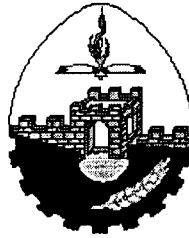


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**Applied Research Institute – Jerusalem (ARIJ)**

## **Impact of Urbanization on Land Use and Local Communities in the West Bank**

### **Final Technical Report**

**Submitted To**

**International Development Research Centre (IDRC)**

**This report is presented as received by IDRC from project recipient(s). It has not been subjected to peer review or other review processes.**

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## **I- INTRODUCTION**

The Applied Research Institute – Jerusalem (ARIJ) received a grant from the International Development Research Centre (IDRC) to conduct a research entitled "Impact of Urbanization on Land Use and Local Communities in the West Bank". The duration of the project was estimated to be two years starting November 23, 1998 until November 22, 2000. Due technical problems and at ARIJ's request, the Regional Director at IDRC – Middle East and North Africa Regional Office in Cairo, Egypt approved an extension of the project until March 22, 2001. This report describes the tasks that were accomplished during the different stages of the project.

The Palestinian Territories are in a critical political situation, especially with the on-going Al-Aqsa Intifada and the lack of any progress in between Israelis and Palestinians.

The interim agreement signed in 1994 should have been followed by an agreement on final status that will translate in recognition of Palestinian borders and make it possible for them to plan and control their own land and natural resources, including human activities and regional and international relationships.

At this stage, it is very difficult to predict the extent of changes that take many place in the political situation and its reflections on the demography and land use in the Palestinian Territories. This is particularly true of Israeli driven activities, such as land confiscation in order to build new colonies, military bases and bypass roads. The situation also affects the Palestinian's policies and plans for land use management and urban expansion. New technology such as GIS and remote sensing can assist in detecting, monitoring and expressing changes and difficulties in land use and natural resource depletion. Surveying the affected Palestinian localities on institutional and household levels is another beneficial tool assist in investigating the socio-economic conditions and land use activities in the targeted Palestinian Territories.

By making use of GIS and remote sensing technology and the outputs of localities and institutions surveys, ARIJ is undertaking the production of a specialized book. This book will give a comprehensive view on urbanization activities in the southern part of the West Bank (Bethlehem and Hebron Governorates). The book will contain information on the trends of urbanization that took place in the past 10 years. It will also provide useful recommendations for future urban land planning for both Bethlehem and Hebron Governorates.

## **II- PROJECT STAFF**

Sixteen employees worked on this project. Some of these employees were involved throughout the entire duration of the project while others participated in periods and phases. The mix of knowledge was beneficial to the project as the diversity of experiences and capabilities lent to a positive atmosphere of continuous evaluation, editing, reviewing and improving project activities and outputs.

The employees involved in this project possessed various scientific and academic backgrounds in the areas of GIS and, remote sensing, urban land use modeling, applied sciences such as environment sciences and agriculture engineering, natural resources management, social sciences and secretarial skills. Individual's roles in the project were classified as project coordinator, GIS specialist, research assistant, field researchers, data entry and secretary. The names, positions and the duration of working period in the project for each individual are listed in table 1.

During the project period, ARIJ invested in the project team through nominating two of them for postgraduate scholarships. Mr. Majed Abu Kubie' came back to ARIJ and joined the project staff last October after completing his masters of science in Geographic Information System from University of Portsmouth in the U.K. Mr. Nizar Qattosh has also returned to ARIJ and joined the project staff last October after completing his Diploma of Specialized Post-Graduate Studies in Environmental Management from the Mediterranean Agronomic Institute of Chania.

Both came back to ARIJ and significantly improved the project's activities and achievements through applying their new experiences and education.

In phase II of the project, Mr. Hanna Ma'oh who replaced Mr. Khaldoun Rishmawi and Mr. Iyad Al-Araj who replaced Mr. Qattosh from the first of October 1999. Mr. Ma'oh hold a Masters of Science in Urban Land Use and Transportation Modeling from McMaster University in Canada (1999). Mr. Iyad Al-A'raj returned to ARIJ last September after completing his Masters degree in Socio-Economic Information for Natural Resources Management in the Natherlands.

Mr. Rishmawi left the project at the end of September 1999 and Miss Sofia Sa'ed left the project at the end of August 2000 to pursue their studies for master degrees in Crete and the U.K., respectively.

**Table 1: Name, position, and duration of working period on the project by individual.**

No.	Project Personnel	Project staff	Duration of working period
1	Project Coordinator (50%)	Nader Hrimat	November, 1998 – March 2001
2	GIS Specialist (50%)	Khaldoun Rishmawi	November, 1998 – end of September, 1999
		Hanna Ma'oh	October 1999 – March 2001
3	Research Assistant	Mohammed Abu-Amrieh	November, 1998 – March 2001
4	First Field Researcher	Majed Abu Kubie	November, 1999 – end of July, 2000
		Sofia Sa'ad	August 2000 – end of August, 2000
		Jane Hilal	September, 2000
		Majed Abu Kubie	October, 2000 – March, 2001
5	Second Field worker	Nizar Qattosh	November, 1998 – end of September, 1999
		Iyad Al-A'raj	October, 1999 – end of May, 2000
		Faten Juniedi	June, 2000
		Nizar Qattosh	July, 2000 – March 2001
6	Data entry	Fu'ad Isaac *	November, 1998 – March, 2001
		Manal Da'od*	
		Suad Istabuli	
7	Secretary	Suha Nazal *	November, 1998 – March, 2001

\* Their salaries during the project were covered by ARIJ, as mentioned in the project proposal.

