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Environmental Impacts Assessment and Horizons of Rehabilitation of Abandoned Limestone Quarries

A Case Study from
The Southern Part of the West Bank

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Dedication

To the memory of my dear uncle Hajj Adel AbuKhalaf and my dear grandfather Dr.Hafez Abdel Nabi.

To My Parents, for an achieving dream, for her prayers, that were always helping me, I love you.

To My Parents thanks for love, patience and precious support.

To my brothers and sisters for their support and love.

To My nephews and nieces, Thanks for being the happiness of my life.

To My Cousins specially Haitham AbuKhalaf and Bisher Shaheen.

To all my friends.

To Jerusalem and Hebron.

Motasem

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Motasem Abu Khalaf

Table of Contents

Abstract

The stone quarries in the West Bank were long excavated to meet the increasing demand for building material. Until to date of this search, there exist no plans for post-quarrying use of the abandoned sites. Quarries that are left untreated after closure cause extensive land disturbances and have negative safety and environmental impacts. The impact is ranging from the removal of the original ecosystems, the significant change of the original topography, the irreversible disruption of the fundamental ecological relations, and the reduced biodiversity.

The core of this study is the evaluation of the environmental risks resulted from the stone quarries in the southern part of the West Bank are and the aspects of rehabilitating abandoned quarries and their future designation land use, emphasizing the theme of abandoned quarries in the study area.

The area of interest of 80 km^2 was determined and delineated based on the distribution of quarries and the surrounding urbanized clusters. Quarrying sites are divided into nine clusters and about fourty quarries outside these clusters. Each cluster was delineated and described in terms of its area and the number of quarries. The location of each quarry outside and inside cluster was also determined using aerial photographs.

To provide the data necessary for the assessment of environmental risks and land-use planning tools, the physical and demographic statuses of the area were described. The quarry were examined and potential impacts on the surrounding land-uses were identified during a site visits to the area. Various thematic geographic features have been included in the analysis and evaluation of the quarries negative environmental impacts.

The following environmental impacts were addressed according to the collected data:- (Environmental Pollution which includes"*air pollution/Noise pollution/water pollution/soil pollution*";effects on land use;effects on biodiversity;effects on landscape and socio-economical effects).

During the study period, many site and field visits were carried out to several abandoned quarries in the study area. In the other hand, several visits to the Municipalities of the main three cites of our study area were carried out.

A literature survey for all the related material to stone and marble industry was carried out since the beginning of the research. It included the publications of the Stone and Marble Industry Union and other applied researches published by researchers from the local universities and scientific institutions, publications of the Environmental Quality Authority (EQA), Ministry of National Economy, Ministry of Agriculture ,Municipalities of the four towns and the Palestinian Central Bureau of Statistics (PCBS).

As to the area delineation part, a detailed, intensive and comprehensive work using the Geographical Information System (GIS) was done, the physical and demographic statuses of the area were being described. The quarry sites and their areas have been examined. Physical features and population data for the whole area were collected and inserted into the GIS structure. These data could be displayed as follows:-(*Land cover/use, topography, soil, geology, main and local roads and the built up area clusters*).

Final recommendations have been divided into general long term addressed to governmental and planning bodies and Practical short term recommendations are addressed for any organization which can sponsor implementing rehabilitation programs for some of the recommended sites.

The ranked post-closure uses proposed in this study response to the specific land use needs are: land reclamation for agricultural purposes or development projects (playing fields with retail services, gardens, composting facility, temporary water reservoir, housing units and health center).

According to the collected data and analysis, the optimal land use of these abandoned quarries was determined according to the characteristics of their nearby environment and their physical and demographic status. In the present study, an environmental database was created by using Geographic Information Systems (GIS), and by cross-checking data of abandoned quarries and their location according to different designated planning areas with the locality development priorities and needs that were set by the administrative authorities of the surrounding area.
The research findings show that more abandoned quarries are located in areas designated for conservation than in areas intended for development projects. Therefore, abandoned quarries that are located in conservation areas should be rehabilitated as open spaces. Those in urban and rural areas should be rehabilitated as development projects, or as open spaces and agricultural land uses, or as combined land uses.

1. Introduction.

Over the past decade, Palestinians have become increasingly aware of their relationship with the environment and the role they can play in preserving its integrity. Residents in most areas of the West bank and Gaza Strip have sought a greater share in decisions that may affect the environment and their quality of life.

It is well known that the preventive measures to environmental protection is truly cost effective, in comparison to finding a cure after the fact. Ensuring that these measures are addressed at the earliest possible stage of development planning is widely recognized as the best way to proceed.

During the last decade, the West Bank and Gaza Strip have both witnessed a noticeable development in industries related to construction shortly after the emerging of the Palestinian National Authority (PNA).The increase in construction of new buildings for houses schools,hospitals,etc.,was also necessity arose from the natural population growth and the growth in demand.

