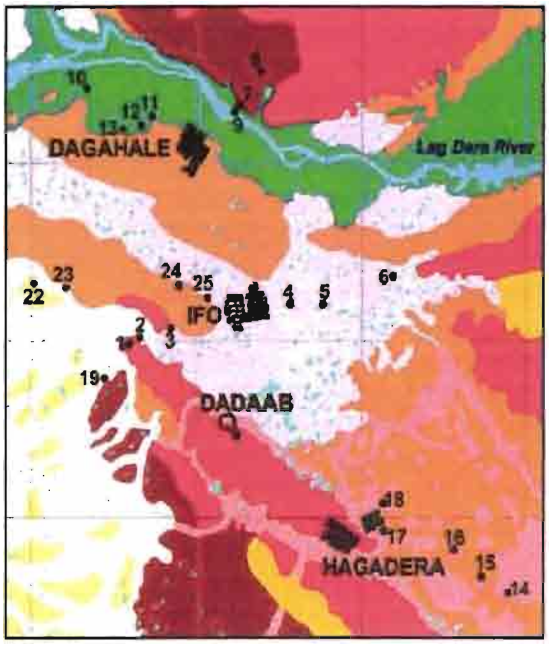
Environment, cartography, demography and geographical information system in the refugee camps Dadaab, Kakuma - Kenya

Final Report

Major findings



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Sumary | **Page**

Thanks

The Institute of Research for Development (IRD ex ORSTOM) is a public organisation of research which depends on the French Ministry for research and higher education. Within the framework of the agreement signed with the United Nations High Commissioner for the Refugees (UNHCR) in July 1998, the IRD thus led its first experiment of research in the particular context of the refugee camps in Kenya.

For the HCR, this type of partnership is of course less frequent than that this agency uses to lead with other UN organisations or Non Governmental Organisations (NGO) directly involved in the humanitarian action. This is why we would like particularly to thank Mr. *A. Peters*, representative of the HCR in Nairobi until 1998, who encouraged the principle of this co-operation and Mr. *S. Malik* who allowed that the first field work can start in 1996. This support was then confirmed by the funding of this agreement. Regarding this aspect we want to specially thank MM. *J-Y. Bouchardy* and *Y. Kimura* of the department of environment in Geneva and Mrs. *Y. Stevens* and Mr. *D. Tshitungi*, respectively HCR representative and Deputy in Nairobi.

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INTRODUCTION

1 - Objectives

In agreement with the HCR Environment Unit in Geneva and its representation in Nairobi (Kenya), the principal results of this program were to be reached through the setting of a Geographical Information system (GIS) making it possible to store and manage all information accessible at the scale of the refugee camps ; that information being statistical, cartographic or numerical (satellite images). In addition to the written reports, the major result of this program was to be presented as a data base provided to the Mapinfo and Access format (GIS and data base software chosen by the HCR). The information gathered in this data base answers the following objectives:
1) - Evaluation of the environmental situation around the camps of Dadaab and, more particularly, estimate of the real importance of deforestation associated with the presence of the refugee camps.
2) – Achievement of a statistic and cartographic data base using the demographic information concerning the refugees.

In addition, another important objective of this program consists in research of methods and instruments making possible the development of large scale cartography of the environment and refugee camps. In this spirit, several methods were tested:
1) - Cartography of the camps by GPS or DGPS
2) - Realisation of aerial mosaics trough numerical imagery obtained with autonomous means independent of the satellite imagery.

In other part, an environmental economy study project had to be abandoned because of the difficulty in defining the terms of references. On the IRD's side, the proposal has been made to engage some studies on the dynamics of the firewood market in Dadaab refugee camps (sold volumes, evolution of the prices, methods of wood collection, distance covered, etc). This study has partially been realized at the end of 1998 in the form of a GTZ consultancy.
Lastly, for lack of precise instructions, we think that the request relating to the "environmental indicators " did not totally succeed (if we except the joint report concerning the environmental situation and deforestation).

In order to achieve these various tasks, the HCR placed at the disposal of the IRD team a computer, an A4 scanner and an A3 printer colour. This equipment has been given back to HCR in July 1998. In addition, several missions were carried out by IRD researchers. These missions made possible to cover the following fields : cartography and air videography (2 missions), environment (2 missions), demography (1 mission). Part of the environmental studies has been subcontracted by two researchers of Moi University in Eldoret.

Beside these specific consultancies, the IRD placed at the disposal of this project a full-time researcher since the beginning of the agreement (the IRD responsible of the HCR/IRD agreement) and a technician cartographer in Nairobi until July 1998. During the last phase (January - December 1999), this program could use part of the equipment and personnel of the IRD « Laboratoire de Cartographie Appliquée» (France). In order to be able to process all the information obtained during these last months (censuses of population, satellite images), a technician cartographer and a demographer specialised in the data processing assisted for three months the researcher responsible for this program.

2 - timeframe

Collaboration between HCR and IRD (ex ORSTOM) officially began in July 1997. This one year initial duration program however suffered a certain number of constraints which prohibited the completion of the project in the intended deadlines (July 1998). Among these constraints it is advisable to recall: 1) the delay of the air survey due to a suspension of the activities issued by the Kenyan government (September/October 1997); 2) - logistic problems associated to the El Nino phenomenon; 3) delay in the acquisition of the satellite images (July 1998) ; 4) - delay in the availability of the censuses of population of the four refugee camps (Kakuma and camps of Dadaab, February 1999).
By mutual agreement between two parts (HCR/IRD), these delays justified the extension of the program until December 1999.

In spite of these delays, several preliminary reports and documents could be transmitted to HCR at of the end of July 1998 :
- report on the use of the GPS for the cartography of the camps (April 1998),
- a report about the geographical origin of the refugees in Kakuma camp and the estimation of the population trough interpretation of aerial photography (June 1998),
- a first environmental situation assessment in the camps of Dadaab and Kakuma (June 1998).
- a cartographic synthesis (uncompleted aerial mosaics of the camps of Ifo, Hagadera and Kakuma, origin of the refugees of Kakuma, satellite image of 1990, ...).

Since January 1999, this second phase of the program was marked by a mission in Dadaab in February. This mission made it possible to complete the study about the deforestation around the camps. This mission was also the occasion to present to the local HCR staff the aerial mosaics of the three camps (Dagahaley, Ifo, Hagadera). More recently (May 1999), a preliminary report on deforestation around the camps of Dadaab accompanied by a cartographic synthesis was submitted to the HCR. This intermediate report was justified by the urgency of an assessment on the real situation of degradation associated with the firewood supply program.

Thus, the present final report has been preceded by the submission of five preliminary reports, two cartographic documents, and several copies (printings and/or CR-ROM) of aerial mosaics of the camps and satellite images of the area of Dadaab.

Principal results

The printed final report is constituted of three volumes (environment, aerial mosaic and GPS, demography and GIS) and several cartographic documents. On the other hand, several CD-ROM give access to the various layers of information of the data base (satellite images, aerial mosaics, maps, data,). They are generally delivered to the Mapinfo format. Particular treatments such as those resulting from the satellite interpretation of the images are delivered in a bitmap format accessible with all the images processing software.

Volume I
Refugee camps and environment : landscape and deforestation

Main conclusions

The essential problem associated to the installation of refugee camps in a semi-arid area like that of Dadaab, is that of the firewood supply (and, for a smaler part, of timber and construction poles). This wood collection should not affect too much such particularly fragile environment. **The importance of this relation wood resource / deforestation is thus obvious.**
However the landscape approach used for the physical environment study revealed **the strong relation between the wood resource and the type of landscape**. The landscape or the segment of landscape are concepts which are based on a global analysis of the environment and are defined by a whole of varied criteria like soil, climate, vegetation, hydrological regime, topography, biological activity, etc. All these criteria thus play an important part in the characterization and the evolution of the wood resource.

1 - Landscapes

On a relatively limited surface, compared to the extent of the district of Garissa, **it exists a great diversity of lansdcape segments, sometimes strongly differentiated, with extremely various potentialities of wood regeneration** taking into account the soils and hydrological characteristics of this area. These segments (or cartographic units) are gathered in four principal types landscapes, which are caracterized by the texture and the color of soils of surface which are the criteria most easily identified in the field and which practically correspond to the traditional perception of the inhabitants of this area.

- the landscape on red dark sands (*Rama gadud*) **(P1).**
- the landscape on red soils with sandy surface horizons and sandy- clayey horizons in depth (*Ber gadud*) **(P2).**
- landscape on reddish soils with sandy or sandy-clayey surface horizons and loamy-clayey horizons in-depth (*Ber gadud* and punctuated structure with ponds) **(P3).**
- landscape of beige-reddish soils or gray-beige, loamy-clayey (*Ber Gagud / Ramaat / Adable*) **(P4).**

To each one of these landscapes and even to each one of the segments (or cartographic unit) do correspond a specific type of vegetation, an intensity of the biological activity, deadwood resources and particular capacities of regeneration which are summarized in the following tables. One can however note some remarkable associations between the various factors which characterize these landscapes.

