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4.2 CLASSIFICATION BY SPECIES

As a rule a stand was classified according to the numerically dominant forest species. Most of the forests are pure, or single species stands, in the terms of the classification. Where two species classes, such as P. brutia and oak for example, were mixed in more or less equal proportion by area, or were both significant for future treatment of the stand, the latter was classified apart as a mixture and both symbols were shown on the map.

In the case of fir and cedar this system was not strictly adhered to and the classification was sometimes used to indicate the presence of these species, although in fact their economically and ecologically less important associates, such as oak and juniper, might be numerically dominant in all or part of a stand classified as fir a cedar.

The actual composition, or range of composition, of stands grouped under one species heading is indicated in the map legend (Appendix No. 3).

Under'Oak coppice' all oak less than 4 or 5m high was grouped, whether true coppice or heavily lopped poles usually without a crown.

Under 'Oak standards' only stands with predominantly single stemmed trees, more than 4 m high and usually with a fairly well developed crown, were grouped.

Only one stand (No. 133) was classified as 'Fir', comprising the only area where this species was truly dominant.

Of the stands classified under 'Cedar' some, such as No. 533, were indeed pure cedar, while in others, such as No. 146, cedar was outnumbered by the sum of the associated species, fir and juniper. With the symbolic significance and economic importance of the cedar of Lebanon, it was considered important to indicate all its occurrences on the map.

Stands of Pinus brutia were either pure, apart from the possible presence of a more or less sparse understorey of oak, or were mixed with cypress. The presence of the latter was always indicated on the map by adding the Cypress symbol c, as far as possible in the

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Proportion and position occupied on the ground. Five stands of Pinus halepensis were also mapped under the P. brutia symbol.

Stands of Pinus pinea were either pure, or had a light and local admixture of P. brutia and sometimes a sparse oak understorey.

Cypress occurred either in mixture with P. brutia or alone, often in groups too small to delimit and was then indicated by placing only the symbol.

4.3 CLASSIFICATION BY DENSITY

The measure of density used was the degree of ground cover appearing on the aerial photographs. In theory this can be measured with a suitable scale, but the ground cover provided by the forests dealt with here was so irregular, that classifying density was largely a matter of judging the appropriate mean value for a fairly well defined stand of more or less constant composition.

Normally the main purpose of a density classification is to correlate a level of production with each density class. While this was of some interest in the present case, for rough estimates in relation to present wood consumption for example, its main interest lay in indicating what forest was potentially productive and the type, and period of application, of measures required to preserve and improve the existing forests.

A limit of 40% density was selected, for the potentially productive coniferous stands, to separate stands which were at present dense enough to bear some improvement cutting and would require this to obtain adequate regeneration, from stands already sufficiently, or more than sufficiently, open to regenerate and consequently in need of immediate protection from grazing and further uncontrolled cutting.

For stands of oak and juniper, whose eventual role would be protective rather than productive, this limit was reduced to 30%, to separate stands which under adequate protection could spontaneously increase the ground cover they afforded, from stands so open that their improvement even over several decades, would require intervention in the form of planting.

Those limits were selected in accord with the widely prevalent condition of the forests. Thus for example 98% of the area of juniper forest in density classes 1 and 2 fell into class 2.

For all forest types a lower limit of 10% density was set below which the cover could no longer be considered to represent forest, neither in a productive nor a soil protective sense. Many of the areas in density class 3 were of very large extent and embraced completely bare areas, as well as small isolated areas of denser stocking. In all cases the density class represents a mean value for a forest stand, separated equally as likely on grounds such as species composition, general condition, or site occupied, as on the homogeneity of the density.

It may be noted that the choice of density class limits for the potentially productive forests in fact coincided with those used for productive forests in the FAO World Forest Inventory, with all the attendant advantages.