Building stone is one of the essential building materials that is increasingly demanded. Such increase in demand lead to establishing new stone quarries in traditionally chosen areas for quarrying activities. These quarries had produced the Palestinian stone which proven to have many good properties like hardness, attractive colors, etc. However, quarries were randomly established without any territorial or environmental planning. They were mainly established on natural grassland and some of them are recently established on agricultural area and urbanized zones. With time all topsoil was lost, and the land became barren and desolated, where nothing grew. Considering the national economic values of quarries, Palestinians have compromised the environment and ecology of the areas.

Quarries play a key role in a region's vitality. Opened for a decade or more of operation, they not only constitute a source of direct employment, but also contribute to the creation of lasting business relations among local economic players, such as suppliers, processing industries, hauler and customers(LAFARGE,2004).

The Palestinian stone found along a hill where they are located miles upon miles in the range which passes through the West Bank is a mainstay of the battered Palestinian economy. Palestinian stone, has been used throughout history to build some of the most notable structures in the Middle East, such as the Aqsa Mosque, the Dome of the Rock in Jerusalem and the Church of the Nativity in Bethlehem..
According to Stone Statistics, Palestine contributed approximately 1.8 % of the world stone and marble market in 2002 (The Palestinian Union of Stone and Marble Industry-USM,2009). The Palestinian Union of Stone and Marble Industry has estimated that the country's annual Production is estimated at 22 million m^2 ; this figure can be increased to 32 million m^2 using the existing capacity.The average annual sales is estimated at 600 million $. The local market demand for Palestinian stone is in excess of 150 million dollars (USM,2009).

The Stone and Marble industry is considered as one of the most significant and most active industry in Palestine, as this sector contributes approximately 25% to Palestine's overall industrial revenue and 4.5% to the total Palestinian GNB and 5% of the Gross Domestic Product (GDP). There are also about 25 thousand workers whom are employed directly in the industry and thousands of workers who works in the supportive sectors (USM,2009).

Stone making is an important contributor to the Palestinian economy, it provides a source of income for many families and investors and also helps ease unemployment through providing work in this industry.

The Palestinian Stone production is the 12th largest in the world, which is remarkable considering the small sizes of the Palestinian territories *(Marble-Stat 2002)*. The Palestinian output from the stone and marble is 4% from the whole world outputs, almost double as large as Germany's production, half that of Turkey and 70% of the Americans'. The Palestinian stone has a prestigious reputation among the world; this is due to its sacredness as it's extracted from the Holy Land and also due to its attractive colors, such as (yellow, gold, white, creamy, red and blue…) in addition to that, most stone types meet international standards and specification.
Only 25% of the production consumed domestically, the rest reminder is being exported to international markets in 33 countries (USM,2009), such as:-

The United States, France, United Kingdom, Germany ,Korea, Japan, and the Arab Gulf States.

The average annual sales per employee are approximately $40,000, a figure five times the average productivity per employee across all industries in West Bank/Gaza (USM,2009).Technology in use is mostly semiautomatic (85 %) and automatic (15 %). Almost 95% of raw material comes from local sources and the annual growth rate is about 10%(USM,2009).
Palestine has a rich, natural reserve of colorful, multi-purpose, soft and hard limestone. Stone quarries situated across the West Bank extract Palestinian stone as raw blocks for processing into f
The total number of facilities in the West Bank and Gaza are about 1124, between the quarry, the factories and the workshops (USM,2009).

Quarries for building stone are widespread in the West Bank and mainly concentrated in the Hebron District. The amount of investment in this sector is the highest in Palestine.
The establishments in the sector are spread all over Palestine. More than half of the establishments are located in the southern region of the West Bank, in Hebron and Bethlehem.(USAID,2006)

Palestinian stone is found all along the chain of the Palestine Mountains, but marble and stone production is located in the south of Palestine .mainly, in the Hebron District. Where there is a large amount of stone , some is being already used and some has been stored to be used later. The stone is considered by some as a national treasure and by others as the white gold for its economical values.
Palestinian West Bank marble and stone is known for its high quality.
It is highly water resistant and keeps it color well, retaining its creamy white, yellowish white or reddish brown tints over many years.
Palestinians in the West Bank have earned a world-wide reputation in stone making, particularly since the 1950s when technology became more accessible to them.

As quarrying is a major developing activity taken places in the Palestinian Authority, and as such activity could possibly associated with adverse impact on the environment, Palestinian Authority have addressed such activity in its formulated policies and legislations.

To provide a legislative framework for environmental planning, which includes opportunities for public involvement, Palestinian National Authority regulations on Environmental Impact Assessment was promulgated in 1999.