### **III- ACTIVITIES PROGRAMMED AND EXECUTED**

Many activities have been programmed and executed during the project period. These activities can be sub-divided into the following categories:

#### **1st. RESEARCH**

##### **Phase I ((First year): The Socioeconomic Study:**

##### **1- Selection of the target area and establishing the “plan of action” for the socio-economic survey:**

Two intensive technical meetings (September 28, 1998 and October 5, 1998) were held between ARIJ's project staff and the program officer, Dr. Dina Craissati, to decide the suitable “plan of action” for conducting the socio-economical survey and the urbanization study in the West Bank.

A decision was made to examine urbanization from a Palestinian point of view and to assess how both Israeli settlements and Palestinian built-up areas affect Palestinians territories.

It was decided that the study should span from September 1993 (signing of the Oslo agreement) and to referencing period.

It was also decided that the project would focus on two Districts in the southern part of the West Bank, namely Bethlehem and Hebron. Each would be taken as a case study.

The primarily GIS analysis immediately showed the importance of both districts. Bethlehem is under particular pressure to its land use in the western part of the district, being close to Jerusalem, where the highest population density is located. It includes also areas A, B, and C in addition to Israeli colonizing activities. In addition to the pervious land use constraints, Hebron district shows a special case in which H1 and H2 areas are existing.

## **2- Conducting the Socioeconomic Survey:**

Three different questionnaires were designed and developed for this survey under the supervision of Dr. Craissati and Miss Eva Warlond (Canadian socio-economic specialist) and Dr. Jamil Hilal (Palestinian consultant specialized in socio-economic studies). The questionnaires were designed and addressed to community leaders, households (to gauge the impact of Palestinian urbanization), and those affected by Israeli settlements.

The study addressed the period following the signing of the first Oslo Agreement in September 1993. This time frame was chosen in order to examine the effect of the Oslo Agreements on Palestinian urbanization and Israeli settlement activities. What is evident is that although there have been some short-term gains for the Palestinians, such as the recognition of the PLO and some Israeli withdrawal from the 1967 occupied Palestinian territories, the plight of the Palestinians persists.

Following are the titles of conducted questionnaires:

- ☐ Socio-Economic Impact of Israeli Colonies and Palestinian Urbanization on Neighboring Palestinian Communities, Questions for Community Leaders
- ☐ Socio-Economic Impact of Israeli Colonies on Neighboring Palestinian Communities, Household Survey
- ☐ Socio-Economic Impact of Palestinian Urbanization on Neighboring Palestinian Communities, Household Survey

All three questionnaires were pre-tested. After making the necessary modifications, the research team used GIS and remote sensing to asses demographic, house demolition and land confiscation data available at ARIJ in selecting the towns, cities and villages for the case studies. The questionnaires were conducted in twenty-eight selected sites (sixteen sites in the Bethlehem area, and twelve sites in the Hebron area); thirty cases were completed in eight towns, twenty-five in six cities and forty-three in fourteen villages. In total, ninety-eight cases were interviewed. Forty-nine cases were interviewed in the Bethlehem district and forty-nine in the Hebron district. Forty-two cases were investigated with the purpose of determining the impact of Israeli settlements on their life (twenty-one in the Bethlehem district and twenty-one in the Hebron district). Forty were investigated with regard to the impact of Palestinian urbanization on their life (twenty from Bethlehem district and twenty

from the Hebron district). Sixteen cases involved community leaders (eight from the Bethlehem district and eight from the Hebron district).

Care was taken to assure that female respondents would be included in the three types of case studies. However, the fact that the research team was entirely male restricted access to females interviewees. This aspect should receive more attention in future studies.

The case studies were selected in areas A, B, C, H1 and H2, with the aim of obtaining the maximum amount of data in the most proficient and economical manner. Originally, it was our intention to elicit responses from households directly affected by Israeli settlements and households directly affected by Palestinian urbanization or those directly affected by both. It soon became apparent; however, that this would be a difficult undertaking as all Palestinian households have in one way or another been affected by the building of Israeli settlements and the imposition of land use restrictions. So we decided to take a sample from towns and villages that had been directly affected by Israeli settlements, Palestinian urbanization or both. In the selection process criteria included size of community, the proximity to both settlements and Palestinian urban centers.

### **3- Data Analysis and report writing:**

The collected data from the three questionnaires was analyzed by using a SPSS software program.

Furthermore, four actual stories and cases about house demolition by the Israeli Military Forces in the study area as described by the owners of demolished houses were attached to analytical report.

The technical, description, and analytical components of the study are listed in the attached comprehensive report entitled **"Socio-Economic Impact of Israeli Colonies and Palestinian Urbanization on Neighboring Palestinian Communities in the West Bank"**

The drafted final report was submitted to the IDRC by the end of the first year with the technical and financial reports.

### **Phase II (Second year): Urban land cover spatial analysis and modeling:**

Different activities were conducted to accomplish the objectives of the second year as submitted to the IDRC with the technical report of the first year. These activities can be divided in the following categories:

- ☐ Data collection and surveying, from different available resources about natural resource and land use in the Palestinian Territories.
- ☐ The project team had visited the municipalities of targeted areas, meeting the specialists and collecting the available information and maps regarding the urbanization and land use in addition of getting the of master plans.
- ☐ The creation of different GIS land use layers from field investigations, available maps and aerial photos.
- ☐ Different SPOT Pan and Landsat TM for the years of 1990 and 1996 and aerial photos of 1995 were used in detecting the changes in land use, especially urban expansions.