- with the sandy dark red landscapes :
  . excessively poor soils
  . the absence of biologic activity and the weak transformation of the vegetal material
  . an homogeneous vegetation but of rather high shrubby type, which apparently does not produce deadwood

- with the landscapes of sandy red soils:
  . soils still very poor but having some physicochemical characteristics slightly more favorable (pH, content and type of organic matter)
  . a better biological activity and a better transformation of the vegetal material
  . a more heterogeneous vegetation **with a** arboreous **layer** sometimes rather important producing the deadwood.

Table 1: Principal caracteristics of the landscapes and their potentialities

TYPES OF LANDSCAPE			
SAND - >90 % de Sg+Sf ** - <10 % A+Lf * **(P1)**	**SANDY SOILS** - 75 à 90 % de Sg+Sf * - <20 % A+Lf * **(P2)**	**SANDY TO SANDY-CLAYEY SOILS** - 60 à 75 % de Sg+Sf * - < 30 % A * **(P3)**	**LOAMY-CLAYEY SOILS** - > 30 % A * - > 15 % Lf * - < 30 % Sg+Sf * **(P4)**
CARTOGRAPHIC UNITS			
2, 5 (unit 1 could be associated in some places)	**3, 4** (unit 9 could be associated in some places)	**6, 7, 8, 9, 10** (unit 3 and 12 could be associated in some places)	**11, 12, 13, 14** (unit 1 and 3 could be associated in some places)
Ph			
acidic	acidic to neutral	slightly acidic to slightly basic	neutral to basic
ORGANIC MATTER CONTENT			
vey low to low	low to very low	very low	low to medium
NITROGEN CONTENT			
very low to null			
C/N (organic matter status)			
weakly transformed	moderatly transformed	moderatly to weakly transformed	moderatly to well transformed
INTENSITY OF BIOLOGICAL ACTIVITY			
null	null to weak	high to very high	high to very high
ESTIMATED DEADWOOD POTENTIALITY			
null to low	low to moderate	moderate to high	moderate
VEGETAL COVER			
Dry and woody forest with high shrub and low trees. Moderatly dense and regular, average height (3 to 5m)	Shruby savannah moderatly dense, woody in some places, almost regular, averages height of shrub (2 to 5/6m)	Shruby savannah moderatly to weakly dense, woody in some places, irregular, spotted and scattered, averages height of shrub (1 to 5/6m)	Herbaceous and shruby savannah weakly dense, woody in some places, very irregular, spotted and scattered, averages height of shrub (1 to 3 m and 5/6 m).
RUN OFF			
No run off, no erosion. (very fast infiltration of total rain water)	Very weak to weak sheet flood. Fast infiltration of rain water	Sheet flood and small gullies. In some placesrun off through a slightly marked drainage pattern.	Floodable areas (small basin, valley floor,...).
SAMPLES			
1, 8	**5, 14, 15, 17**	**2, 4, 7, 11, 16, 19**	**3, 6, 9, 10**

** Sg = coarse sand, Sf = fine sand, Lg = coarse silt (or loam), Lf = fine silt (or loam), A = clay

Table 2 : Landscapes characteristics

Éch	UC	Landscapes (defined by soils)	Texture	pH	Organic matter content	C/N (organic matter status)
1	2	SAND **(P1)**	- >90 % de Sg+Sf * - <10 % A+Lf *	acidic	low to very low	weakly transformed
2	**8**	SANDY AND SANDY-CLAYEY SOILS **(P3)**	- 60 à 75 % Sg+Sf * - < 30 % A	slightly acidic to slightly basic	very low	moderatly to weakly transformed
3	14	LOAMY-CLAYEY SOILS (P4)	- > 30 % A - > 15 % Lf - < 30 % Sg+Sf	neutral to basic	low to medium	moderatly to well transformed
4	**9**	SANDY SOILS**(P2)** and SANDY AND SANDY-CLAYEY SOILS **(P3)**	- 60 à 75 % de Sg+Sf - < 30 % A et - 60 à 75 % de Sg+Sf - < 30 % A	acidic to neutral	low to very low	moderatly to weakly transformed
5	**9**	SANDY SOILS**(P2)** and SANDY AND SANDY-CLAYEY SOILS **(P3)**	- 60 à 75 % de Sg+Sf - < 30 % A et - 60 à 75 % de Sg+Sf - < 30 % A	acidic to neutral	low to very low	moderatly to weakly transformed
6	14	LOAMY-CLAYEY SOILS (P4)	- > 30 % A - > 15 % Lf - < 30 % Sg+Sf	neutral to basic	low to medium	moderatly to well transformed
7	12	LOAMY-CLAYEY SOILS (P4)	- > 30 % A - > 15 % Lf - < 30 % Sg+Sf	neutral to basic	low to medium	moderatly to well transformed
8	5	SAND **(P1)**	- >90 % de Sg+Sf - <10 % A+Lf	acidic	low to very low	weakly transformed
9	13	LOAMY-CLAYEY SOILS (P4)	- > 30 % A - > 15 % Lf - < 30 % Sg+Sf	neutral to basic	low to medium	moyennement à bien transformée
10	12	LOAMY-CLAYEY SOILS (P4)	- > 30 % A - > 15 % Lf - < 30 % Sg+Sf	neutral to basic	low to medium	moderatly to well transformed
11	**10**	SANDY AND SANDY-CLAYEY SOILS **(P3)**	- 60 à 75 % de Sg+Sf - < 30 % A	slightly acidic to slightly basic	very low	moderatly to weakly transformed
14	**3**	SANDY SOILS **(P2)**	- 75 à 90 % de Sg+Sf - <20 % A+Lf	acidic to neutral	low to very low	moderatly transformed
15	**4**	SANDY SOILS **(P2)**	- 75 à 90 % de Sg+Sf - <20 % A+Lf	acidic to neutral	low to very low	moderatly transformed
16	**3**	SANDY SOILS **(P2)**	- 75 à 90 % de Sg+Sf - <20 % A+Lf	acidic to neutral	low to very low	moderatly transformed
17	**3/4**	SANDY SOILS **(P2)**	- 75 à 90 % de Sg+Sf - <20 % A+Lf	acidic to neutral	low to very low	moderatly transformed
19	**8**	SANDY AND SANDY-CLAYEY SOILS **(P3)**	- 60 à 75 % de Sg+Sf - < 30 % A	slightly acidic to slightly basic	very low	moderatly to weakly transformed

* Ech = Sample, UC = Cartographic unit, Sg = coarse sand, Sf = fine sand, Lg = coarse silt (or loam), Lf = fine silt (or loam), A = cla

- to the landscapes of sandy or reddish sandy-clayey soils are associated :
  . more varied soils, potentially less poor (higher content of clay).
  . an always important biological activity and, generally, a rather good transformation of the organic matter, variable according to the places, taking into account the greatest heterogeneity of the soils.
  . a fairly dense, shrubby and raised vegetation, producing deadwood.

- to the landscapes of **limono**-argillaceous and beige-reddish or gray-beige soils:
  . soils definitely more argillaceous allowing the stagnation of rainwater in the lowlands and having some potentialities (push back possible certain raised and shrubby species) but generally with a basic PH. The installation of some cultures was observed.
  . a rather strong biological activity and a strong transformation of the organic material.
  . an herbaceous vegetation (zone of pasture) with a raised layer sometimes important and well developed near the wettest zones and which can be a source of deadwood.

2 - Deforestation

In 1995

- Each camp is surrounded with a more or less circular halo of nearly absolute degradation. This halo diameter which includes the surface occupied by each camp varies from 3 to 6 km. The surfaces totally denuded following the three camps settlement covered 3107 ha. 846 ha, that is 27% of this surface, accounts for the camps and their infrastructures (Dagahaley, ifo and Hagadera).
- Beyond this halo, a second more diffuse degradation belt is to be observed.
- The total surface having undergone a total and diffuse degradation reaches 5282 ha.
- Ifo exhibits the largest degradation. Dagahaley situation on the bank of the Lag Dera Valley disturbs this concentric disposition.
- Compared with the total surface of Garissa District (43392 km2) this degradation only represents 0,12% of the territory.

Table 3 : Surface status in 1995

CAMP	Area (ha)	Very high degradation (ha) *	High degradation (ha)	**Total (ha)**
Dagahaley	272	643	827	**1470**
Ifo	308	1499	1270	**2769**
Hagadera	266	965	78	**1043**
Dadaab	60	132	-	**132**
Total	**906**	3239	2175	**5414**

* : this acrage includes the area of the camp (blocks, infrastructures)

In 1998

- The surface completely or partially degraded reaches 8616 ha (that is 0,2% of the Garissa District). Approximately half of this surface (4117 ha) squares with the very heavy degradation halos which rose in three years up to 1010 ha.
- The increase of very heavy degradation surfaces between 1995 and 1998 accounts only for Ifo camps and mainly Dagahaley.
- The very heavy degradation halo around the Hagadera camp is the same as in 1995.
- The diffuse degradation areas existing between Dagahaley and Ifo in 1995 constitutes a one unit.