4.4 CLASSIFICATION BY AGE CLASS

This was very rudimentary and confined to the only two extensive types of productive conifers, P. brutia and P. pinea, which were also the only types in which noticeably young stands occurred. In practice a distinction could be made on the aerial photographs between pine regeneration, or dense pole stands, and older stands. No hard and fast age limit could be applied, but the so called 'young' stands consist either of regeneration, or of dense stands of young trees mostly under 10 cm D.B.H., requiring protection from grazing and some tending.

The location of these few young stands is also of interest for the possible execution of sylvicultural trials (especially concerning the pruning of P. pinea) and for analyses of stocking and growth at this stage of development.

The age of the great majority of the remaining stands of productive conifers may be assumed to lie between 40 and 100 years.

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5. FOREST STAND INDEX

5.1 The stand index compiled in the course of photo-interpretation (3.6), when annotated and illustrated, will provide a descriptive accompaniement to each set of the Forest Type Map.

5.2 In addition and as a permanent and cumulative forest record, a punched card index was started. So far this covers all the density class 1 stands of the productive conifers. Its completion will be undertaken by the expert's Lebanese colleague and successor.

This index uses Copeland Chatterson 12.cm x 20 cm edge punched cards (serial P.2), each card representing one stand. These cards are punched to show forest type, forest area, and a range of site characteristics according to the classification reproduced in Appendix No. 5. Most of these site characteristics can be taken from the existing topographic geological and rainfall maps, supplemented as required from field observations.

The stands comprising the forests of Lebanon may thus be sorted in any desired manner for subjection to a variety of analyses. Each stand card at the same time may carry descriptive notes and can be used to record any operations carried out, a summary of any inventory data and any other information of interest.

The versatility of the punched cards will enable to punched information to be still considerable augmented, as new information, e.g. on ownership, location according to administrative districts, etc, becomes available.

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TABLE: 2

AREA OF FOREST TYPES BY DENSITY CLASSES; HECTARES

TYPE \ DENSITY	1	2	1 + 2	Young	3
Oak coppice	20525	17524	38049		29344
Oak standards	556	414	970		938
Oak coppice & standards		151	151		384
TOTAL OAK	21081	18089	39170		30666
Juniper	91	7752	7843		24568
Juniper & oak	48	1553	1601		1627
TOTAL JUNIPER & OAK	21220	27394	48614		56861
Cedar	1104	968	2072		276
Fir		1759	1759		
TOTAL CEDAR & FIR	1104	2727	3831		372
Pinus pinea	3202	3795	6997	734	1803
P. pinea & oak					731
Pinus halepensis	89		89	72	
Pinus brutia	5111	1375	6486	575	764
P. brutia & oak	76	791	867		3490
P. brutia & cypress	456		456		272
Cypress	82		82		
Mixed conifers					1703
TOTAL PINE & CYPRESS	9016	5961	14967	1381	8763
TOTAL ALL TYPES	31,340	35,082	67,422	1,381	65,900

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6. RESULTS AND CONCLUSIONS

6.1 Table 2 shows that a total of 68,803 ha of forest of all types with a density of more than 10% was mapped. This effectively constitutes the present forest estate of Lebanon, covering about 7% of the non-urban land area.

Other than the 7731 ha of P. pinea forest, virtually none of this forest is at present under any form of systematic management. Consequently much of the area of forest in density class 1, and the age class young, is in need of thinning, both to obtain regeneration and to reduce the overstocking which is inimical to maximum volume production; and of improvement cutting to remove dead or diseased or damaged trees and to ensure the continued dominance of the most productive species.

Conversely, the forests in density class 2 are all in need of protection from further excessive and unselective cutting and from grazing, particularly of the regeneration.

6.2 Of the above total, 48,614 ha or 70%, consists of oak or juniper forest, whose vocation is mainly firewood and charcoal production and eventual conversion to more productive species. With the large area involved, such conversion would evidently occupy the bulk of the resources of any future forest management programme.