- Following intensive technical investigation regarding the selection of suitable satellite images for the project and after Israeli Authority allowed the Palestinians to purchase satellite images of high resolution, but not less than 4 meters, ARIJ purchased Ikonos-2 (multispectral) satellite images.
- After many negotiations with the Israeli satellite images dealer, the project team succeeded in purchasing the Ikonos satellite images for the year 2000 with 4 meter spatial resolution and 4 bands, multi-spectral for Bethlehem and Hebron districts.
- Ground control points using the differential GPS were collected mainly to rectify Ikonos imagery to UTM 84-projection system to achieve the best geo-referencing. In addition, the collected ground points were used to assist the supervised classification process for the land cover.
- CORINE nomenclature classification system to the second level was adopted to classify the Ikonos and other satellite images. This resulted in getting a harmonized statistical and spatial database for changes in landuse and urbanization through different years for Israeli settlements and Palestinian built-up areas.
- The collected master plans for the different targeted areas were digitized and super-imposed on the analyzed satellite images detect the rate and directions of urban expansions in these master plans.
- Different resultant data on urbanization activities and changes in landuse were use in a special land evaluation and projection program. This program was of great benefit to monitor landuse changes and highlighted the sensitive areas. This helped the project team project the future changes in land use depending on the past and current trends.
- The resulted data were presented in a specialized report supported with analytical maps and figures for land use change in the targeted areas.

### **3. Technical activities, field surveys and data collection completed throughout the project.**

The work for this project was mainly based on fieldwork and surveys (in the household and Institutional) conducted by the project staff. In addition, data was collected from other various sources (e.g. literature, personal and official contacts and the Internet) as well as the analysis of satellite images and socio-economic data using the latest versions of GIS and remote sensing and SPSS software.

#### **1. Baseline Data**

The Master plans of targeted areas were collected, digitized, and super imposed over the current maps of land use and the political situation. All necessary data were obtained from ARIJ databases and other sources such as published books, atlases, journals, the Internet, published maps, maps from the Palestinian Authority, Palestinian municipalities and personal contacts.

In the socio-economic section of the project, the project staff relied completely on the data collected through the project survey and on 1997 census data published by the Palestinian Central Bureau of Statistics (PCBS). This data included the analysis of completed socio-economic questionnaires in addition to the total population, number

of households and districts in the targeted areas, and the number of building permits given since the beginning of the Palestinian Authority.

The available agricultural base map of 1987, statistical data, field surveys and the analysis of satellite photographs were used to produce the agricultural maps for the targeted areas.

The purchased Ikonos satellite images of year 200 and Landsat TM of 1990 and 1996 were used for landuse classification. Supervised classification for urbanization activities was implemented for the Landsat TM images, while CORINE land cover nomenclature system was implemented for classifying Ikonos satellite images.

A site suitability model was developed in GIS to identify the potential areas for urban development. The model makes use of the Spatial Analyst Model in ArcView and produce a suitability map from number of GIS grid layers according to a pre-defined criteria.

A linear regression model was developed for each of two target areas. The correlation equation for each target area is used to quantify the relationship between population growth and the amounts of urban development. The estimated models are also used to calculate the amount of land developed under a number of various population scenarios.

## **2. Field Surveys**

Differential GPS was used to determine the location and elevation (X, Y and Z), of human activities including Israeli colonies and Palestinians build-up areas, road systems, administrative boundaries, and vegetation types. GPS was also used to verify certain locations on aerial and satellite images.

Field surveys were conducted using a deferential GPS to collect ground truth points to geometrically rectify the Ikonos – 2 images.

The classification of green coverage from Landsat images and Ikonos was mainly dependent on field surveys and the actual ground investigation made by taking many geo-referencing points and using the digital camera to take documentary photos. This method of investigation allowed the researchers to measure the wavelengths reflected from certain cultivated or wild species of flora and measure their areas in the target area. A remote sensing technique called supervised classification was also used.

## **3. Analysis of Data Results**

In general, land use patterns are in part determined by natural conditions, environmental factors and Human activities. Also important are the distribution of human settlements, roads, and supporting infrastructure. Socioeconomic and political factors equally influence the type of land development that takes place in a given area. Thus, a natural outcome of these practices is the impediment of sound natural resource management schemes that will in turn have detrimental effects on sustainable development and render it virtually impossible to achieve.



The resulted data in the first year of the project life were analyzed and developed in an integrated report about the effect of urbanization activities on socio-economic conditions in Bethlehem and Hebron governorates.

In the second year the activities were focused on urban land, cover spatial analysis and modeling. Through analyzing different satellite images and the master plans of different urban sites of target areas a special model for land use evaluation in urban areas and the optimum sites for future urban growth were used. In addition, the project had focused on analyzing the trends of Urbanization and projecting future Development.

The obtained results were so valuable and gave the project team a potential to produces analytical maps for urban expansion in the last ten years and to project the future development in urban activities in the target areas.

This is the first time such a model for urban and land use analysis has been developed and used in Palestine we believe that it has the potential to be replicated in other areas of the West Bank. By expanding this research activity to the rest of the West Bank, we can assist the Palestinian planners and decision-maker with valuable source of information about the urban areas and prospectives for future development taking into consideration the socio-economic status.

Annex 1 contains two samples from the results of urban land use from the second year activities.

The first one: Modeling the Optimum Sites for Future Urban Growth.