Item no. 16 of the law no. 7 (1999) related to the environment, which is approved by the Palestinian Legislative Council on 6/7/1998 and endorsed by Palestinian president, Yaser Arafat, on 28/12/2000, is designed to identify the environmental impacts associated with development

proposals, well in advance of their implementation. The Environmental Impact Assessment (EIA) process gives technical specialists from government agencies, as well as local residents and the general public, a chance for input to the decision-making process regarding specific development proposals. Final approval from the Palestinian National Authority is required before any project subject to EIA can proceed.

Article no. 16, emphasizes the role of the Environmental Quality Authority (EQA), in cooperation with specialized agencies, in setting the suitable environmental conditions related to the exploration and mining activities of limestone quarries and other mines, in a way that protect the environment from the risk of pollution

Under this regulation, individuals, companies or public agencies which propose certain types of projects are required to register information about the proposal with the Environmental Quality Authority (EQA), at an early stage in the planning schedule. The Ministry then screens the proposal to determine whether it is likely to have significant environmental effects. In this regard, it is important to note that the definition of "environmental impacts" in the relevant sections of the Clean Environment Act includes reference to both socio-economic and biophysical effects that could result from the project.

According to item no. 10 of the same law, all parties and personnel excavating, constructing, demolishing, mining or transporting soil or waste should take all the necessary precautions to prevent any environmental deterioration or pollution. . Also, article 18 of the same law, prohibits bulldozing the agricultural land or transferring its soil for the aim of using it for non-agricultural purposes.

Photo 1.1: Examples of worldwide constructions (constructed by stones imported from the study area).

1.1. The Environmental Impact Assessment:

An **environmental impact assessment** (**EIA**) is an assessment of the possible impact-positive or negative-that a proposed project may have on the environment, together consisting of the natural, social and economic aspects.

The International Association for Impact Assessment (IAIA) defines an environmental impact assessment as "the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made." (IAIA ,1999).

The purpose of the assessment is to ensure that decision makers consider the ensuing environmental impacts to decide whether to proceed with the project.

EIA is an important procedure for ensuring that the likely effects of new development on the environment are fully understood and taken into account before the development is allowed to go ahead.

According to the Environmental Protection Agency (EPA), **EIA** is the process by which we measure anticipated effects on the environment of a proposed development or project. If the likely effects are unacceptable, design measures or other steps can be taken to reduce or repair those effects. (EPA)

Environmental Impact Assessment (EIA) is a tool used to identify the environmental, social and economic impacts of a project prior to decision-making. It aims to predict environmental impacts at an early stage in project planning and design, find ways and means to reduce adverse impacts, shape projects to suit the local environment and present the predictions and options to decision-makers. By using EIA both environmental and economic benefits can be achieved, such as reduced cost and time of project implementation and design, avoided treatment/clean-up costs and impacts of laws and regulations.

The key elements of an EIA are (a) Scoping: identify key issues and concerns of interested parties; (b) Screening: decide whether an EIA is required based on information collected; (c) Identifying and evaluating alternatives: list alternative sites and techniques and the impacts of each; (d) Mitigating measures dealing with uncertainty: review proposed action to prevent or minimise the potential adverse effects of the project; and (e) Issuing environmental statements: report the findings of the EIA.

Impact analysis is performed in hopes of forecasting the impact in advance of the actual activity. (Global Development Research Center).

Modern policy analysis includes several concepts that now pervade environmental control policy: assessment, forecast, and impact. These are derived from the notion that we know enough about scientific and sociological fundamentals that we can predict the outcomes of our actions. These outcomes may be environmental, economic, or political.

Assessment is a word used extensively by the medical community and others and implies a thorough review of current conditions (of a patient, of an ecosystem, or of an educational outcome). Assessment is done by medical people as part of a diagnosis of a problem and becomes part of the process of selecting a treatment. Similarly for the environment, assessment is a thorough review of the environmental baseline.

A forecast is an informed judgment of future actions, results, or developments. By informed, we imply that a forecast is made by experts and is based on a thorough assessment of current conditions.

Impact suggests that some current action or activity will create a consequence that can be measured. An impact analysis is performed in hopes of forecasting the impact in advance of the actual activity.

1.2. The Area of Interest at a Glance.

The studied area is located in two districts of the southern part of West Bank. Mainly at the northeastern part of the Hebron District ,and at the southern eastern part of the Bethlehem District. The Hebron District has an area of about 1064 km^2 and populated with about 552,000 inhabitants. whereas the Bethlehem district has an area of about 575 km^2 and populated with about 176,000 inhabitants (PCBS,2007).The area of interest, which accommodates the largest number of stone quarries and cutting stone plants in the West Bank, has an area of about 80 km^2 .