Table4 : Surface status in 1998

CAMP	Area (ha)	Very high degradation (ha) *	High degradation (ha)	Low degradation (ha)	**Total (ha)**
Dagahaley	272	1260	390	536	**2186**
Ifo	308	1897	988		**2885**
Dagahaley and Ifo				1619	**1619**
Hagadera	266	960	-	966	**1926**
Dadaab	83	203	175	-	**378**
Total	**929**	**4320**	**1553**	**3121**	**8994**

* : this acrage includes the area of the camp (blocks, infrastructures)

These first figures led us to retain a zone of study sufficiently vast in order to better evaluate the relative importance of the impact of the refugee camps in this environment considered as particularly sensitive.

3 - Wood resources

- The hypothesis of degradation being explained by the needs of firewood for the refugees kept in mind, all the calculations and observations show that cleared or degraded surfaces are very distinctly less than surfaces which would have been necessary for supplying the needs of the population within 7 years.
- Consequently, supplying with firewood is not the direct cause of observed deforestation.

This observation simply confirms the fact that refugees preferably use deadwood as energy resource. Deadwood collection, naturally existing on the ground does not entail an environment degradation.

- Insofar as refugees have no possibility of storage collected firewood, gathered quantities correspond to the immediate needs (2 to 4 days).
- This practice excludes the green wood cuttings by refugees as well as its carrying and its storage in the camp before use (time of drying).
- Land clearings linked with camps and infrastructure settlements (notably in Ifo), collection of timber for building huts, planting of live-fences and pastures would be the main cause of deforestation.
- Between 1991 and 1998, dead wood resources relatively close to the camps must have been very important. They allowed the refugees to fill their fire wood needs without strong degradation of the environment.
- Within a range of 5 to 10 km around the camps, dead wood resources are today bare bones. - Distances to trek across are more and more important.
- The lengthening of these distances may explain the growth of firewood trade in these three camps observed between 1996 and 1998. It accounts also for the more and more important share taken by men for collecting firewood (wheelbarrows, donkey-carts).
- The collection and woody supply system spontaneously set up by refugees has been partially changed in June 1998 into wood distribution organised by UNHCR and GTZ.
- This distribution founded on deadwood collection per private entrepreneurs within a range greater than 30 km proceeds from two hypotheses :

disappearing of deadwood within a range lower than 30 km.

- A remaining constant deadwood resource further.

- These hypotheses do not take completely into account the existence of deadwood within the range of 30 km and the environment diversity.
- Regeneration capacities of the environment allow to look, through selected cuttings, to a deadwood supply (after drying) non insignificant.
- To-day knowledge do not permit to evaluate the available deadwood stock inkeeping with the different environments units. Generally the times necessary for this stock reconstitution is unknown. A complementary study on one hectare sample plots localised in respect of the different environment units must be set up.

4 - In terms of methods and diagnosis

- The aerial photographs and, still more, the satellite imagery interpretation bears risks when this interpretation has not been accompanied with fieldwork at the time of pictures taking.
- Without a continuous observation of environment problems it is all the more difficult to rebuild the different phases of a supposed degradation process because the memory of setting up of the Dadaab camps does not seem to have been saved.
- The starting hypothese of the present diagnosis relied heavily upon the idea that refugees presence is inevitably accompanied with an important deforestation. Conversely to the observed reality, this hypothese supposes that refugees cut green wood to supply their needs for firewood.
- It is following this hypothese that varied environment actions set up by GTZ took place (energy saving, reforestation, live fences, environment education).
- The absence of a global analysis of the refugees practices to supply their firewood needs and of the evolution of these practices is to be regretted. Similarly, the lack of an environmental monitoring system since the beginning of the camps settlement considerably shortens the range of a a posteriori interpretations.

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Volume II

Aerial Videography and GIS

Executive Summary

The method of air data acquisition trough numerical videography suggested in this document makes possible to obtain aerial images with a possible resolution (i.e. size of a pixel, element of image) variable from 3 meters to 0.2 meters. It is located thus between the resolution of the current civil satellites of observation most powerful and traditional aerial photography. The developed method aims answering constraints often met in the developing countries, to minimise the deadlines, the costs and the infrastructure necessary to the catch of air sight.

The light air remote sensing meets many technical needs : basic cartography, cartography of soil using on a large scale, thematic cartography, sampling, updating, etc. Many disciplines are concerned by these techniques : one can quote hydrology (irrigation and water stock management), environment and natural resources management, rural development, urban development, land tenure ...

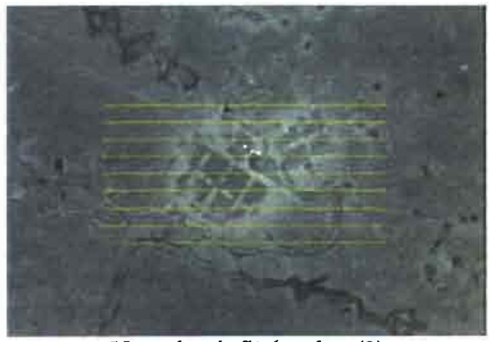
The principles of the method presented in this document are the following : after having prepared a detailed flight plan (2), the overflight by light plane with a numerical video camera and directed towards the ground in a roughly orthogonal way (3) makes it possible to have a video film covering wished surface, by parallel traces with a certain overlap between traces (4). From numerical video film, one can extract directly digital images and download them on a computer. The user has the choice of the images to capture : he must only ensure himself of the correct overlap between the images and their best horizontality.

After downloading the images on a computer (6), it is necessary to find points of geographical reference to locate, readjust and rectify the images in order to eliminate the deformations due to the catch from sight (optical deformations, horizontality, altitude). One associates position of a point in the captured image and real geographical position to create points of landmark. The real geographical position can be given directly by GPS on the ground (5), or on an already readjusted and positioned photograph, on a chart, etc. Lastly, thanks to the landmarks, the captured images are rectified (i.e. put in geographical conformity), readjusted (i.e. positioned in space), then joined (7) (i.e. integrated in a whole of images) to constitute a geo-referred mosaic (8). This mosaic is integrated in a geographical information system, which makes it possible in its turn to use the mosaic as a basic map for later work (9) (digitisation, representation, thematic cartography, etc.).

The method described above was used to carry out the cartography of the refugee camps in Kenya (Kakuma, Dadaab), within the framework of the research agreement on the refugees being the subject of a convention between the UNHCR and the IRD (ex-ORSTOM).

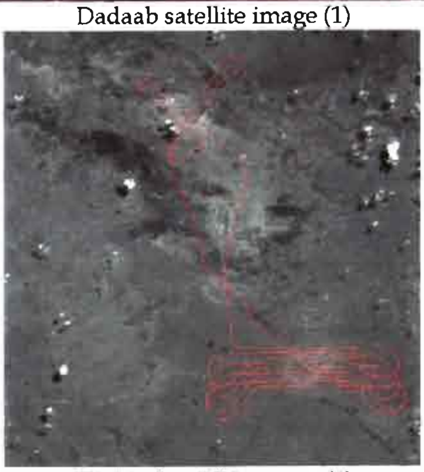
Many difficulties were joined together on this site : difficult access (the camps are far away from the great agglomerations), unstable weather conditions (El Niño consequencies), lack of cartography to large and average scale, logistical difficulties, security concern, etc. Nevertheless, the method of catch of sight was effective in spite of these difficult conditions : we thus could carry out geo-referenced mosaics of the four refugee camps of Kenya : Kakuma, Ifo, Dagahaley, Hagadera. The method as well as the results obtained are presented in the second part of this document.

Dadaab satellite image (1)



Hagadera's flight plan (2)

Preparing the flight (3)



Flight plan GPS survey (4)

Field GPS survey (5)

Downloading the pictures (6)

« Mosaiquing » (7)

Global mosaic (8)

Digitalisation on the screen (9)

Technical Guideline

Generalities

From aerial photography to satellite images, many are the methods to obtain earth images trough remote sensing techniques. The method of aerial images acquisition trough numerical videography suggested in this document makes possible to obtain aerial images with a possible resolution (i.e. size of a pixel, element of image) variable from 3 meters to 0.2 meters. It is located thus between the resolution of the current civil satellites of observation most powerful and traditional aerial photography. The developed method aims answering constraints often met in the developing countries, to minimise the deadlines, the costs and the infrastructure necessary to the catch of air sight.

This development of this method of acquisition falls under methodological research of Geographical Information Systems (GIS) : it is comprised of development of methods and software for the setting up, «mosaiquing» and integrated management and processing of the images data in a GIS (SAVANE). In this guide, all stages of methodology, acquisition of images to their integration in a geographical information system are explained.