The present area of cedar and fir forest, at 5.7% of the total, is insignificant and mainly of historical and ecological interest, as indicating the type of site where these noble species might be re-established.

The area under P. pinea comprises 11.5% of the total and is managed at present primarily for the production of the edible seeds. The remaining 8,627 ha, mainly of P. brutia, comprising about 18% of the total area, includes no stands of good quality at present. But this is due only to neglect or over-exploitation, for these forests show signs of potentially high production, vigour and ready regeneration, making their early protection and improvement all the more desirable.

6.3 Even such a brief analysis of the species composition of the forests indicates a gross imbalance at present between the forests of high production potential, with only 30% of the area, and those of relatively very low production potential, comprising 70% of the total. One of the leading articles of any future forest policy, must therefore be the elimination of this imbalance.

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While the ecological distribution of the forests will be analysed in a separate note, it would clearly be desirable to subject the geographical distribution, in relation to urban concentrations, patterns of land use, recent demographic movements etc. to closer examination. This is however not possible at present, due to a variety of factors, but is one of the tasks to be undertaken by the expert's Lebanese colleague and successor. The distribution of the forests by administrative districts will appear almost automatically from the 1:200,000 forest map which is at present in course of production.

6.4 While alone the Biblical Old Testament provides ample evidence for the richness and importance of Lebanon's forests in past millenia, its recent history is virtually undocumented. To elicit this it is therefore necessary to resort to the forests themselves and these provide a sadly eloquent testimony of continuous degradation and destruction. Thus for 68,803 ha of forest mapped with a density of more than 10%, another 65,996 ha of forest vegetation with a density of less than 10% were also mapped. There can be little doubt that a century or so ago most of this area would have been mapped in density class 1 or 2. For there is abundant evidence throughout the forests that their condition is anything but static and that the rapid regression and disappearance of forest indicated by the above figures continues from day to day.

Apart from the ecological evidence which can be cited for this contention, it is demonstrated well enough by the continuous range of densities in ecologically constant conditions which the forests everywhere exhibit. This varies from 100% crown closure to something in the order of one tree per km^2 for all the main species. Apart from certain limited instances of ecological influence, this range of densities must therefore be a direct reflection of the biotic pressure, i.e. the degree of cutting and grazing, to which the forests have been and are subjected.

The intensity of this pressure and the fact that it is a currently active phenomenon also appears from the figures in Table 2. Thus the fact that of the total area mapped in all three density classes only 23% is in density class 1, strongly indicates that the forests are progressively disappearing rather than the reverse. The same is true of the fact that 70% of the total area in density classes 1 and 2 consists of what is more or less all degraded oak

and juniper forest, while only 30% consists of valuable conifers. This indicates a general process, of the initial removal of the most desirable species, followed by the more gradual disappearance of the hardier and less desirable ones. This is also substantiated by the fact that only 8% of the pine forest is in the young category.

More evidence to the same effect appears in Table 3, which shows a breakdown of the forests with more than 10% density by the size of the stands in which they occur. Density class 3 is not considered here because it consists to a considerable extent of a grouping of many very small stands or occurrences, within a single boundary.

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TABLE: 3

DISTRIBUTION OF DENSITY CLASSES 1,2 AND YOUNG BY STAND SIZE CATEGORIES

CATEGORY / TYPE	UNDER 100 ha		100-199 ha		200-499 ha		500-1000 ha		OVER 1000ha	
	STANDS	AREA	STANDS	AREA	STANDS	AREA	STANDS	AREA	STANDS	AREA
Oak	283	11665	65	8825	32	9692	9	6348	2	2489
Juniper	8	363	2	263	1	455	1	502	4	6260
Cedar	11	364	2	264	5	1444				
Fir									1	1759
Pinus pinea	71	2644	13	1803	6	1752			1	1532
Pinus brutia	75	2949	14	1909	4	1290	1	913		
Various	19	663	1	151	4	1138	2	1366		
TOTAL	467	18648	97	13215	52	15771	13	9129	8	12040
% Age of Occurrences	73%		16%		8%		2%		1%	

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Table 3 shows in effect that the forest is extremely fragmented, with 73% of the stands less than 100 ha in area and 89% less than 200 ha in area. Thus 47% of the area is in the form of homogenous stands of less than 200 ha in extent, although some of the stands are of course contiguous. The relatively few very extensive areas of forest remaining, though for the most part open and degraded, indicate that this fragmentary character is by no means natural, but a result of the disappearance of formerly existing forest.