The population density in the studied area is 799 person/ km^2 , although parts of the Jerusalem wilderness (unpopulated area) at the eastern part of the area are included in the studied area.
There are four main clusters of population: Sier with its villages and hamlets (Khirbeh) (22500), Bani Naim with its surrounding villages and hamlets (19117) , Shyoukh with its villages and hamlets (10008) and Beit Fajjar with its villages (12324). The distribution of population among clusters is shown in table 2.1:

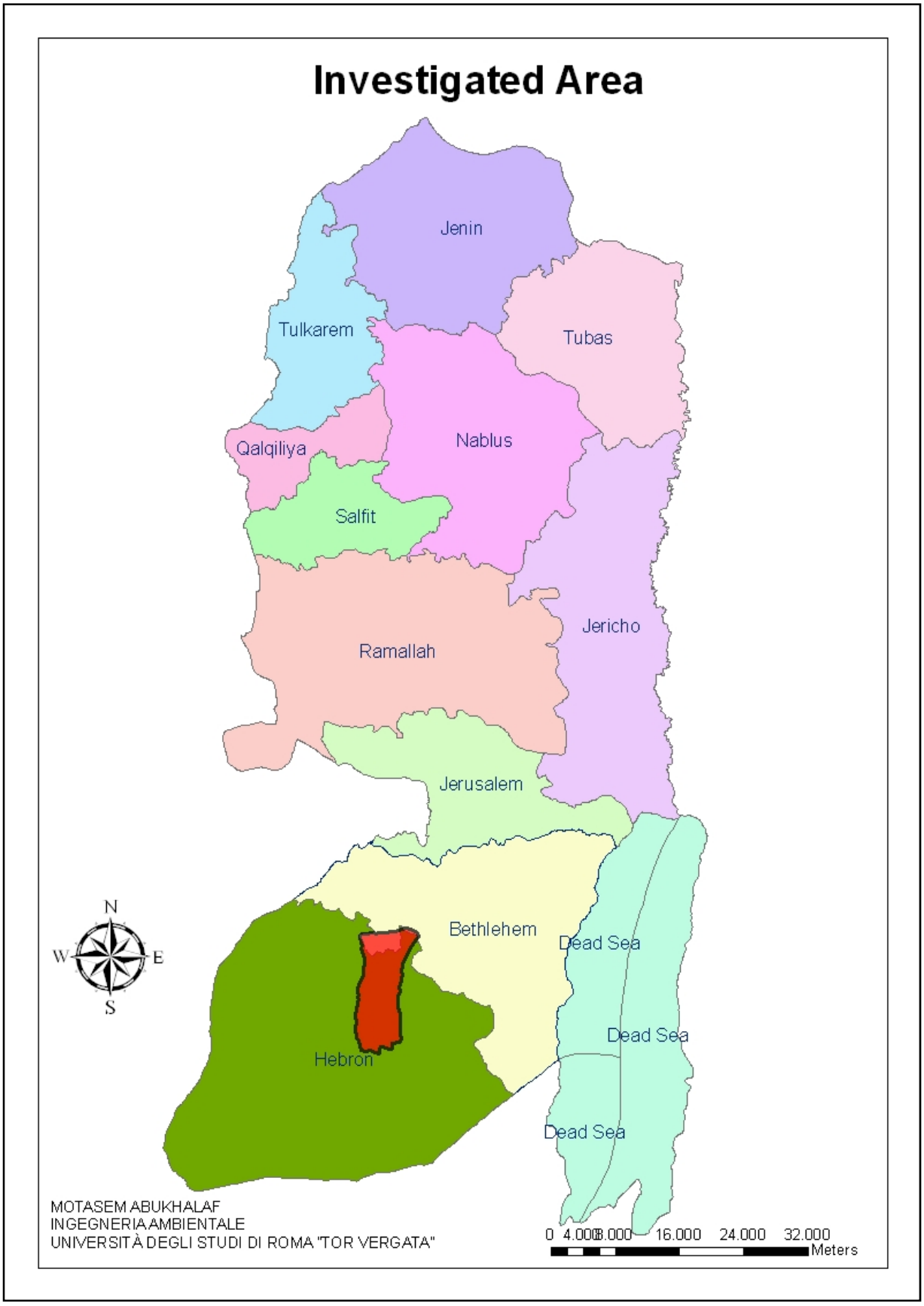
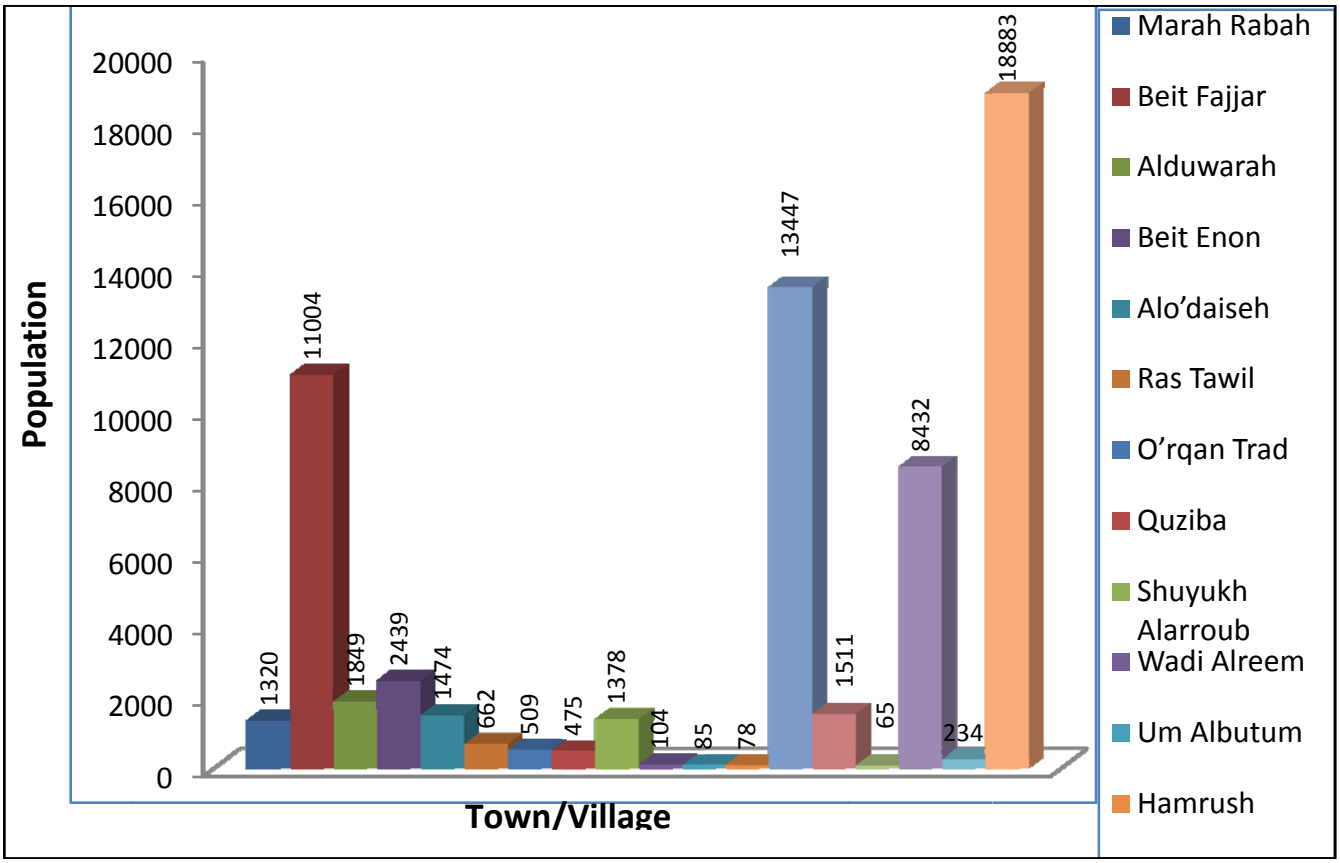