This method of acquiring images was used in Kenya, under the IRD/UNHCR co-operation programme on refugees. This guide gives a detailed description of the example, which also puts together several difficulties in implementation (accessibility, security, infrastructure, and climate.).

Light air remote sensing : many applications

The light remote sensing methods relates to all the techniques aiming at obtaining air images of the Earth by air trough accessible tools easy to carry on. It completes the traditional air photography and satellite images.

The light air remote sensing meets many technical needs : basic cartography, cartography of soil using on a large scale, thematic cartography, sampling, updating, etc. Many disciplines are concerned by these techniques : one can quote hydrology (irrigation and water stock management), environment and natural resources management, rural development, urban development, land tenure ...

To achieve a light air remote-sensing programme, one needs an apparatus of catch of sight (camera) and a mean of transport of this apparatus. Among the means of transport, one can quote : light single-engine aircraft, helicopters, ULM, drones (planes without pilots), balloons, airships and Montgolfiers. The apparatuses of catches of sight form two groups: on the one hand traditional optical cameras, on the other hand numerical captors. The method presented in this document – the aerial videography – uses a numerical video camera embarked on a light aircraft or an ULM.

Aerial Videography : General Principles

The general principle of aerial videography is as follows :

After preparing a precise flight plan, flying using a low airplane with a digital camera, directed towards the ground in an approximately orthogonal manner enables one to have a video film covering the desired area in parallel tracks with an overlap between the tracks. The user chooses which images to download : he must only be sure of the images overlap and ensure proper seating on the airplane.

After the (optional) printing of the images on paper, it is necessary to identify points of geographical reference to confine, correct and set up and thus exclude deformations during shooting (as a result poor seating position on the flight or optical deformations). The position of a point in a captured image and the real geographical position are associated to create the landmark points. The real geographical position can be determined directly by the GPS on the ground or from photography already mounted and positioned, on a map, etc. Finally, using the landmark points, the captured images are set up (that is, put in geographical conformity), mounted (that is, positioned in space) and then integrated into the entire images to constitute a geo-referenced mosaic.

We will first situate this method within the general context of the methods of acquiring images in visible spectrum.

Actual methods of acquiring remote sensing images in the visible spectrum

Today (1999), it does exist many performing methods of acquiring images on the Earth using civil remote sensing techniques in the visible spectrum. By order of resolution (height of pixel, element of image), they are :

- Satellites with Low Resolution (height of highest pixel up to 500 meters)
- Satellites with Medium Resolution (height of pixel between 500 and 50 meters)
- Satellites with High resolution (height of pixel between 50 and 5 meters)
- Satellite with very high resolution (height of lower pixel - to 5 meters)
- Aerial videography (height of lowest pixel 3 meters)
- Aerial Photography

Aerial videography enables one to obtain resolutions varying between 3 and 0.2 meters. Satellites with low and medium resolution do not fall in this field of operation. Civil satellite images in high resolution have a resolution that can attain 2 meters, but the most current images are those of the SPOT satellite (10 meters in panchromatic mode, 20 meters in multi-spectral mode). The cost is between 0.3 USD/km2 for Landsat (one image cover 34000 km2) and 0.6 USD/km2 for Spot (an image cover about 3600 km2). Other satellites with high resolution (between 5 and 1 meter) will definitely be introduced in the years to come (2000-2005), and could thus make obsolete the technique of acquisition trough numerical videography ; unless the flexibility of the method, the speed of obtaining of the result and the increase in resolution of the video sensors do not continue to make it competitive.

Of all the methods of acquisition, classical aerial photography remains the best as pertains to resolution : a scanned aerial photograph enables one to have a resolution much lower than a meter. On the contrary, cost is an important factor (from 50 $/km2 for a 1000 km2 survey) and implementing an aerial photography campaign calls for the use of heavy means. Since the principal criteria is the resolution and that there already exists a recent aerial photography cover, it is preferable to buy and then scan the photographs than take an aerial view again using another method. Often, the colour is missed out : most of the aerial photographs are in black and white.

Thus, aerial videography enables the classical aerial photography and us to ensure the continuity of the resolutions between the high-resolution satellite images. We can develop a comparative matrix of the diverse methods using various criteria :

	Resolution	Availability	Cost	Meteorology	Duration
Satellite	From 30 m to 2m	Depends of the Satellite and Meteorological Conditions	0.3 to 0.6 USD/Km2	No clouds	From some days To some months
Videography	From 3 m to 0.2 m	Must be managed Light aircraft Video camera GPS	5 to 20 USD/Km2	No clouds under the flight plan level	Some days
Aerial Photographs	Up to 0.1 m	Classical aerial Photograph Techniques	10 to 50 USD/Km2	No clouds Under the flight plan level	From some days To some weeks

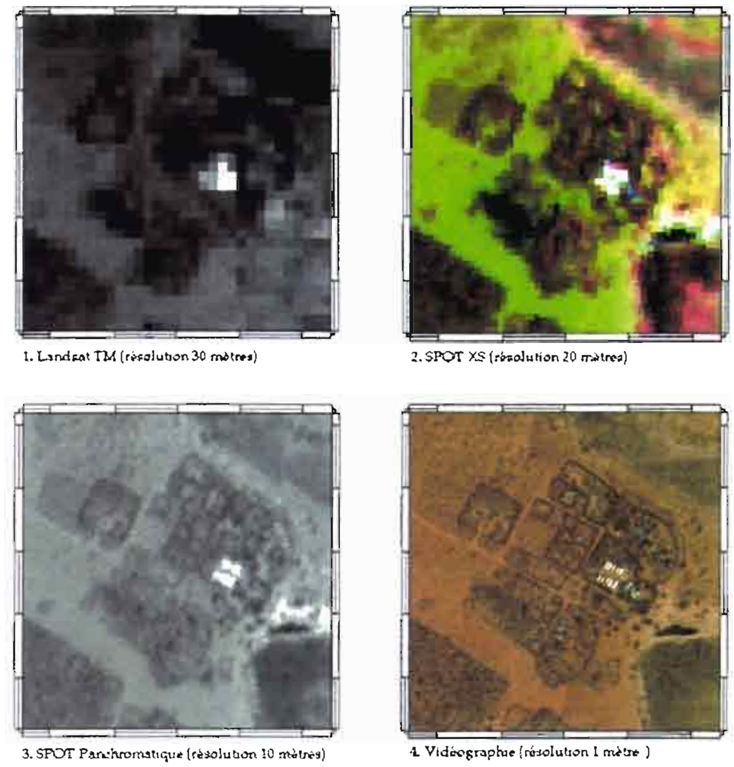


Fig 1: Examples of images from the same area with different resolutions: Satellite Landsat (30 meters), SPOT Multi-spectral (20 meters), SPOT panchromatic (10 meters), videography (1 meter).

Aerial Videography: Principles of the Techniques Used

Aerial videography uses many techniques whose principles are worth understanding: geodesy and cartography, accurate aerial navigation, digital videography, positioning by differential GPS, correction and re-sampling of images, mosaiquing and geographical information systems.

Geodesy and Cartography

To represent a point on the Earth, a simple mathematical surface, which is close to the real shape of the earth is used. This surface has the shape of a revolution ellipsoid and enables to represent the position of a point using spherical co-ordinates: Longitude, Latitude, altitude in relation to the surface of the ellipsoid. Practically, several sizes and positions of the ellipsoids are used: It is necessary to be careful with the parameters used (the datum).
To represent a piece of this curvilinear surface on a flat surface, we use cartographic projection exercise, which deforms the curvilinear surface and projects it on a two-dimension plan.

Aerial Navigation

To ensure proper covering of the area to be represented on the map, it is necessary to inform the pilot of the light aircraft, the total number of parameters in order to enable him undertake an accurate navigation. A flight plan should be made using geographical co-ordinates of entry and exit points of the tracks (navigation is then done by GPS following an orthonomy, lines of the shortest curvilinear distance between two points of the same altitude), or using an entry point and a cape (navigation is then done by compass according to a loxodromy provided that the vertical stability of the aircraft is taken into account).

The Principle of Videography and the miniDV Digital Format

A video film is made up of consecutive images (frames) at the rate of 50 (PAL, SECAM) or 60 (NTSC) images per second. Each frame corresponds to the scanning of one line out of two on the screen, which in turn enables one to have a full image every 1/25th (PAL, SECAM), or 1/30th (NTSC) of a second and to make sure that there is a better result of the motion (it is said that the images are intertwined, with both odd and even frames). The miniDV digital video format is made up of 720*576 pixels for each frame.

Acquiring a Fixed Image
An image can be captured from two consecutive frames of the video film, in order to obtain a fixed image. Using digital coding of the signal and DV format resolution, the fixed images are of excellent quality and cannot be obtained when using a video camera, which has almost the same format as the Hi8.
If the speed of the object to be filmed in relation to the video camera is high, two consecutive frames (distance of 1/50th or 1/60th of a second) will show big differences and the fixed image will be constituted from one of the two frames only due to a minor interpolation between the lines.