The second: Analyzing the trends of Urbanization and Projecting future Development.

## B. CONSULTANCIES

During the project first year and for improving the project activities and outputs of the socio-economic part Dr. Craissati had advised ARIJ to employ a national sociologist consultant and she sent us her approval by E-mail message to add the consultancy cost (three thousand US \$) to the budget of the first year and to the total project budget as an extra expenses.

The consultant was so cooperative and he assisted the project team in designing and formatting the questionnaires, evaluating and analysis the results, and in finalizing the report.

## C. ADMINISTRATIVE ACTIVITIES

One technical report was submitted to the IDRC by the end of the first year. ARIJ's administrative staff has maintained contact with the IDRC managerial staff during the length of the project. Any problems faced by the project were discussed directly and solved in a cooperative manner. The positive cooperation appeared clearly through different technical and administrative meetings. This healthy environment of relations between both organizations resulted in improved project activities and achieved further progress in the outputs.

Due to political conditions and being late in getting the satellite images, ARIJ asked the IDRC to extend the project for four additional months. IDRC was generous and agreed on the extension, giving financial support to cover the activities of the extended period.

#### **IV. DISSEMINATION OF INFORMATION**

**1. Monitoring Land Use Changes:** Since the beginning of this project detecting land use changes in the targeted areas in particular and the Palestinian Territories in general, several politically induced circumstances have occurred. Therefore, ARIJ found it necessary to detect and analyze these incidents and disseminate information on them on its' homepage on Eye-on-Palestine site. After the beginning of Al-Aqsa INTIFADA ARIJ had decided to create, a new sub-site called Intifada Special. The project team succeeded in preparing several studies in the targeted areas about the Israelis destructive activities on Palestinian lands. These activities included land confiscation, demolishing houses, shooting houses, uprooting trees and confiscating agricultural lands to construct new by-pass roads, etc.

Each case includes a summary fact sheet about a certain activity, supplied with location maps, aerial photos, satellite images and images for the site involved. (Some of the published cases are attached to this report).

2. The resulted GIS and Remote sensing section, the socio-economic section and interpretation and recommendation section on the relationship between land use change, the availability of natural resources and their effects on socio-economic conditions were compiled in one big report. This report is the final draft and it is attached to this final technical report. After receiving and doing the comments of IDRC on the report, it will be translated to Arabic language and printed as a book.
3. This report is the final draft and after receiving the IDRC comments and doing them the report will be translated to Arabic and developed to a book.
4. A special workshop will be held to present the project results. The book will be distributed to the targeted municipalities and related ministries and NGO's.

#### **V. BUDGET**

See the attached financial report.(It is located in attached separated files)

### **Annex 1:**

#### **1. Modelling the Optimum Sites for Future Urban Growth**

So far, this research has given an indication of the significant changes, which have been brought about by urban growth over the last ten years. A shift in the land cover of the two study districts - Bethlehem and Hebron - has been qualified and quantified, and the socio-economic impact of urbanization on the Palestinian population investigated.

In the future, there will undoubtedly be further urban expansion in the West Bank. Given the current high levels of population growth, this expansion may be considerable. The purpose of this section is to model how this urban growth could best be accommodated in Bethlehem and Hebron districts. In particular, the areas most suitable for urban growth will be identified using a spatial GIS-based model.

### **Modelling Procedure**

The approach taken to model the most suitable land for urbanization was the sum weighted modelling approach. Factors that contribute to the suitability of sites for urbanization were carefully selected. The factors were limited to those which could be represented spatially, and hence for example demography could not be included.

The factors were assigned a weighting from 1 to 10 based on the extent to which they indicated a suitability for urban expansion (for which a 1 rating was assigned) and the extent to which they were indicated land unsuitable for urban growth (a 10 rating).

The key factors selected were as follows:

1. *The classification of land as Areas A, B and C*
2. *Water sensitivity*
3. *Land use cover (derived from IKONOS scenes), including agricultural areas that should be maintained and conserved*
4. *Master plan (land zoning restrictions).*
5. *Soil type*
6. *Urban zoning system*
7. *Slope*
8. *Distance from the city centre*
9. *Accessibility*

Model formulation began with the development of a spatial database for Bethlehem and Hebron districts. GIS data for all the parameters that contributed to the model were arranged and identified in a way that suited the modelling processing. GIS layers were produced for each of these variables from existing linear GIS data (Polygons) and from grid data (DTM).

Although the model is fairly simple and weighting factors were subjectively assigned, the results are a useful starting point from which to identify the most appropriate sites for future urban expansion and development.

### Site Suitability Model Evaluation

This section is devoted to discussing and evaluating the results of the weighted modeling technique. The modeling was carried out for both Bethlehem and Hebron study areas. Two models were created; one that considers the Israeli existence as a fact on land and one that postulates a withdrawal of Israel from the occupied territories. The results of the models were compared with the future urban trends in order to estimate the sustainability of each model to accommodate population growth rates.

#### *Bethlehem Model One Evaluation*

Model one integrates nine factors. These parameters are listed as follows: zoning, accessibility, master plan, water sensitivity, soil type, distance from city center, land use / land cover inventory, slope and area A/B/C. The model takes into account the Israeli existence in the Bethlehem area as a constraint on the Palestinian urban development. This factor is represented in the land use / land cover inventory in which the Israeli colonies are considered as areas not available for Palestinian urbanization. The Israeli constraint is also represented in the division of the district into Areas A, B and C, in which Palestinian urban development is limited to Areas A and B (where the PNA has full or partial control).