Figure 1.1: The investigated area at the mid northeastern part of Hebron District.

Table 1. 1: The population distribution among the three main towns and belonging hamlets in the studied area(PCBS,2007).

Cluster of Population	Town / Village	Population
Beit Fajjar	**Marah Rabah**	**1320**
	Beit Fajjar	**11004**
Sier	**Alduwarah**	**1849**
	Beit Enon	**2439**
	Alo'daiseh	**1474**
	Ras Tawil	**662**
	O'rqan Trad	**509**
	Quziba	**475**
	Shuyukh Alarroub	**1378**
	Wadi Alreem	**104**
	Um Albutum	**85**
	Hamrush	**78**
	Sier	**13447**
Shyoukh	**Qufan Khamis**	**1511**
	Jrun Allouz	**65**
	Shyoukh	**8432**
Bani Naim	**Masafer Bani Naim**	**234**
	Bani Naim	**18883**
Total		**63949**



1.3. Background of the Study.

The southern part of the West Bank accommodates the largest number of limestone quarries in the West Bank. There are more than 300 quarries in this area. Some of these quarries are currently active, some are temporarily abandoned and some are permanently abandoned. It is worth mentioning that not all of these quarries are officially permitted by the Palestinian Ministry of National Economy.

Although the building stone industry represents an important percentage in the Palestinian National Gross Product, it represents a major environmental threat due to the following reasons:

1. It changes the landscape and creates a dangerous area for the movement of the people and the animals.

Photos 1,2: Quarries exactly Adjacent to houses.