6.5 The information contained in Tables 2 and 3, and on the map itself in regard to forest areas, can be further analysed in greater detail as required for particular purposes. But even this cursory examination of the results of the mapping, in terms of relative areas of the various classes, provides a clear picture of the state and status of the forests.

As a form of land use forest, even considering as such stands with only 10% - 30% ground cover, accounts for an insignificant 7% of the land area of Lebanon. Of this forest, 52% by area (density class 2) is too open to be productive for at least two or three decades. There remain some 30,000 ha of forest sufficiently well stocked to be exploited. Of this area 20,000 ha is oak coppice. This leaves 10,000 ha of pine and cedar forest to produce anything other than firewood, charcoal or poles, and in fact little more than half of this area can at present yield any timber worth exploiting as such and then only locally.

There is at present therefore a sufficiently large area of forest for the commercial exploitation of firewood and charcoal, while the area capable of commercial exploitation for timber, especially if problems of fragmentation and accessibility are considered, is virtually negligible from a national standpoint.

It can therefore be concluded that, if forest production is to play any role in the future economy of Lebanon, some action in the form of protection and improvement of the remaining forest areas is needed. Since it has also been shown, as a result of mapping the forests by species and density classes, that their degradation and disappearance is actively in progress, such action is clearly needed soon.

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6.6. Even when the ca. 67,000 hectares of forest in density classes 1 and 2 are eventually brought into good condition, which could be achieved in about three decades of intensive sylviculture and management, this will still leave Lebanon with only about 7% of its land area under forest.

For a country consisting largely of mountains, with an abundance of steep slopes and rocky soils, this proportion of forest is evidently inadequate. This is true from the general aspect of land use and from detailed considerations of forest production, soil protection, water control, and tourist attraction. It may therefore be concluded that in addition to the rehabilitation of the existing forests, any future forest policy must also envisage the creation of large areas of forest by afforestation.

The location and extent of the areas suitable for afforestation will appear from the Land Capability Map at 1:200,000 which it is intended to prepare jointly by the U.N.S.F. Forestry Project and Soils and Irrigation Project. The optimum forest type to establish on the various sites will appear partly from a general study of the forest type map, partly from the detailed ecological analysis of the forest type distribution recommended below. The yields to be expected are dealt with by the writer in the Report on Forest Inventory. Reports on the costs of the improvement and establishment of forests will also appear from the work of the Project, and will enable detailed input/output analyses to be made of those operations. The present forest type map thus forms the first step in a systematic analysis of the ecological and economic aspects of forest development in Lebanon.

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7. RECOMMENDATIONS

7.1 Recommendations for the use of the Forest Map.

7.1.1 The Determination and Analysis of Forest Ownership.

For the rehabilitation and massive extension of forests it will be essential to establish, on a cadastral basis, the present ownership of the forests and of the land suitable for afforestation.

The forest map provides an ideal base for recording this information, as the nature and distribution of the forests by ownership categories-private, communal, state - will immediately appear. Similarly the location of land available for afforestation will appear in juxtaposition to existing forests and so suggest the species to be used, and local priorities for afforestation on both ecological and administrative grounds.

It is therefore recommended that the cadastral boundaries separating blocks of private and communal lands and of all state land be transferred from the cadastral plans to a set of the 1:50,000 forest maps. This may be done using a large pantograph, directly from cadastral plans at 1:5,000 and in two stages from plans at 1:2,000.