Using the representative grid cover values for each factor the sites most suitable for urban development could be modeled. Using the map calculator functionality the coded grid covers were added, resulting in the final cover given in map 1 that represent potential sites for urbanization. Table 1 shows the area of each class in the thematic map (Map 1), from areas with a high potential for urbanization to those with only a low potential. The first three levels are the most suitable sites for urbanization.

Using the model it is possible to examine the degree to which current urban development has occurred in the most suitable locations. Superimposing the current built-up areas analyzed from the IKONOS scenes over the site suitability model thematic map shows out that many of the Palestinian and Israeli localities have been constructed over areas with low potential for urbanization. This is evident for example in the localities dispersed over the western and south-western regions of Bethlehem district (shown in Map 1).

The model therefore provide a good opportunity to reevaluate or assess the development of the Palestinian built up areas and to sketch new master plans to accommodate future urban expansion. In addition, the model has the power to depict the areas with high potential for urban development. These areas are distributed on the peripheries of Bethlehem city center. Map 1 shows that the potential for urbanization increases towards the southern and eastern slopes as the areas favored for urban development.

It is calculated that the total area suitable for urban development equals 33,381 dunums, taking the first three levels as areas with the optimum suitability for urbanization. However, large areas of these sites are currently occupied by urban land cover. This obviously limits the area available for future urbanization.

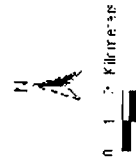
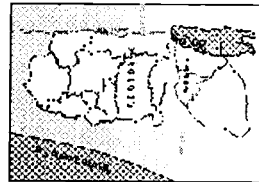
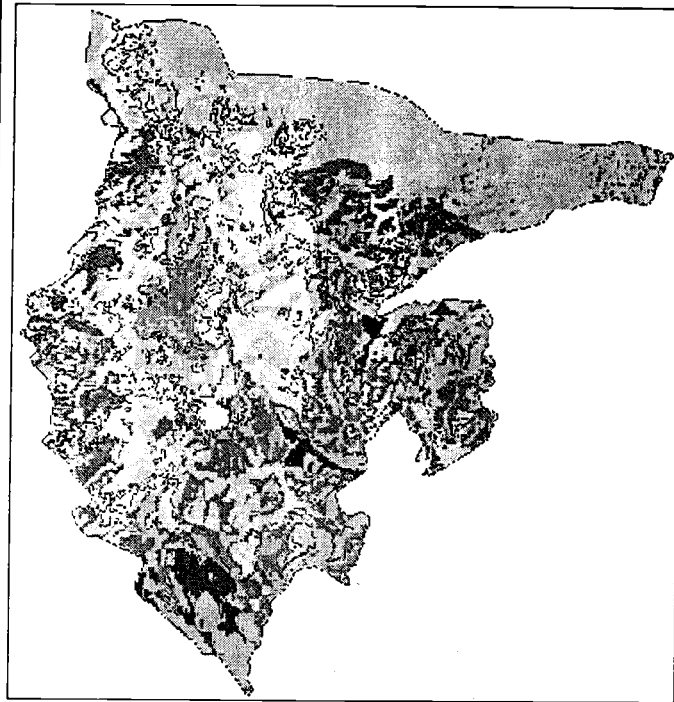
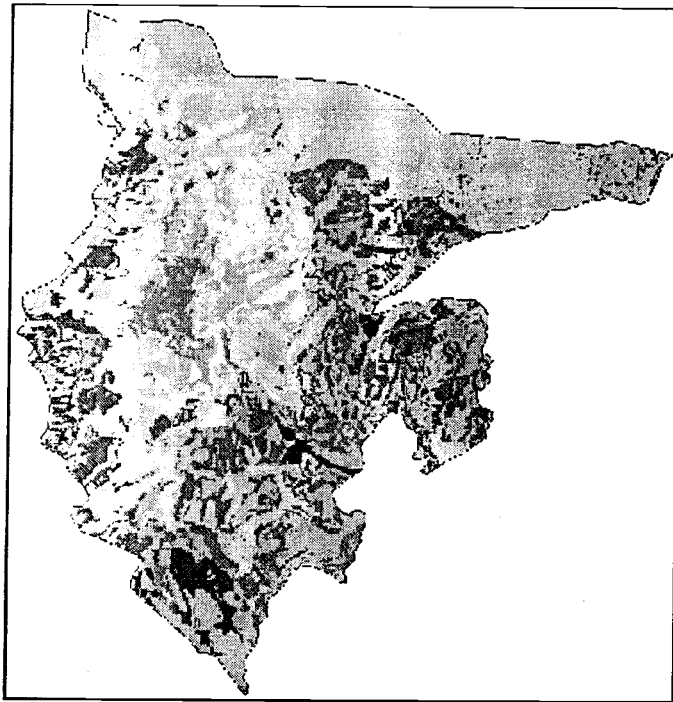
Superimposing the current Israeli colonies over the model shows that most of the Israeli establishments are constructed over areas with low suitability for urbanization (see Map 1). Most of the Israeli colonies are built over areas with grid values of 6,7 or 8, which represent highly sensitive regions. Hence building in these regions may well have a negative impact on the natural land and water resources.

The current total area developed in the Bethlehem area is estimated to 35 thousand dunums. This area is more than the total area of land (33 thousand dunums) which is classified as having a high suitability for urbanization. However, there is clearly a mismatch between the spatial distribution of the sites suitable for development and the sites where development has taken place.