2. It decreases the area of agricultural land directly through the occupied area of the quarry and indirectly through its negative effect on the surrounding area. It also decreases the grazing land which negatively affects the livestock and animal raising. If the sediment yield is measured at the drains area affected by limestone quarrying, it will be found that it is tens of times greater than yields at other areas.

Photos 3,4: encroachment of agricultural land by quarries.

3. The mineral deposits always occur within special geologic units or structures such as fault zones, which can be detected and mapped by satellite images. The existence of the abandoned quarrying site would increase the instability of the land and pose problems of landslide and soil erosion and uncontrolled deposition.

4. The limestone waste sludge resulted from the plants of cutting stones pose a severe waste problem on the adjacent agricultural lands and on the land where this disposal is dumped.

Photo 5: Limestone waste sludge disposed randomly.

5. The scene of the quarrying site place pose an aesthetic issue that should be taken in consideration, especially for those plants adjacent to the urbanized area.

Photos 6,7: Quarries change the landscape and pose aesthetic problem.

6. The haulage ways leading to these quarries are mainly unpaved and creates a dusty area around. This dust reduces the agricultural development of the surroundings.


Photos 8,9: Unpaved roads (haulage ways) are widespread all over the studied area.

7. Solid waste disposal places.
In some cases, the abandoned quarries were turned into solid waste and rubble disposal sites.

Photo 10: An abandoned quarry turned to rubble disposal site.

Utilizing the above-mentioned laws and the possibilities to rehabilitate the old quarries, it is possible to ameliorate the environmental status in the area of interest. Rehabilitation of two or three pilot sites would present prototypes that could be implemented by relevant municipalities, ministries or other environmental bodies.

1.4. Objectives of the Study.

The main objective of this study is to survey the current situation of the existing quarrying sites and evaluate their negative effects on the environment and land use plans of the surrounding areas. This will be conjugated with suggestions for quarries rehabilitation combined with ecological restoration recommendations. The final purpose is to implement rehabilitation and reclamation schemes for the quarries starting with selected strongly recommended sites.

The ultimate goal is to transform the harsh and hostile quarry land into usable with acceptable aesthetic view land. This will depend on the status of the quarry and other factors. Sustainable environmental development could be achieved by compromising between economic benefits and the clean environment when working on clear basis.

The reclamation or rehabilitation of the land requires an important preparatory phase to set the solid basis for the practical fieldwork. This preparatory phase is the subject of this study.

2. Literature Review.

In fact, the literature material related to the environmental impacts of the stone quarries is very rare. There are some studies related to the properties of building stones and the possible exploitation of limestone powder waste sludge resulted from cutting stone plants.

In a recent study published by the Palestinian Environmental Quality Authority (EQA) and entitled "Israeli Environmental Violations", the environmental problems resulted from six main quarries associated with stone crushers adjacent to the Israeli-Palestinian borders were addressed. However, they haven't addressed the environmental negative effects of the Palestinian stone quarries inside the West Bank.

EIA studies for the licensed stone quarries are available at the archives of the offices of these quarries. Currently, any new established quarry is required to submit such a study to the Ministry of National Economy to obtain the working license according to the Palestinian EIA policy and guidelines. On the other side, the number of quarries working without permission is exceeding those permitted. This fact creates clusters of quarries very close to urbanized areas and affecting severely the flora and fauna life in the area.

The following table displays the distribution of stone quarries in the studied area. In fact, the real number of quarries is far exceeding the registered number in the Ministry of National Economy because each quarry owner is working at more than one site using the same permission. The same thing is applicable to those working without permission.

Table 1.1: The distribution of stone quarries in the studied area.

Area	Total
Bani Naim	55
Sier	130
Shyuokh	73
Beit Fajjar	34
Total	292

The physical and some mechanical properties of some building stones of the West Bank were investigated . It is found that these stones have very low water absorption (2.6%) compared with those in Jordan. Also, mechanical strength expressed as the modulus of rupture indicates that these stones are in the medium range (800-1800 Kg /cm^2) with. Regarding the specific weight, it is clear that they can be classified as hard limestone (2.36-2.75) because they are in the range of 2.6 to 2.9(Land Research center,2002).

The property which most influences their potential usefulness is the chemical composition. Iron content, for example, is undesirable in limestone to be used as dimension stone, because with weathering, the iron will alter the oxide, and stain the stones surface to a reddish or brownish color. Several organizations published results of the investigations and give recommendations as to the limits of impurities that can be tolerated in stones and carbonates for industrial use. Regarding the building stones of the West Bank - Palestine, there is very limited information about their chemical composition.

Photo 11: Working quarry at the studied area.

3.Methodology.