The ownership category of each stand should also be recorded in the Stand Index (5. above). The complete analysis of forest ownership by forest types and administrative areas will not be possible until the current cadastral survey of Lebanon is completed, but partial analysis, by Cazas for example, can be made progressively.

7.1.2 The Determination and Analysis of Forest Distribution by Administrative Areas.

To enable final recommendations for the development of forestry and land use to be made on a regional basis and to be able to plan the detailed execution and administration of such development, it will be necessary to analyse the distribution of forest types, and eventually of the areas suitable for afforestation by Cazas and Mohafazat.

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It is therefore recommended that a tabular statement be prepared showing the area of each forest type by Cazas, from which the area in each Mohafaza will appear automatically. This may be done by transferring the administrative boundaries from the new 1:100,000 map series on to a set of the 1:50,000 forest maps and listing the stands and their areas accordingly.

Such analysis may be carried further by preparing histograms showing for example the relative forest area and total human and livestock population in each Caza. This latter information is already available in the Project.

7.1.3 The Determination and Analysis of Forest Distribution by Ecological Categories.

As a guide for determining the type of forest to develop on a given site and for the selection of sites to obtain specific forest produce, it will be necessary to know the natural site range of each forest type in some detail. This may then be further broken down by yield classes within each forest type, using the results of the present and future inventories.

It is therefore recommended that the punched card Stand Index (5.2. above) be completed at the earliest opportunity. With the aid of this classified index and of the forest map a tabular statement should be prepared showing the percentage of each forest type density class corresponding to the site categories shown in Appendix No. 5, modified as appears appropriate.

Such a tabulation will immediately indicate the broad ecological features of the forest distribution and those aspects requiring further investigation, e.g. the significance of the influence of aspect on stand density. It is recommended that for such investigations the collaboration of the appropriate University Departments should be sought, since they are generally better equipped to undertake them and are often glad of subjects which may be studied locally.

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In addition it is recommended that the distribution of forest types and density classes be studied in the light of the land type and land use classification already mapped for the Land Capability Map (6.6 above). This mapping was undertaken at 1:50,000, so that transparent overlays of the land classification may readily be prepared for superimposing on the forest map. The occurrence of different forest types on various land units may then be analysed in terms of limiting ecological factors, evident from the tabulation discussed above, and of present land use (cf. reports by J.R. Desaunettes and A. Saliba), to arrive at a correlation between the land capability units and the type of forest which they can support.

7.2 Recommendations for the Expansion, Revision and Improvement of the Forest Map.

7.2.1 For areas where detailed inventory, management or afforestation is contemplated, it is recommended that the forest detail be transferred to the appropriate 1:20,000 maps, or enlargements thereof. This will provide detailed and up to date topographic base maps, with equally up to date forest detail, such as will be required for local planning and control.

Such work may justify or require the more detailed mapping of the forest, which the larger scale will also support. This may be done on the already interpreted aerial photographs, transferring the new boundaries to the larger map using a third order photogrammetric instrument such as a Zeiss Stereotope. Even when no revision of boundaries is involved, these should be mapped at the larger scale photogrammetrically, since there is no detailed correspondance between the 1:50,000 maps established from ground survey several decades ago, and the new 1:20,000 series established recently from the same photos used in the forest mapping. Transfer of boundaries between the old and new maps using a pantograph would therefore give rise to errors.

7.2.2 In the first instance only 50 sets of the forest map have been produced. If the production of further copies is eventually contemplated this will provide an opportunity to improve on certain details. Thus the placing of the stand numbers on the map often coincides with other detail, obscuring the numbers. In a few cases small gaps have been left in certain stand boundaries. Also the green base printed on all forest stands does not always coincide perfectly with the stand boundaries, especially when these are formed by an international frontier.

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It is therefore recommended that the maps should be systematically examined for such faults and the films corrected to obtained an improved second printing.