In conclusion, the model suggests that the area of land which is suitable for urban growth, under the current political situation and with the current master plan boundaries, will not accommodate future population growth. Comprehensively, Bethlehem urban areas needed for future projections are discussed in urban trend section. The analysis poses many issues and concerns regarding the need for new potential areas for urbanization. This can only be possible by formulating new policies on land management to overcome the high population growth in the Bethlehem district.

**Table 1: Bethlehem model one results**

<b>Grid-value</b>	<b>Potential urbanization</b>	<b>of Area (dunum)</b>	<b>Percent</b>
1	High Potential ↓	4599	2.12%
2		11042	5.09%
3		17740	8.17%
4		26875	12.38%
5		72515	33.40%
6	Low Potential	45989	21.18%
7		30700	14.14%
8		7638	3.52%
<b>Total</b>		<b>217098</b>	<b>100.00%</b>



Public: Forest, Inland, and Marine  
GIS and Remote Sensing Unit, 2001

### *Bethlehem Model Two Evaluation*

This model is based on the assumption that the Palestinians sign a peace agreement with the Israelis in the near future, and that the Israelis subsequently retreat back to the pre 1967 border. By modeling a scenario in which the constraints imposed by the Israeli occupation are not present, the model can be used to investigate the impact which the Israeli existence has on Palestinian urbanization and the land available for urban development. The model was formulated by removing the factor that represents Areas A, B and C from the model and by assigning a low value for the current Israeli settlements to promote Palestinian urban developments in these regions.

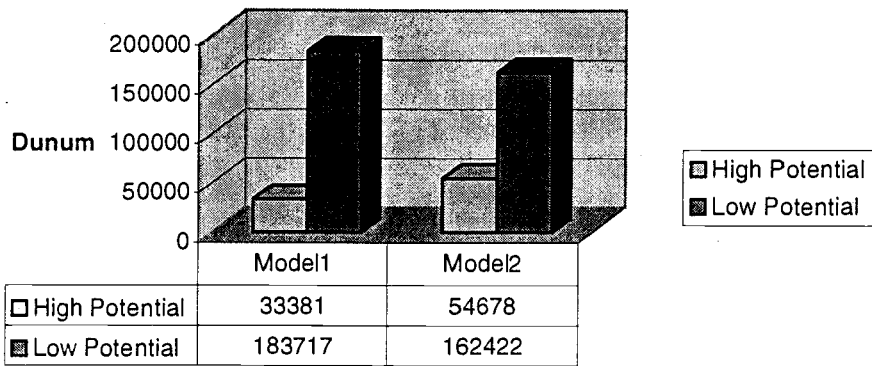
The results show that the area suitable for urban development is significantly increased in comparison to the first model (Map 2). The area characterized with high potential for urbanization is estimated at 54678 dunums (Table 2), an approximate 21,297-dunum increase from the scenario represented in model one (Figure 1).

This model therefore indicates the impact which the Israeli presence has on restricting the areas suitable for Palestinian urban expansion. Under the pressure of high population growth the area available for urbanization is decreasing every year. Thus, the increase in the area of high suitability for urbanization projected in this model scenario offers considerable potential for Palestinian expansion in order to accommodate this population growth.

1. Table 2: Bethlehem Model Two Results

<b>Grid-value</b>	<b>Potential urbanization</b>	<b>of Area (dunum)</b>	<b>Percent</b>
1	High Potential ↓	7964	3.67%
2		15714	7.24%
3		31000	14.28%
4		78555	36.18%
5		47672	21.96%
6	Low Potential	30183	13.90%
7		6012	2.77%
<b>Total</b>		<b>217100</b>	<b>100.00%</b>

**Figure 1: Bethlehem site suitability models comparison**





## 2. Analyzing the trends of Urbanization and Projecting future Development

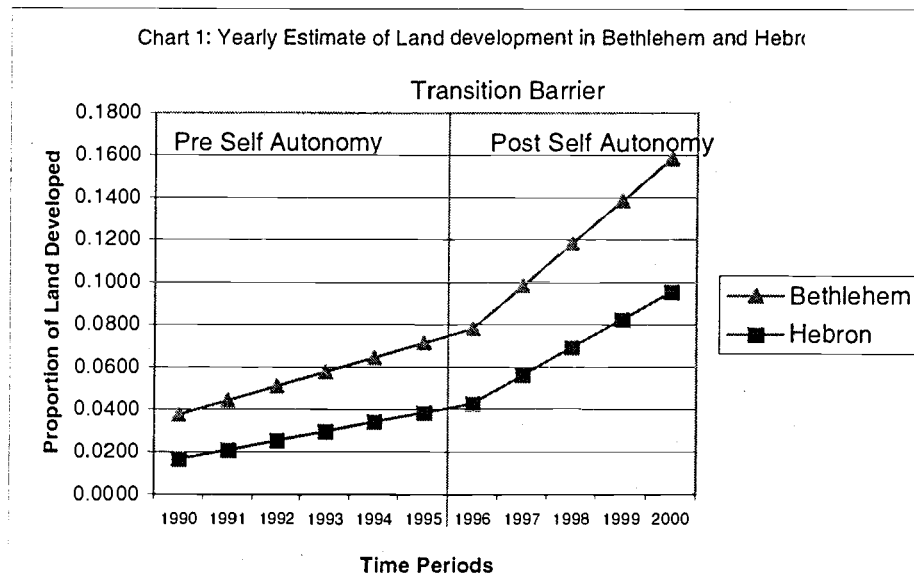
### Objective:

The main objective of this task is to use the time series data resulted from the GIS and RS platform to observe the trends of urbanization in Bethlehem and Hebron in the past 10 years. These data sets will be used to quantify the relation between land development and the population growth. Therefore, a statistical model correlating the amount of land developed with the population growth is estimated in order to forecast future urban development in the two study areas under different population scenarios.