The Principle of Differential GPS
The GPS system (Global Positioning System) is a system of global positioning using satellite, enabling one to calculate the position of any point whatsoever on the Earth, in the three dimensions. Simultaneously, the GPS system enables the aircraft to have an accuracy of 100 metres, the measurements being obscured by several factors: error on the orbital parameters of the satellite, errors on the satellite clock, errors of propagation of signals due to weather conditions and to the satellite positions, error from the radio clock, errors of reception due to reflections of the signal, voluntary degradation of the signal by the Department of Defence of USA (who manage the system).

To locate one's position with an accuracy corresponding to the resolution of the image, it is necessary to take the measurements with relative accuracy among all the points less than a meter. This accuracy can be obtained using the differential GPS.

Adjusting and re-sampling of images
In determining the correspondence between the points of the image and the points localised geographically (using landmarks), one can calculate the modifications to put on the image to make it concur with the geographical reality following a given geographical projection. With two landmarks, a rotation can be carried out followed by a translation. With three landmark points, a polynomial distortion of 1degree can be carried out. With several landmark points, a local adjusting can be done by covering 1-degree distortion in each triangle emerging from triangulation between the landmark points.
Re-sampling enables one to modify the resolution in the arranged image by choosing the pixels to take into account in the original image in order to calculate the value of an arranged pixel in the target image.

Mosaïquing and Geographical Information Systems
From the rectified images, integrating the pixels of the adjusted images into one whole can constitute one big image. The structure of a mosaic is more complex than that of a simple image because mosaic does not necessarily have the shape of a rectangle. Mosaics are managed by geographical information systems. These systems enable one to manage other types of geographical data (polygons, lines, points) and to compare among them these different data types.

Materials and software required implementing aerial videography

Materials required:
• Digital video camera that can capture fixed images on a computer (SONY type DCR-VX1000E with a DVBK2000E target for capturing image on a computer)
• A waterproof battery 12V7VAH (minimum), a battery charger 12V and a special 12V cable for the camera
• Special mounting that enables to set the camera vertically outside the aircraft with device for adjusting the seating and inclination
• An adjustment instrument for the focal distance (for cameras with different focal distance that does not show the actual focal distance).
• Alternatively, a small 12 V control monitor equipped with a video input
• Two GPS enabling differential measurements for relative positioning of less than a meter (MAGELLAN PROMARK X CM type).
• Two professional antennae with a tripod for the GPS
• A computer to charge the measurements from the GPS (an exercise to be undertaken every half day) to download images from the camera, to rectify, resample, mosaic them and use the mosaic.

Required Software:
• Software for acquiring fixed images (supplied with the camera or capture card),

- Software for calculating differential positions for GPS points (supplied with GPS),
- Software for preparing a flight, to rectify the images and to mosaic them,
- Geographical information system that works with mosaic or a large volume of images.

The SAVANE geographical information system was used for all the exercises presented in this document.

Cost evaluation

To evaluate the total cost of the aerial videography exercise, we will need to aggregate an estimated cost of the materials and software, the costs of infrastructure (hiring an aircraft), manpower costs (basing on the expertise rate of the Institute) and overall transport costs.

Material and Software
Filming: 4200 $ (camera), 700 $ (capture), Control monitor (170$), other equipment's (170$)
Differential GPS: Two units (20.000$), Two antennae (2500$), Tripod (340$)
Lap Top: 4200$
Software: Depends on the GIS used (2.000$ for the SAVANE system)
The total estimated cost for the purchase of material and software is 33.000$. Expecting depreciation in costs within three years, at the rate of 4 exercises by year, depreciation per exercise can be estimated at 1700$ (the same is also expected of GPS and Computer on other exercises). Without the GPS, depreciation falls below 800$.

Preliminary maps and Data
Maps, satellite images or aerial photographs (a Panchro SPOT scene costs between 1000 and 2800$)

Filming
Cost of fieldwork for a few days by an engineer (170$/day)
Hiring an aircraft with a pilot (between 170 and 670$/hour)

Countryside GPS Exercise
Cost of a field exercise for several days by an engineer or technician (170$/day)

Capture and sampling of Images
This depends on the number of images (about 30 images/day per operator) (1KF/day)
This cost of this exercise therefore varies between 3300 and 17000$ to which transport costs must be added

Perspectives

Digital photography is undergoing rapid change, and especially with increase of cheap high-resolution video cameras (1999, cameras with a resolution higher than 1.3 MegaPixels for an image with a resolution of 1600*1200). If the principles remain valid, the camera can be adequately replaced by a high resolution filming equipment that enables the capture and storage of digital images in a magnetic form within a short time, at a rate compatible to the needs of aerial filming (almost one image per second). This technology would enable one to make filming much easier and to increase the resolution tremendously.

Volume III

Demographic data processing, thematic cartography and GIS

Major findings

I-1 - Demography

The objective consisted in integrating the censuses of population in the Geographical Information System (GIS) in order to be able to produce a cartography set of themes of the refugee camps relating to the principal variables contained in the censuses of population (population, age, sex, ethnic origin, etc). This objective was completely achieved on the camps of Dadaab. In Kakuma, on the other hand, we had to limit us to the only statistical analysis of information. The cartographic representation of this census could not be carried out because of many uncertainties which remain on the distribution in the space of the various groups of population. The number of groups identified in the census (204) is indeed much higher than the number of groups correctly localized in the camp on the chart carried out in 1994. Lastly, the data placed at our disposal date from August 1997, date on which the camp of Kakuma counted yet only 37,000 refugees.

In Kakuma as in Dadaab, the analysis of the censuses shows the importance of a systematic processing of these data. It is necessary to consider a two months deadline between the availability of the census (in a computerised format) and the restitution of a complete report on the socio-demographic structure of each camp. This type of analysis requires the participation of a statistician or, better, a demographer. This last must however be assisted by a GIS specialist for the realisation in the charts sets of themes which rise from its analysis. We suggest that this type of treatment be systematic after each census. Information which it contains largely exceeds the interest which the only figure of the total population represents. A suitable treatment gives indications on:

- the precise composition by age and sex (which one can deduce the age groups - according to their sex - on or under represented)
- the age and the sex of the head of household
- size of the family
- its composition (children, and others)
- country and the ethnic origin
- the district and the province of origin
- the date of arrival in the camp
- the religion

The introduction of the censuses into a base of data allows many requests which can make it possible to answer precise questions; for example:
- which are the women who declare head of household which has between 15 and 20 years?
- how many children do they have?

or even:
- how many refugees belong to a precise ethnic group?
- from which districts do they come?
- where are they located in the camp

Concerning the statistical data itself we mentioned in previous reports:
- importance of a *good recording of the localisation* of the refugees in the camps (addresses),
- frequent confusions and the insufficient *rigour in the recording of the codes of district and province* of origin,

- need for a *regular updating of this coding* and the setting in conformity of the statement made by the refugees with this coding,
- the interest which information would represent on the *former professional activity of the refugees* in their countries of origin.

Research more recent carried out on the population of the camps of Dadaab revealed new difficulties which could be taken into account by the HCR:
- the census makes it difficult to understand *the real structure of the family* since neither polygamy nor the divorces or separations are not recorded,
- so the census does not make it possible to identify with certainty the single-parent families and in particular *the women alone* (accompanied or not by children or other people with load),
- in the case of the Somalian society, treated on a hierarchical basis in a very significant number clans, the ethnic membership is impossible to analyse without the support of an anthropologist specialised in the questions of relationship and genealogy. It indeed appeared that the refugees can declare an ethnic membership which corresponds, according to cases', on levels very different in the hierarchy of the clans.
- finally, *the regular treatment of the censuses of population*, such as it is proposed here, should make it possible to answer an important question. In case of camps stabilised - as it is the case with Dadaab - it would be very useful *to measure shifts in population year after year* in order to identify manpower of population stable (that which is present since the settlement of the camp), manpower of refugees which left the camp and manpower of refugees more recently made. A *longitudinal study on the stable population* would make it possible to provide essential demographic information (fruitfulness, mortality, birth rate).

I-2 : Exploitation of the aerial mosaics

The aerial mosaics of the refugee camps were to be used to answer the following requirements:

- cartography of the refugee camps,
- estimate of the populations by counting of the huts,
- results of the integration of maps and data in a GIS

On these three points, the principal conclusions are developed below.

1 - Cartography of the refugee camps.

The cartography of the refugee camps can be directly carried out digitising on the screen starting from the air mosaics. The choice of an adapted geographical projection gives to the user the insurance that measurements of distance and surface will have a certain reliability.
The choice of the elements to be digitised must be carefully considered according to its employment in a Geographical Information System. From the point of view of a cartographic representation of the censuses, it is for example important to distinguish the blocks in a specific layer since it is on this level that the direction ("address") of the refugees is recorded. This layer of information will have thus to be separated from the other forms of organisation of space such as the " green belts " or the various pieces of land allotted to the management of the camp (offices, schools, dispensaries, hospital, police station, market, etc).