7.3 Recommendations for expanding the use of Air Photo-Interpretation and Photogrammetry for Natural Resources Development in Lebanon.

7.3.1 Recommended Applications

The manifest advantages in precision, in time and labour and in comprehensiveness of planning to be derived from the use of aerial photographs and the maps made from them, in all fields of natural resources development, have not so far been fully realised in Lebanon.

It is therefore recommended that the use of the appropriate techniques should be rapidly expanded. Immediate applications for work already in progress or soon due to start can be found in:

The detailed reconnaissance and mapping of areas for forest protection and management and for afforestation, including reconnaissance for the emplacement of temporary nurseries.

All aspects of land reclamation, including detailed terrain and soil studies, lay out of terraces, access roads and drainage systems.

The preliminary selection of individual road traces and study of earth moving and drainage required. The detailed study of small scale road networks in restricted areas. The progressive mapping of completed road sections, terraces, drain, etc.

The lay out and mapping of irrigation and windbreak networks.

The survey and mapping of soils, (already being practised); of all kinds of land use and of individual crops and vegetation types.

The production of schematic maps showing the results of any such surveys and studies, at a variety of scales, using as base the already existing detailed topographic maps.

The design and execution of statistical sampling, for economic and other surveys.

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The design and execution of statistical sampling, for economic and other surveys.

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7.3.2 Given these multiple applications for aerial photo-interpretation and photogrammetric mapping for work for the most part already in progress in the Plan Vert and the Ministry of Agriculture, it is recommended that a section to execute this aspect of the work be established as early as possible.

Since two projects, Cadastral Survey of State Lands and Survey of Perennial Crops, both due to make extensive use of photo-interpretation and producing schematic maps, are currently being planned by the Plan Vert, this body would be in the best position to establish a comprehensive photo-interpretation and mapping section. Such a section in the Plan Vert should then service the whole range of its own activities and those of other interested Government bodies. These may eventually form their own similar sections, as circumstances require.

The functions of such a section should be:

1. To form a comprehensive collection of examples of the types of aerial photographs, at various scales and on various films, available for Lebanon, to be consulted by specialists of different disciplines as an aid to selecting the most suitable photography for their particular purposes.

2. To form a similar collection of maps.

3. To keep a cumulative record, with costs, of the air photo and map series available for Lebanon as these appear, as a knowledge of this is essential in the earliest stages of planning any work.

4. To maintain a staff of trained and eventually experienced photo-interpreters, and of photogrammetrists conversant with sketchmaster and 3rd order photogrammetric techniques.

The size and competence of this staff should suffice to provide technical advice in the design of surveys and studies of the type mentioned above; to carry out systematic photo-interpretation of a variety of subjects to given specifications, and to produce the required schematic maps.

Personnel

In the immediate future it will only be possible to engage one trained and experienced photogrammetrist and one trained photo-interpreter experienced in soil and crop surveys, as being the only personnel available. These should be supplemented by personnel to be trained by them in such numbers as required for the work to be immediately undertaken. After a suitable interval at least two of these trainees should be sent to complete a course at the International Training Centre for Photogrammetry at Delft, Holland, one to specialise in photo-interpretation and survey techniques, the other in photogrammetry and map production. Thereafter the section may be expanded as required.

Equipment

The initial requirements for equipment will be covered by the purchases to be made for the two above mentioned survey projects.and the items, already available.

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APPENDIX No. 1

1:50,000 Map Sheets Comprising the Forest Type Map.