The following main procedural steps were conducted in order to realize the main outputs of the study:

3.1. Literature Survey.

A literature survey for all the related material to stone and marble industry was launched at the beginning of the study. It includes the publications of the Stone and Marble Industry Union(USM-Pal) ,Land research center(LRC), Applied Research Institute-Jerusalem(ARIJ) and other applied researches published by researchers from the local universities and scientific institutions, publications of the Environmental Quality Authority (EQA), Ministry of National Economy, Ministry of Agriculture , municipalities of the four towns and the Palestinian Central Bureau of Statistics (PCBS).Actually, there is no directly related material was found dealing with the rehabilitation of the existing quarries.

3.2. Area Delineation.

The area of interest is located at the southern part of West Bank. The delineated area was estimated at about 80 km^2 .
The selected area accommodates the largest number of stone quarries and cutting stone plants in the West Bank. The delineated mapped area included all the limestone quarries and the population of the Four main towns: Sier, Bani Naim, Shyoukh and Beit Fajjar and their hamlets.

3.3. Data Collection of the Studied Area.

The following is a classification of the data collected in the context of this study:

Whole area data:

Physical features and population data for the whole area were collected and inserted into the GIS structure. These data could be displayed as follows:

a. Land cover/use: the land cover and use for the whole area was prepared in the form of map at a scale 1/57,000. Aerial photographs and satellite images were utilized in this preparation.
b. Topography: the topographic features of the area were investigated in the form of Digital Terrain Model (DTM) and land system classification of the area. Elevation was the main derivatives of the DTM, it was displayed in maps at a scale of 1/57,000 at a 5m contour intervals.
c. Soil: soil types in the area of study were displayed in descriptive and mapping format.
d. Geology: geological formations of the area of study were displayed in descriptive and mapping format.

e. Main and local roads: the main and local roads in the studied area were also displayed in map format.
f. Palestinian built up area clusters was delineated because the built up area is continuously extending and creeping at the expense of the agricultural land. Also population statistics were also obtained to figure out the distribution of people and the expected trends in the future.

Quarrying sites area clusters:

The following data were collected for area clusters of quarrying sites and/or for each quarry site either through fieldwork or by utilizing the remote sensing tools such as aerial photographs and satellite images. For the fieldwork a special questionnaire was prepared and filled mainly by responsible at the main towns municipality and the Union of Stone and Marble Industry ,it relates mainly to the field:

a. General geographic location of the site; location of the quarry in relation to towns, local and main roads and other landmarks; adjacent land use features.
b. Existing condition of the land affected. This included the following:
   - Previous land use;
   - Vegetation;
   - Topography;
   - Drainage.

c. the nature of roads leading to the quarry; the suggestions of possible future quarry rehabilitation.

3.4. GIS use in building and analysis of collected data.

The analysis of the collected data and information involved the following steps:

1. Geographic Information System (GIS) build up:
   There are two types of GIS projects established in the context of this study. One for the whole area built at a scale of 1/57,000; the other for quarrying clusters built at a scale of 1/9,000 and at a scale of 1/4,000.The spatial and attribute data collected were inserted into one of these two GIS structure.

The GIS structure for the whole area included the following themes:

- General geographic location of the area;
- land cover/use;
- DTM derivative: elevation;
- soil;
- Geology;
- Groundwater Elevations;
- local and main roads;
- Arab communities build up area .

The GIS for the quarry clusters areas include the following themes:

- The whole cluster area;
- location of each quarry (Israeli_TM_ Grid);
- outlining of the affected land;
- location of adjacent land features;
- Site topography shown with elevation contours;
- Soil and geological maps;
- Length of the unpaved roads in the cluster.

2. Analysis of Inserted Data Utilizing GIS Processing Tools:

Following the data insertion and construction of the GIS projects, the GIS tool were utilized in capturing, arranging, querying, overlaying, geo-processing, analyzing and displaying and mapping.

3.5. Environmental Negative Impacts Evaluation.

The following environmental negative impacts were addressed according to the collected data:

1. Environmental Pollution:
   This included the following:
   - air pollution (dust);
   - Noise pollution;
   - Water pollution (water borne sediments);
   - Soil pollution.

2. Effects on Land Use:
   The agricultural and grazing land reduction and the quality of land deterioration were investigated due to the random spread of quarries. The effect of quarries on the urbanization was also addressed.

3. Effects on Biodiversity:
   Both the agro and animal biodiversity were touched in the context of the random spread of the quarries. The negative impacts in this regard are going beyond the studied area.

4. Effects on Landscape.
   The negative impacts of quarries on landscape was investigated and analyzed.

5. Socio-economical effects.
   Quarrying is an activity with economic as well as social and environmental impacts, mainly on the local landscape and ecology, noise and traffic problems for local communities.