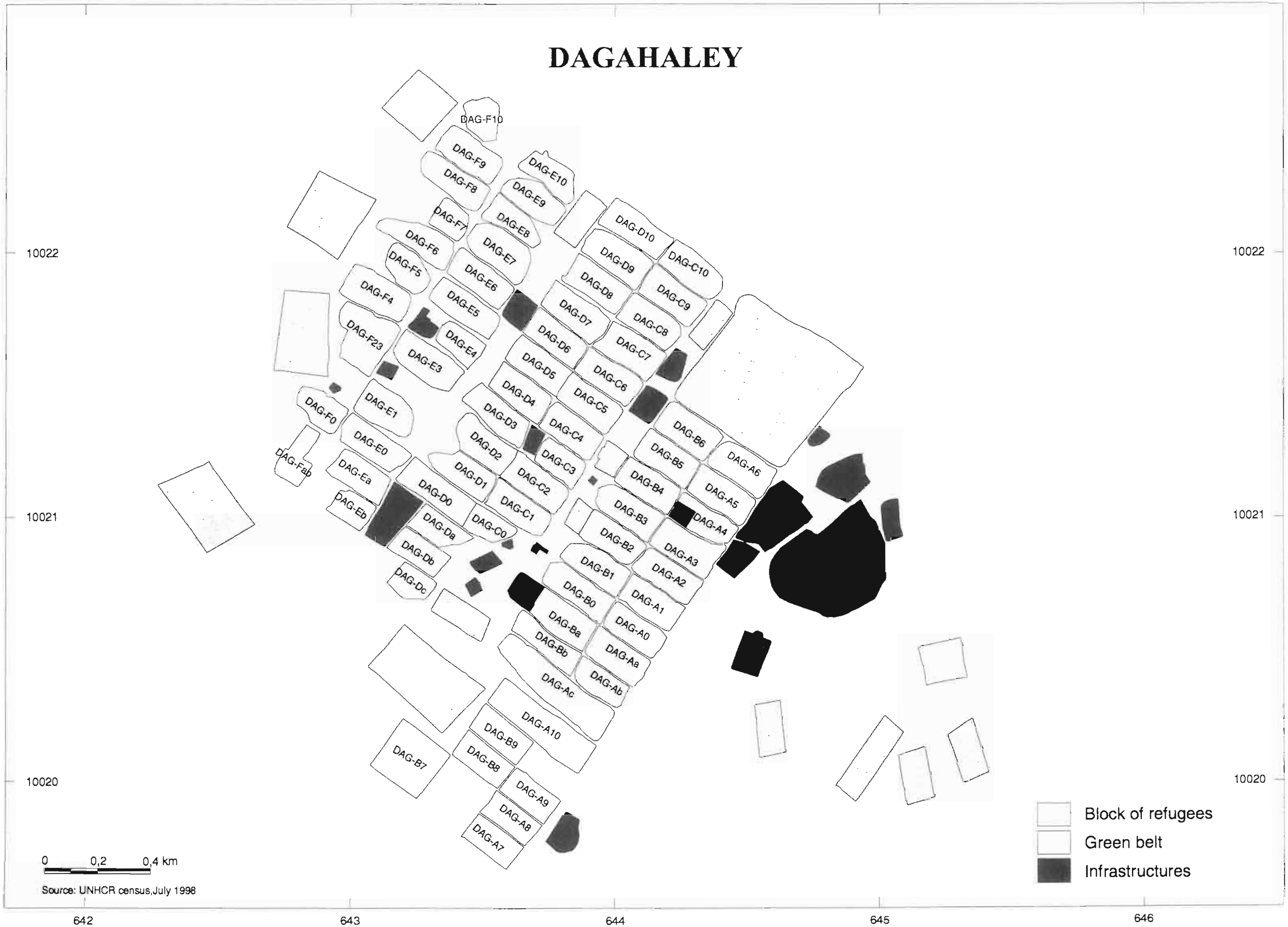
The "points objects" (and not zones) must also be digitised in a different layer of information. It is the case of the huts sheltering the refugees. Lastly, other data elements can be digitised in order to give a better legibility to the chart; that can be cultivated pieces, isolated trees, river or certain element of the relief (ridges, hill).

By the wealth and the diversity of information contained, the cartography of a refugee camp starting from an aerial mosaic is appreciably more promising than a traditional topographical survey. This method does not exempt of any fieldwork since it is necessary to know what is the pertinent information. For example, it is necessary to know the address or the code allotted to each block since it is by this code which the link between the chart and the census of population can be established.
The various maps as well as the statistics which accompany them (distances, surfaces) result directly from the integration of the aerial mosaics in a GIS. The map of the density of population per block illustrates the use which one can make of these charts for the representation of the data of population.

Camp	Block		
	Number	Area (ha)	Perimeter (m)
Dagahaley	73	200,3	50861
Ifo	71	267	52821
Hagadera	86	218,4	56753
Total	**230**	**685,7**	**160435**

Camp	Green belt		
	Number	Area (ha)	Perimeter (m)
Dagahaley	16	74,1	12742
Ifo	14	53,9	10813
Hagadera	25	67,6	17136
Total	**55**	**195,6**	**40691**