HALBA	SAHLE
TELL-KALAKH	RAYAK
BATROUN	AASSAL - EL - OUARD
TRIPOLI	SAIDA
SIR - ED - DANIE	JEZZINE
HERMEL	RACHAIYA
JEBAIL	ZEBEDANI
QARTABA	TYR - NABATIYE
BAALBEK	MARJAYOUN
AARSAL	HERMON
NEBECK	NAQOURA
BEYROUTH	BENT JBAIL

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APPENDIX No. 4

Classification of Forest Stands for entry on punched cards

FOREST TYPE	PUNCH
Oak coppice	B
Oak standards	C
P. brutia	D
P. haloponsis	E
P. pinea	F
Cedar	G
Fir	H
Juniper	I
Cypress	J
DENSITY CLASS	
1	L
2	M
3	Mc
Y	K
GEOLOGY	
Limestone jurassic	N
Albian - aptian	O
Sandstone	P

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GEOLOGY	PUNCH
Limestone cenomanian	Q
Marl	R
Basalt	S
Quaternary	T

ALTITUDE	
0 - 200 m	V
201 - 800 m	W
801 - 1300 m	X
1301 - 1750 m	Y
1750 +	Z

SLOPE	
0 - 20%	A
21 - 40%	E
41 - 70%	I
71 - 100%	O
100 +	U

ASPECT	
North	A 1
East	A 2
South	A 4
West	A 7

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RAINFALL	PUNCH
200 - 500 mm	B 1
501 - 700 mm	B 2
701 - 1000 mm	B 4
1001 - 1300 mm	B 7
1300 mm +	B 1 + B 7

BIOTIC INFLUENCE (Cutting, Grazing, Fire)	
Absent	C 1
Light	C 2
Moderate	C 4
Severe	C 7

OWNERSHIP	
Private	D 1
Communal	D 2
State	D 4
Undetermined	D 7

TOTAL AREA HA		
- 50	E 1	
50 - 99	E 2	
100 - 199	E 3	(E 1 + E 2)
200 - 299	E 4	
300 - 399	E 5	
400 - 699	E 6	
700 - 999	E 7	
1000 +	E 8	

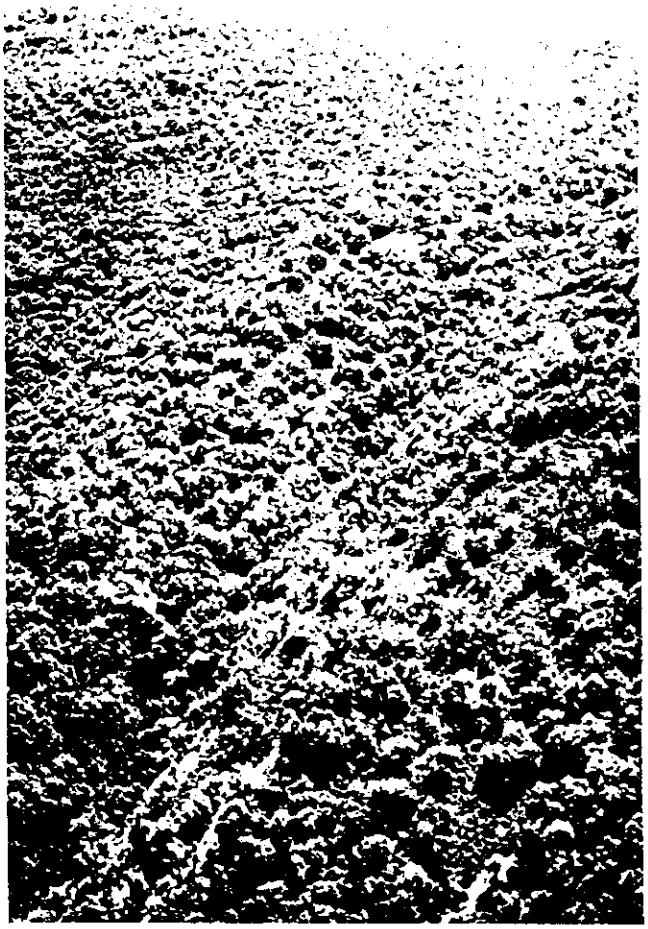

Figure 1. Oak coppice, density class 1. Stand 287. Altitude 600 m-900m. Mainly Q. calliprinos, 2-3m. high, with Arbutus Andrachna, Phillyrea media, Calycotome villosa, Cretaegus spp., Rhamnus spp. etc. and a ground cover of Poterium apinosum. The abundance of thorny species is typical of degraded forest under heavy grazing pressure, also indicated by the rounded form of the bushes.

