

14TH CONGRESS OF THE INTERNATIONAL SOCIETY OF
PHOTOGRAMMETRY

HAMBURG 1980

COMMISSION VII
WORKING GROUP III

PRESENTED PAPER
HARRI LEPPANEN
DEVECON OY, ENGINEERS AND ARCHITECTS

AERIAL DATA IN FORECASTING OF URBAN DEVELOPMENT
AND TRAFFIC OF TRIPOLI

AERIAL DATA IN FORECASTING OF URBAN DEVELOPMENT AND TRAFFIC OF TRIPOLI

Introduction

In this paper one example of the use of aerial photos in practical urban planning will be discussed. Devecon Oy was engaged in preparing the Transportation Master Plan of Tripoli in the Socialist People's Libyan Arab Jamahiriya 1977. The project including comprehensive traffic surveys, forecasts and 25, 15 and 5 year traffic plans was completed in 1.5 years.

When studying the data material available for planning, many gaps were found. Almost the only comprehensive and reliable source of information was the population census carried out in 1973, in which population by mahallah (statistical zone), household size, sex, age distribution and economically active population were surveyed. Especially statistics of economic activities and employments were insufficient, again the census material gave the most reliable figures. Statistics about housing existed but they were very general.

Maps and aerial photos were quite good: black and white aerial photography 1:25 000 from 1973 and 1:5000 topographical maps compiled from this photography as well as 1:20 000 black and white photography from December 1976 were available.

The city plans were out of date. The most recent master plan was from 1966-69 and since that the situation and trends of development in Tripoli have been thoroughly changed, due to among other things a revolution, which took place in 1969. However, the sectoral master plans, among them the Transportation Master Plan, were based upon this master plan.

It was found quite necessary to create new statistical background for planning. In this respect a land and space use survey (1) of the entire city was carried out. This survey was in many ways used in the planning and forecasting processes. The methods and the results of this use are discussed below.

Land and space use survey

The land and space use survey was carried out to form the basic new information source for the work. Following information could be obtained from survey results allocated by city zone:

- total land area of the city and the zones
- distribution of land use by economic activity
- ground floor space, i.e area covered by buildings classified by land use activity.
- total floor space by economic activity.

Thus in addition to land use the intensity of it was also measured in terms of ground floor space and total floor space.

The survey method and procedure has been presented in previous publications (1) Stereoscopic aerial photo interpretation was of great importance and the essential method in practical survey.

DEFINITION OF ACTUAL POPULATION 1977

Because of the fast urban development in Tripoli since 1973, the population figures of the 1977 census were not accurate enough to be used in the traffic model calibration based on surveys carried out in July 1977. Specially the distribution of the population by city zone, one of the key factors in traffic modelling, had to be revised.

The actual population by city zone was processed out as follows:

- 1- The residential floor space for each mahallah (1 mahallah=1-3

city zones used in the traffic and land use survey) were calculated from the land use and space use survey results.

- 2- A development ratio indicating difference between 1973 and 1977 residential floor space was determined for each city zone and further for each mahallah. This was done by comparing the 1973 and 1977 aerial photographs zone by zone. Excluding areas of exceptional changes i.e. new residential areas or demolished slum areas, in which the new or the demolished residential floor spaces should be determined accurately as in the 1977 land and space use survey, it was found accurate enough to compare residential ground floor spaces for both years.
- 3- Using development ratios the 1973 residential floor spaces for each city zone and mahallah were calculated.
- 4- Knowing the 1973 population by mahallah from the census 1973 population by city zone was calculated by distributing the population of mahallahs to the city zones proportionally to the residential floor space in each zone.
- 5- Finally the population of 1977 by city zone was extrapolated using the above mentioned development ratios (i.e. the 1977 residential floor space versus the 1973 residential floor space) assuming that the average urban density (inhabitants/residential floor space) in each zone had remained unchanged. This assumption was found justified in comparison of the situations with aerial photos. The changes in the residential floorspace between those years were less than 20% of the total in each zone.
- 6- The total population 1977 for the entire city was calculated and compared with an estimate made using average growth rate 1973 - 1977. This rate could be estimated from annual registration of Libyan population in some parts of the city. The growth and distribution of expatriate population, however, was uncertain.

This check indicated that the estimate of total population 1977 in Tripoli was accurate enough for further use. Specially the zonal distribution of population obtained in this way could be considered reliable. The total population of Tripoli, which was 555 000 in 1973, had increased to 632 000 in the beginning of 1977 representing a 3% rate of annual growth.

DEFINITION OF EMPLOYMENT 1977

As mentioned the employment statistics were insufficient. In 1973 census the number of economically active population by activity was surveyed and using this activity rate an estimate of number of jobs in each category of economic activities could be made. However, the zonal distribution of jobs was unknown, because the working population was allocated in accordance with their residences, not with the location of their jobs.

The number of jobs by activity and their zonal distribution was estimated followingly:

- 1- Using the above estimated total population 1977 and the average activity rate obtained from the household interview survey the total number of jobs in the entire city was estimated. It was found that the activity rate 1977 was slightly higher than the corresponding rate 1973.
- 2- This number was adjusted in accordance with home based work trips commuting in and out of the city, which were observed in a roadside interview survey at the outer gordon line located at the city border.
- 3- The distribution of jobs by activity was determined using results of the 1973 census and various statistical sources (other studies about the same subject).