DAGAHALEY



DAG-F10
DAG-F9
DAG-F8
DAG-F7
DAG-F6
DAG-F5
DAG-F4
DAG-F23
DAG-F0
DAG-Fab
DAG-E10
DAG-E9
DAG-E8
DAG-E7
DAG-E6
DAG-E5
DAG-E4
DAG-E3
DAG-E1
DAG-E0
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DAG-Eb
DAG-D10
DAG-D9
DAG-D8
DAG-D7
DAG-D6
DAG-D5
DAG-D4
DAG-D3
DAG-D2
DAG-D1
DAG-D0
DAG-Da
DAG-Db
DAG-Dc
DAG-C10
DAG-C9
DAG-C8
DAG-C7
DAG-C6
DAG-C5
DAG-C4
DAG-C3
DAG-C2
DAG-C1
DAG-C0
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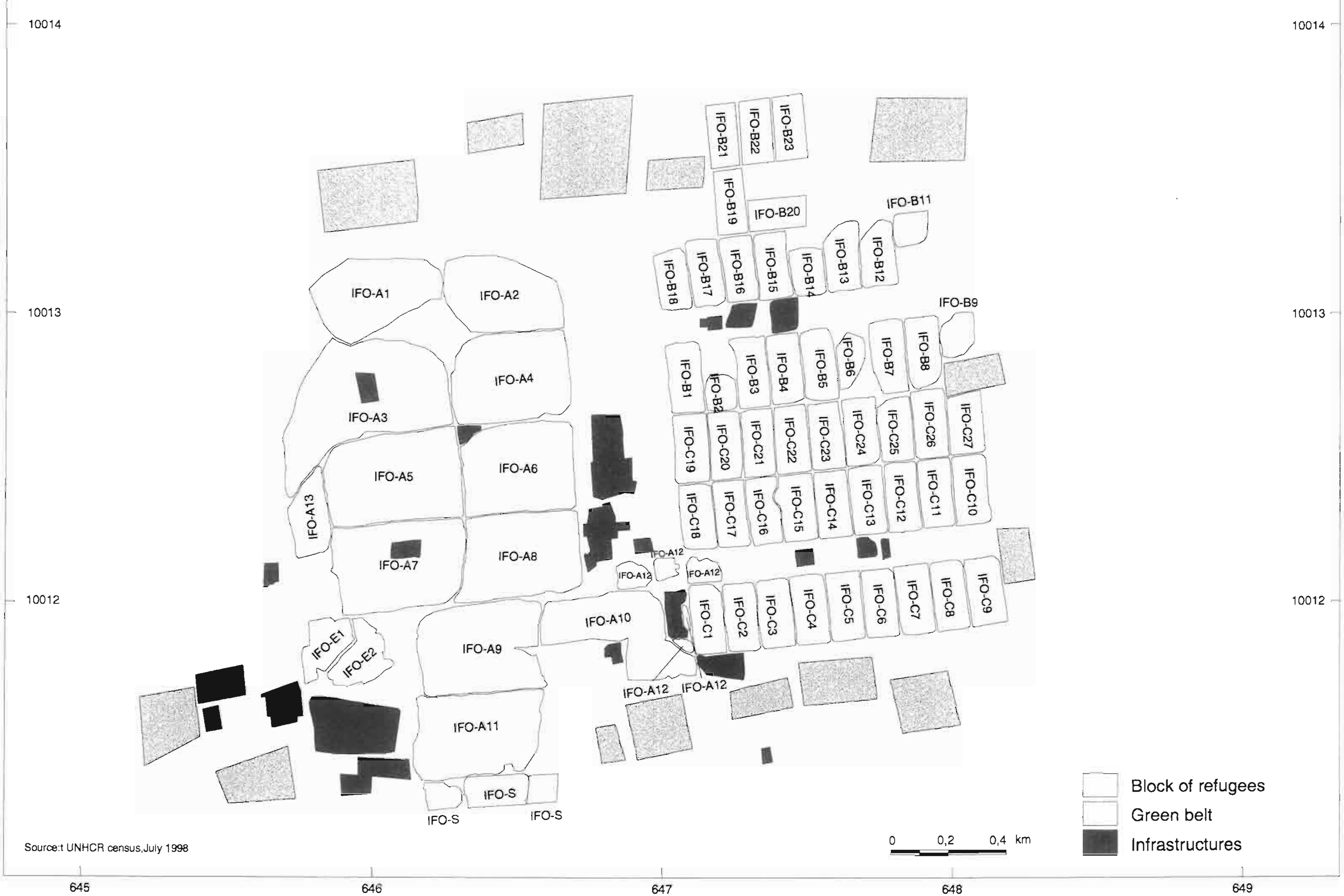
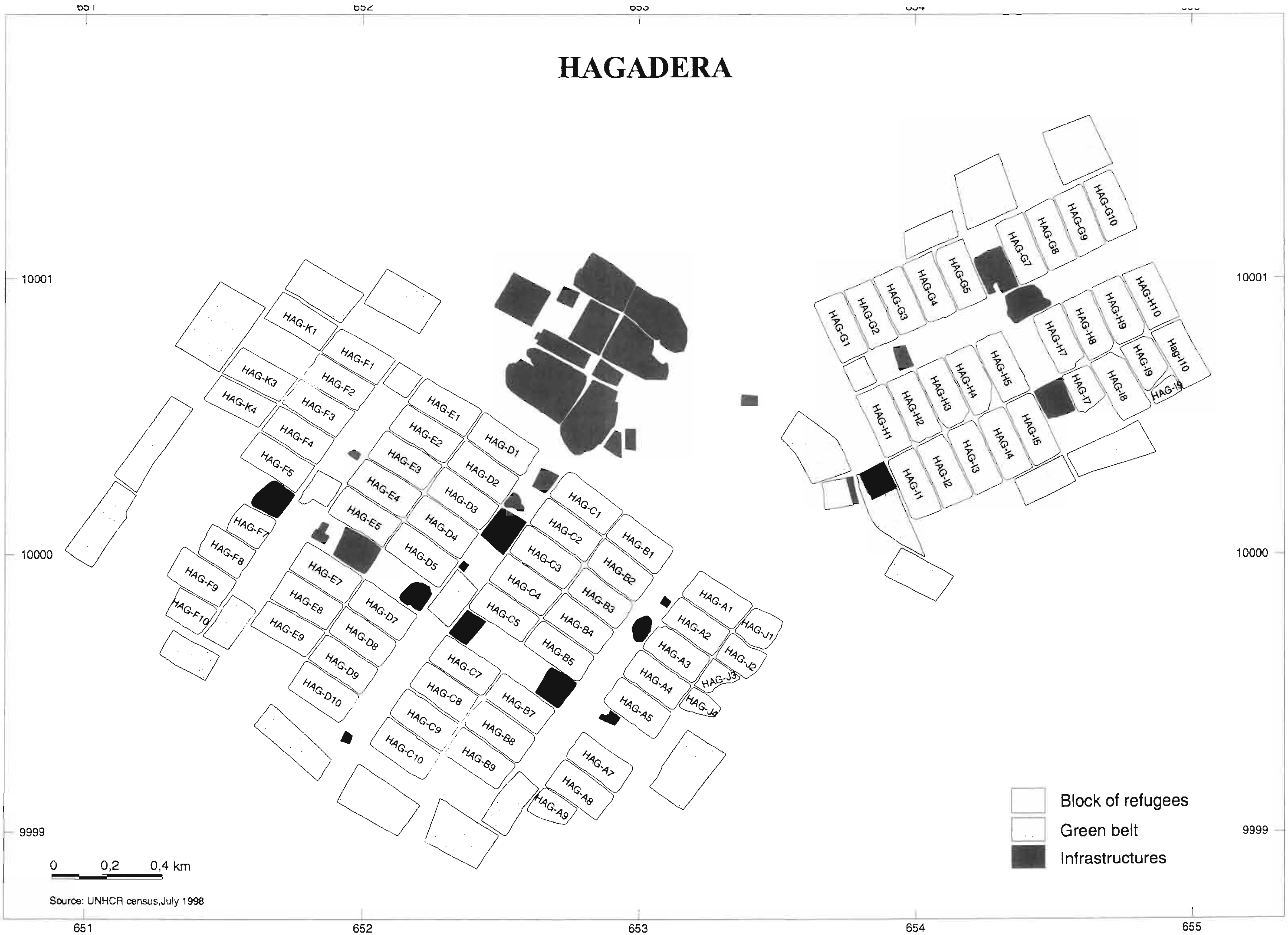
DAG-B5
DAG-B4
DAG-B3
DAG-B2
DAG-B1
DAG-B0
DAG-Ba
DAG-Bb
DAG-B9
DAG-B8
DAG-B7
DAG-A6
DAG-A5
DAG-A4
DAG-A3
DAG-A2
DAG-A1
DAG-A0
DAG-Aa
DAG-Ab
DAG-Ac
DAG-A10
DAG-A9
DAG-A8
DAG-A7
10022
10021
10020
642
643
644
645
646
0
0,2
0,4 km
Source: UNHCR census,July 1998
Block of refugees
Green belt
Infrastructures

IFO



Source:t UNHCR census,July 1998


HAGADERA
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652
653
654
655
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HAG-I2
HAG-I3
HAG-I4
HAG-I5
HAG-I7
HAG-I8
HAG-I9
HAG-I9
Hag-I10
Block of refugees
Green belt
Infrastructures
0
0,2
0,4 km
Source: UNHCR census,July 1998

Camp	Infrastructures		
	Number	Area (ha)	Perimeter (m)
Dagahaley	23	35,2	9457
Ifo	22	23,9	8989
Hagadera	36	39,6	13924
Total	**81**	**98,7**	**32370**

Camp		Total	
		Area (ha)	Perimeter (m)
Dagahaley		309,6	73060
Ifo		344,8	72623
Hagadera		325,6	87813
Total		**980**	**233496**

2 - Estimation of the populations

The first results summarised in the preliminary report of June 1998 had shown the limits of this method for a reliable estimation of the populations. The problems of identification of the huts because of the vegetable cover and the resolution of the image had been in particular mentioned. In addition, the enumeration of the huts resulting from the interpretation of the air mosaic had been compared with an investigation much older carried out by CARE. The comparison of the obtained results on the base of different dates posed obviously a problem of credibility of interpretation.

In July 1998, thanks to the support of CARE, a field survey was led in the two weeks which followed the flights realised to carry out the aerial mosaics. In roughly 10 % of the blocks[1], a precise counting of the number of shelters was carried out. The choice of the blocks was made on "transects" oriented from the centre of the camp (always densely populated) towards the periphery.
Same counting was carried out on the aerial mosaic directly on the screen of the computer. The results of this comparison are the following:

[1] The camp of Ifo differs from the camps of Hagadera and of Dagahaley where all the blocks have approximately same surface A Ifo, of A1 with A11, the blocks have a surface four times higher than the " normal " blocks.

Camps	Blocks	Number of shelters (field survey - 1)	Number of shelters Mosaic interpretation - 2)	Ratio % 1/2
IFO	A5	465	349	
	A11	578	238	
	B4	85	70	
	B13	79	51	
	C18	153	80	
	Total	1360	788	57,9
HAGADERA	A7	68	74	
	B8	87	103	
	C4	130	109	
	D1	198	159	
	E7	104	109	
	F5	104	91	
	G10	74	68	
	H1	115	86	
	I5	34	34	
	Total	914	833	91,1
Dagahaley	A7	124	47	
	B6	124	76	
	C3	159	76	
	D1	83	57	
	E4	54	34	
	F6	60	39	
	BB	149	91	
	Total	753	420	55,8

Observations:

· the number of huts identified on the aerial mosaics is always lower than the counting carried out on the ground,

· the difference between the two types of counting varies from 55,8 % with Dagahaley, 57,9 % with Ifo and 91,1 % with Hagadera.
· the weak success with Dagahaley and Ifo is explained by the conjunction of several phenomena: air mosaic of worse quality (clouds' shade), more abundant vegetation, strong mobility of Dagahaley population following the abandonment of some flooded blocks.
· Under very good conditions like those of Hagadera (good quality of the aerial mosaic, little vegetation), one can consider that this method is at least as reliable as a counting on the ground.

In addition the demographic data collected during the investigation of ground show that it is difficult to establish a strict relation between population and habitat and consequently, between the aerial photographs and the number of refugees.