### Approach:

In analyzing the trends of urbanization, the GIS and RS tools were used to extract time series information on the urban land developed in Bethlehem and Hebron. The data included the analysis of LandSat TM images for the years 1990, 1996 and 1998 and IKONOS satellite images for the year 2000. The data extracted were used to obtain the yearly estimates of land developed between 1990 and 2000.

The estimated yearly data were sketched to observe the trend of urbanization in the past 10 years. The trend showed two main periods of land development. These are 1990 – 1995 (Phase I) and 1995 – 2000 (Phase II). Phase II shows higher growth rates of land development, which postulates that the Palestinian land development is a function of the political situation. The high growth in land development took place after the Palestinians started ruling their own land as a result of the Israeli-Palestinian peace process and the self-autonomy. Chart 1 presents the yearly trends of urbanization in Bethlehem and Hebron in the past 10 years.



### Results:

The data on the amount of land developed since 1996 were used to estimate an empirical formula to quantify the relation between population growth and the amount

of land developed in Bethlehem and Hebron. In this context, two regression models<sup>1</sup> were estimated one for each of the two target areas. The population figures were utilized from the PCBS publications (1999)<sup>2</sup>. The two models show a high correlation between land use development and the growth in population. The Models also shows a high goodness-of-fit given the existing data.

The two models are then used to test three population scenarios in year 2005 and 2010, these are:

- Low growth scenario
- Medium growth scenario
- High growth scenario

Table 1: Population Scenarios

	2. Scenario	Population Natural Growth Rate	Population 2005	Population 2010
Bethlehem	<i>Status Quo (Population = 130,361) *</i>			
	Low Growth	3.50%	170,773	209,881
	Medium Growth	4.00%	178,595	225,525
	High Growth	4.50%	185,113	241,168
Hebron	<i>Status Quo (Population = 385,165) *</i>			
	Low Growth	3.50%	504,566	620,116
	Medium Growth	4.00%	527,676	666,335
	High Growth	4.50%	546,934	712,555
<i>* Source: PCBS, December 1999</i>				

The outcome of the scenarios suggest that urban growth is likely to occur under any of the above three scenarios. However, the positive relation between population and land development indicates that the highest development will occur in the high growth scenario. The results indicates that the urban growth will be doubled in 10 years in the high growth scenario utilizing about 34.31% and 22.66% of the original target areas in Bethlehem and Hebron, respectively. Chart 2 presents the results from the three tested scenarios.

Table 2: Urban land developed in year 2000

Target Area	% Urban land development	Area (dunums)
Bethlehem	15.84	34536.74
Hebron	8.43	72695.58

<sup>1</sup> Bethlehem Model:

$$D(t) = -0.368 + 3.6E-6 P(t)$$

Hebron Model:

$$D(t) = -0.253 + 7.9E-7 P(t)$$

Where:

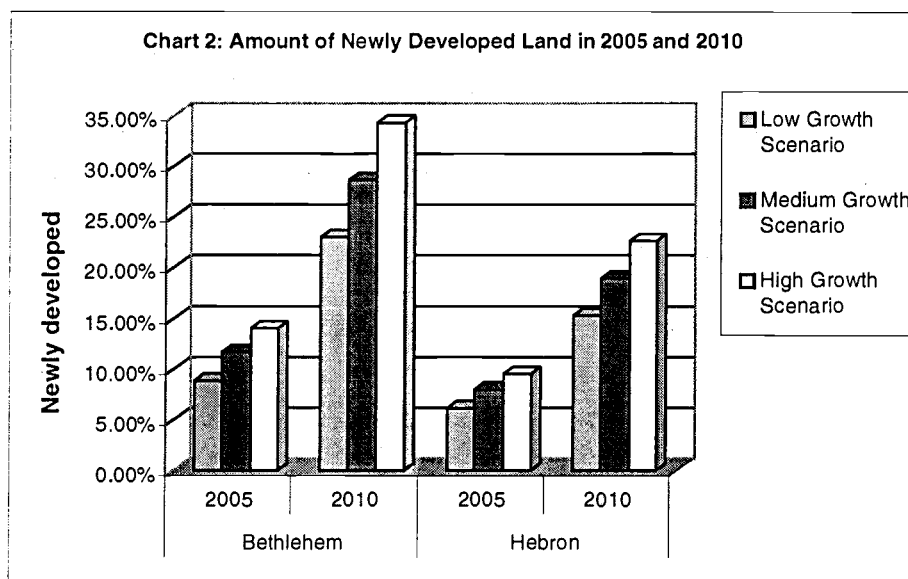
$D(t)$  – is the fraction of land  $R$  developed for urban use at time  $t$