4- The zonal distribution of jobs by activity was estimated using zonal distribution of floor space by activity (excluding residential floor space) obtained from space use survey.

The estimate gave the following results

- number of jobs in accordance with activity rate(25.4%)160000
- number of jobs in accordance with the estimated net commuting 20000
- total number of jobs 180000

Thus the total number of jobs in various economic activities was distributed to the city zones in accordance with the floor space occupied by the corresponding activity in each zone. This implies that the average floor space per job would be the same in each category all over the city.

This deduction can of course be disputed

FORECASTING OF POPULATION 2005

The forecasting procedure is always a complex issue of assumptions, development policies and strategies. These things are not discussed in this paper. In regard to birth and mortality rates the growth of Tripoli is very high and could lead to various scenarios for the future. However, there is a considerable restricting factor - availability of urban space-which affects the development of physical conditions.

In general it was found desirable to preserve the existing, still human, urban scale of the city. In this respect the space use characteristics obtained from the space use survey were of great importance, to describe the present situation. On the other hand the development of economic activities and the investments already made, decided or planned (harbour, rail and street networks, parking, office complex, hotels etc.) indicated pressure to increased

efficiency in space use and consequently changes in the urban scale.

When summarizing all these factors it was found out that the land reserve available in the city would be used for urban economic activities and communications and the land available for residential development would be equal to present residential land. Thus an increased population could only be accommodated by increasing urban densities within the city limits.

Therefore the final forecasting process used in the Master Plan Study could be defined as follows:

- 1- The natural population growth taking immigration into account was estimated.
- 2- An allowable maximum urban density (inhabitants/ha/) for each city zone was figured out.

In this consideration the existing urban densities obtained from the land and space use survey were essential as well as knowledge about Libyan living habits and social structure.

It is impossible to accurately define acceptable environmental quality in terms of urban density only. Comparisons with international averages and especially with monitored urban densities in Tripoli provided background for this judgement.

- 3- Using these densities a future population estimate for each zone was made.
- 4- The population exceeding the total obtained from these estimates was recommended to be channelled to other settlements within the urban agglomeration of Tripoli and its environs.

The following figures will give an idea of urban population of Tripoli:

- urban densities (inhabitants /ha)	1977	2005
- maximum	343	202
- average	54	71
- average/residential	121	164
- total population	632000	822000

The urban population is thus estimated to be more evenly distributed in the future, although the average densities are considerably higher.

FORECASTING OF EMPLOYMENT 2005

The basic concern from the strategic point of view in forecasting employment for the year 2005 was the future economic structure of Tripoli and the whole Jamahiriya. From the environmental point of view, however, the existing distribution of economic activities indicated by the number of jobs in each activity would give a good basis for future development.

The work process in forecasting employment for the year 2005 was in principle similar to the forecasting of population, i.e the environmental capacity of each zone to accommodate new activities was deducted by utilization of the land use and space use data and the new distribution made in accordance with these potentials taking also the population catchment of each area into account.

The following set-up would indicate the development in Tripoli:

activity	1977		2005	
	jobs	%	jobs	%
- agriculture	6000	3.3	5000	1.9
- industry	13000	7.2	24000	9.3
- construction	30000	16.7	20000	7.8
- electricity,gas,water	3000	1.7	5000	1.9
- wholesale,retail trade restaurant,hotel	3900	21.7	42000	16.3
- transport,communication	15000	8.3	28000	10.8
- financing,insurance, real estate, services	17000	9.4	41000	16.0
- community,social and personel services	57000	31.7	92000	35.9
total	180 000		257 000	
employees living in Tripoli	160 000		277 000	
avarage activity rate	25.4 %		33.6 %	

TRAFFIC MODEL CALIBRATION

The normal procedure of traffic model calibration is to determine trip generation and attraction in each trip category as a function of the land use presented in terms of population and employment by means of multi variable analysis. Then the forecasted present traffic assigned to the present street network will be compared to the actual traffic volume and distribution monitored in traffic surveys. The differences would indicate the accuracy of the calibration and several iterations may be required to adjust the discrepancies.

In the Tripoli Study the statistics of population and employment both for the present and for the future were created on the basis of the land use and space use data as described above. Thus this survey was a fundamental importance, in which only an intensive use of aerial photos made an economic and work saving approach possible.

COMMENTS

The use of the above described methodology as well as the land use space use survey was made in practical consulting work, in which scientific accuracy and quality tests are impossible. However, the consultant is confident that the results reliably represent relevant features of city functions. It should be remembered that in a rapidly developing country many factors of the future are uncertain and therefore the tools of planning should be chosen correspondingly. The present use of urban space and the development potentials of urban environment will remain as key factors for every strategic alternative. Therefore these kind of studies will not be waste work although with time and money they can be made more comprehensively, more accurately and scientifically more elegant.

BIBLIOGRAPHY

- 1) Harri Leppanen: Aerial Photos in Urban Survey of Tripoli, Proceedings of the International Symposium on Remote Sensing for Observation and Inventory of Earth Resources and the Endangered Environment, Volume II, p 1003, July 2-8, 1978, Freiburg, Federal Republic of Germany.
- 2) Devecon Oy: Transportation Master of Tripoli, Second Stage Final Report 15.11.1978, 25 Year Traffic Plan, Project Report for the Municipality of Tripoli.