Camps	N° bloc	1.1 Number of families	1.2 Population	1.3 Total shelters
Ifo	A5	426	1978	465
	A11	410	1536	578
	B4	66	225	85
	B13	53	233	79
	C18	138	562	153
Total		**1093**	**4534**	**1360**
Hagadera	A7	82	513	68
	B8	101	457	87
	C4	177	563	130
	D1	240	984	198
	E7	124	467	104
	F5	85	572	104
	G10	80	441	74
	H1	120	704	115
	I5	50	238	34
Total		**1059**	**4939**	**914**
Dagahaley	A7	262	1245	124
	B6	166	812	124
	C3	134	630	159
	D1	120	507	83
	E4	57	236	54
	F6	74	275	60
	BB	181	557	149
Total		**994**	**4262**	**753**

- the number of families per shelter varies from 0,8 in Ifo, to 1,15 in Hagadera and 1,32 in Dagahaley. These figures confirm the character more " installed " of the camp of Ifo and the crisis in Dagahaley caused by the closing of some flooded blocks.
- the average size of the family also varies in significant proportions: 4,14 inhabitants per family in Ifo, 4,66 in Hagadera and 4,28 in Dagahaley.
- Lastly, the number of inhabitants per shelter varies from 3,3 in Ifo with 5,4 to Hagadera and 5,6 in Dagahaley.

General remarks:
These variations are important. They are explained by the history of each camp, even of each block. Under these conditions, it is difficult to recommend the use of air photography (even of excellent quality) to lead to a reliable estimate of the population. These precautions do not diminish the interest of the air mosaics since they make it possible in a quick blow-of eye to locate the most important concentrations of population or, contrary, the slightly populated zones. The air mosaics in addition represent an incomparable advantage for the preparation of sample surveys (nutritional investigations, vaccine investigations, etc).

I-3 - Results of the integration of maps and data in a GIS

It is thus seen that the interest of the air mosaics of the camps varies according to the question which one wishes to answer. Those prove extremely useful for the cartography of the various elements of the camp (blocks, infrastructures) and for the later use which is made of these charts (planning, thematic cartography). They are of an limited interest for the estimate of the populations but nevertheless useful to visualise the distribution of this population. They are only of very specific utility for the environmental assesment (impact of the afforestation, cartography of the protected surfaces, live fences, erosion of the riverbanks (Kakuma).

It remains that these air mosaics have known a very sharp success as well near the UN and NGO's personnel as near the refugees. This success is not only due to the visual interest to consult a photograph. It is due in fact to the real need to locate itself and to have an overall vision of the refugee camps. Even when it is of the refugees or the personnel knowing best the camps, it is banal of saying that this global perception is impossible starting from the only knowledge of the ground. This request for a better knowledge of the reality of the camps - in all its dimensions - should not thus be underestimated. One can ensure that is the guarantee of a better dialogue between refugees and humanitarian personnel.

1.3.1 The GIS approach

GIS approach answers a major problem as regards storage, management and localised data processing (topographic thematic maps, aerial photographs or satellite images, localised statistics). The possibility of producing many charts starting from the information gathered and analyzed in the database makes GIS very powerful software. Insofar as the consolidated refugee camps constitute major elements in the organisation of space, GIS approach seems to be the best management tool of information.

However this choice makes sense only in two conditions: 1) - it must be possible to gather existing information; 2) – this information must always include the localisation. For example, it is interesting to know the number, the age and the sex of the children who do not assist to school. But if one wishes to draw up the chart of it, it is of course necessary to raise " the address " of these children (the block number for example).

In the camps of Dadaab and Kakuma the question of the localisation posed problems of two orders; that of the basic cartography of the camps ; that of the localisation of the information contained in the censuses of population (adress in the camp, district of origin, etc.).

1.3.2 Basic cartography and GPS survey

We saw previously that the GPS, the DGPS and the aerial mosaics make it possible to solve the initial absence of basic maps. In addition, the integration of the aerial images in the GIS make it possible to find the precise co-ordinates of any point (of the mosaic or of the map). The only true problem arose for the camp of Kakuma. There, following several investigations into the ground, it appeared that the organisation of the refugee population does not correspond to any spatial organisation. The population is organised in " groups " and not in block as it is the case in the camps of Dadaab. So there is no fixed division of space and the refugees belonging to the same group can find themselves dispersed in various parts of the camp. *A rigorous work of localization of these groups on the air mosaic should be undertaken.*

1.3.3 Demographic information and localisation

It is on the level of demographic information (collected at the time of the censuses of refugees) that the localisation posed the greatest number of problems. From this information, it is theoretically possible to produce many thematic maps either at the level of the refugee camps cartography, or at the level of province and district of origin. Several cases appeared.

1.3.4 The case of Kakuma

As it has been said, the basic map of the camp of Kakuma remains to be updated. Insofar as the air mosaic exists, the digitalisation of contours could be led only after one important survey to localise the "groups".
However, if the camp of Kakuma continues to increase - as it was the case in 1998 following the arrival of 15,000 somalian refugees (Kakuma 2), the realisation of a new air mosaic will have to be considered; of course it would suppose a new flight.

1.3.5 In Dadaab

In Dadaab, the basic cartography of the camps exists thanks to the aerial mosaics. Each block is indexed according to its number. Only a few blocks sheltering the Sudanese population, in the south of the camp of Ifo, have not been captured during the flight. On the level of the statistical data, the other difficulties are :

- non-existent or incorrect direction

In many cases, the recording of the block code has been problematic. This gap can have been the fact of the enumerators or, later on, at the time of the capture of the data in the computer. In this last case, the tiny mistakes generally could be corrected. Only the cases of absence of code or non-existent code without relationship with a close code could not be rectified (for example, confusion between O and 0).

These errors could be easily avoided in the future. It would be enough to carry out an exhaustive inventory of the codes of blocks *before* the realisation of the census. This list would make it possible each agent to check that the block number declared by the refugee really exists. This list could in addition be recorded beforehand in the software. Tests of validity with an automatic alarm would then make it possible to avoid this kind of mistakes

- Code district or province

From one census to another, information related to the geographical origin of the refugees can vary in important proportions. Thus, it was possible to locate on the maps of Somalia, Ethiopia and Sudan several thousands of refugees of the camp of Kakuma (see preliminary report, June 1998). In the case of Dadaab, because of the late handing-over of the census (February 1999) and very heavy work of validation of coding at the districts and provinces levels, this same operation could not be repeated. As in the report already quoted, the observations and the recommendations for the future are the following ones.

Quality of information.

At the various phases of the census - from the recording of the refugees to the capture of the data in the computer - several possible causes of errors appeared :

- confusion between the name of the district and that of the province
- ignorance of the refugee who can quote the names of a village or of a close locality which do not correspond to the name of the district.
- same name of district in various provinces.

The system of coding employed by the HCR can also be the cause of other errors:

- a district with several possible codes
- double coding for old and new names of districts or provinces.
- different spelling for the same unit

1.3.6 Recommendations

· At the time of the census, it would be desirable that each enumerator has an up to date list of the districts and provinces in order to check that the declaration of the refugees corresponds to the reality of administrative division.

· During the process of coding and recording of the data in the computer, the same list must be used. According to the history of each country, the " official " names of the districts and provinces must be compared with the list of the older names which correspond to the same units (Benadir for Mogadishu for example).

· in addition this list could be recorded beforehand in the software of seizure of the censuses. Tests of validity by an automatic alarm would then make it possible to avoid the errors of seizure (non existent code, double key , confusion between 0 and O, etc.).

Conclusion

The principal results of the treatment of the censuses of population of Kakuma and Dadaab are gathered in two separate documents.

1)- the first one relates to the statistical analysis of the principal variables usable (age, sex, relationship, clans, etc.). The majority of the tables deliver an analysis per block, which allows a mapping of these results (see point 2). These results are of a considerable interest for a fine knowledge of the population. Thus, can one easily identify and locate the principal anomalies of these populations (imbalance between sex, age groups missing, etc.). They show the evidence of a refugee population which is not homogeneous and that this heterogeneity must be taken into account by the qualified services (schooling, health, social assistance, repatriation, etc.).

2) - the second document gathers the principal thematic maps resulting from the census and carried out on the three camps of Dadaab. As one can note it, the statistical heterogeneity of the population, also finds its translation in a space distribution which is not random. The principal socio demographic characteristics vary from one block to another according to various criteria such as the ethnic group, the date of arrival, etc. This kind of graphic representation must be encouraged in the future. It should allow a better targeted humanitarian assistance and facilitate the sample surveys.

This type of treatment should be able to be repeated regularly after each new census of population. The exhaustive interpretation of these documents remains to be realized. It would make it possible to obtain detailed monographs of each camp which would be of a great utility as well for the humanitarian personnel, as for the visitors of (donors, journalists, etc.). In the immediate future, the personnel directly implied in daily management or the humanitarian assistance of the camps can use the existing base of data to integrate his own data and to provide a cartographic representation of it.