Figure 2. Oak coppice, density class 2. Same slope as Fig. 3 Q. calliprinos 2-3m high.

Figure 3. Oak coppice, density class 3. Below Chateau de Beaufort. Altitude 250m-600m. Q. calliprinos. Note shallow soil on very steep slope (100%) normal to bedding of Cenomanian limestone outcrop. Fig. 2 indicates that even such sites would have forestry potential when protected.

Figure 4. Oak Standards, density class 1. Stand 109. Altitude 1250m-1450m. Q.cerris var. pseudocerris Stand above Fneideq, perennially lopped for fodder and heavily grazed (note absence of lower branches), resulting in absence of regeneration.

Figure 5. Oak standards, density class 3. Stand 481. Altitude 1250m-1500m. Q.calliprinos. Western slopes of Jebel Niha. Tracks and ground vegetation indicate heavy grazing. Relict forest in cedar zone.

Figure 6. Juniper, density class 2. Stand no. 34. Altitude 1600m. Juniperus excelsa, foetidissima, oxycedrus, surrounging Cedar Stand no. 54 which doubtless extended into this area formerly.

Figure 7. Juniper, density class 3. Stand No 73. Altitude 1800 m-1900 m. Juniperus excelsa. Last remnants of what was probably extensive cedar forest, (cf. cedar stand 54, 4 km. to north), disappearing as firewood.

Figure 8. Cedar, density class 1. Stand no. 311. Altitude 1450m-1850m. Pure Cedrus libani with rare oak. Cedars of Hadeth and Tannourine, fairly effectively protected from cutting and grazing in a relatively prosperous area. Note dark bare patch of basalt in middle distance at extreme right. Forest occurs on Jurassic limestone, cultivation on sandstone and basalt.

Figure 9. Cedar, density class 3. Stand no. 72. Altitude 1800m. Western slope of Jebel Niha, near crest. Note wind-swept form and the mist sweeping over the ground in the middle of a bright summer day, an important factor in the ecology of cedar in Lebanon.

Figure 10. Fir, density class 2. Stand No. 133. Altitude 1400m-1700m. Jebel Kammouha. Abies cilicica, in places with cedar, P.brutia and Q. pseudocerris. Junipers and Q. calliprinos and infectoria throughout. Note branches lopped for goat fodder (cf. Fig. 4).

Figure 11. Cypress, Cupressus sempervirens. 1300m. Qadicha gorge.

Figure 12. Pinus brutia, density class 1. Stand No. 241. Altitude 700m-800m. With abundant Q. calliprinos and frequent carob, Ceratonia siliqua. Overstoked in many parts. Note trees pruned for fuel.

Figure 13. P. brutia density class 2. Stand No. 108. Altitude 1250m-1450m. Degraded, heavily grazed and cut stand with abundant Juniperus oxycedrus and Q. calliprinos.

Figure 14. P. brutia, density class 3. Stand 406. Altitude 1000m-1250m. Note nests of processionary caterpillar on tree in foreground.

Figure 15. P. brutia, young stand No. 384. Altitude 250m-550m. Fairly vigorous pole stand 20-30 yrs. old. Q. calliprinos and infectoria common

Figure 16. Pinus pinea, density class 1. Stand No. 253. Altitude 650m-1000m. Typically on lower Cretaceous sandstone, Bkassine. Occasional oak, including Q.pseudocerris. Well protected and managed for production of edible seeds.

Figure 17. P. pinea, density class 2. Upper part of stand No. 253, ca. 1000m. Obviously less well protected. Note even smallest trees pruned.