$P(t)$  – is the population of region  $R$  at time  $t$

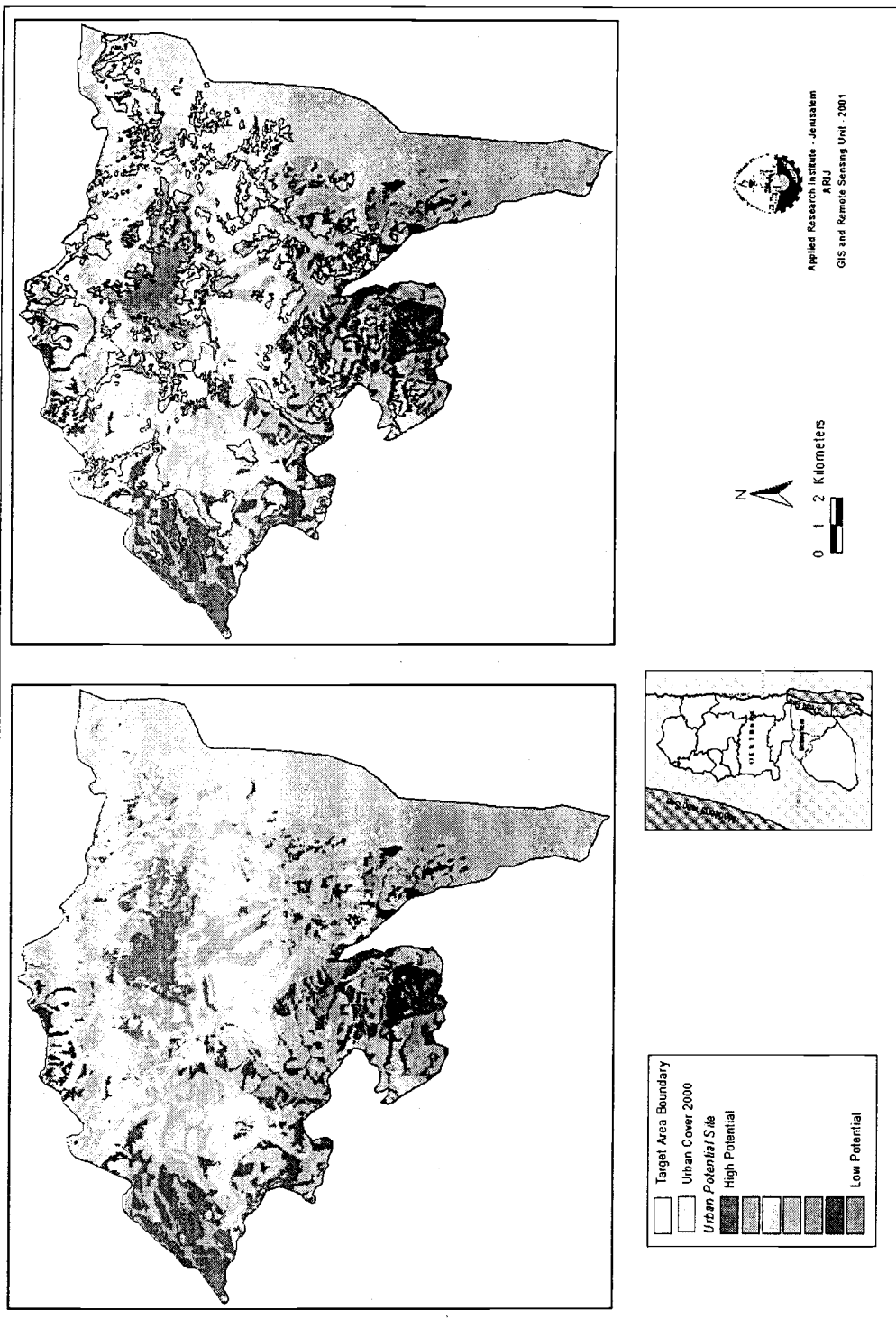
<sup>2</sup> Source: Small Area Population, 1997 – 2010. Palestinian Central Bureau of Statistics, December 1999

Table 3: Amounts of urban Land developed under the three tested scenarios

<b>Bethlehem target Area (218034.94 dunums)</b>				
	<b>2005</b>		<b>2010</b>	
3. Scenario	%	Area	%	Area
<b>Low Growth</b>	24.74	53950.32	38.86	84729.02
<b>Medium Growth</b>	27.57	60106.06	44.51	97040.50
<b>High Growth</b>	29.92	65235.84	50.15	109351.99
<b>Hebron Target Area (862343.77 dunums)</b>				
	<b>2005</b>		<b>2010</b>	
4. Scenario	%	Area	%	Area
<b>Low Growth</b>	14.62	126097.35	23.77	204978.89
<b>Medium Growth</b>	16.45	141873.66	27.43	236531.51
<b>High Growth</b>	17.98	155020.59	31.09	268084.12



Bethlehem High Potential Area for Urban Development Model 2



**Project title: Impact of Urbanization on Land Use and Local Communities in the West Bank**

**Centre File: 98-8601**

**Financial Report for the period from 23.11.2000 to 22.3.2001**

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	<u>US\$</u>	<u>CAD\$</u>
<b>Personnel<sup>1</sup></b>		
Project Coordinator		
Nader Hrimat (50%)	3,278.99	4,979.80
Gis Specialist		
Hana Ma'o (40%)	1,694.51	2,573.45
Research Assistant		
Mohammad Abu-Amrieh (70%)	3,328.75	5,055.37
Field Workers		
Nizar Qatoush ( 5 Months)	3,955.24	6,006.82
Majed Abu Kkobe'a (2 Months)	3,715.43	5,642.62
<b>Subtotal</b>	<b>15,972.91</b>	<b>24,258.06</b>

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<sup>1</sup> The total amount of the supplementary grant of up to 10,600 CAD (6,979 US Dollars, was used to cover the personnel salaries during the extension period. The rest was covered by ARIJ own account.