6. Other Effects such as visual impact, health, Traffic and ground vibration.

3.6. Suggested Rehabilitation Plans and Recommendations.

According to the collected data and analysis, both general long term and practical short term recommendations were displayed. A general designated quarrying rehabilitation plan for the whole area should indicate the following:

1. Specifying the land use objectives to be achieved in the final stage of rehabilitation and reclamation such as:
    - develop site to a condition similar to or compatible with that which existed prior to any quarrying;
    - develop site to some other beneficial use of the land such as forest, crops, leisure facilities or others;
    - develop a site for subsequent development.

2. Reclamation or rehabilitation Method:
   The suggested reclamation or rehabilitation method should include the following details at the implementation stage:
    - grading and slope treatment;
    - disposition of waste, residual material, junk trash and personal property;
    - treatment of haulage ways;
    - Revegetation.

4. Results and Discussion.

4.1. Literature Survey.

The outcome of the literature survey work, as outlined in the references, indicated that there is no comprehensive study in the West Bank done at regional level for the environmental impact assessment of the quarries and their future proposed rehabilitation plans. There is work done for some quarries as an individual not as a cluster of quarries. Actually, there is no directly related material was found dealing with the rehabilitation of the existing quarries; therefore, the literature collected did not supply serious background to start with for this study.

4.2. Area Definition.

The area of interest, which is located at the Southern part of the West Bank, The area of interest accommodates the largest number of stone quarries in the West Bank. The delineated mapped area included all the limestone quarries and the population of the four main towns in the area in addition to other hamlets. The delineated area was estimated at 80 km^2 . It is bordered by Hebron city , Halhul city and Alarroub refugee camp from the West , Um Salmona Tekoa villages from the north, the southern borders of Bani Naim town from the south and the non-permitted quarries establishment area (at the line of Asfar Colony) from the east. The area is shown in figure 4.1.

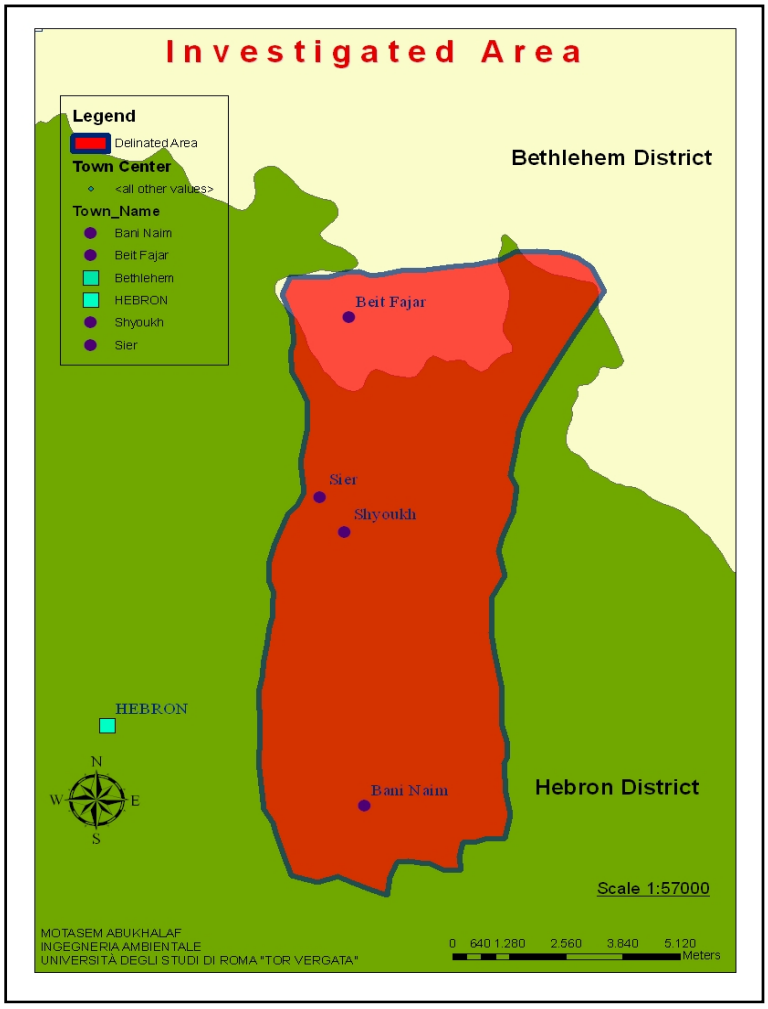


Figure 4.1: The investigated area.

4.3. General Characteristics of the Area.

The following are the main general features of the investigated area that directly or indirectly intermingled with the objectives of the study.

4.3.1 Land Cover/Use.

The land cover and use for the investigated area was prepared in the form of map at a scale 1/57,000. Aerial photographs at a scale of 1/25,000 and SPOT satellite images (1/50,000) in addition to fieldwork for verification were utilized in this preparation.

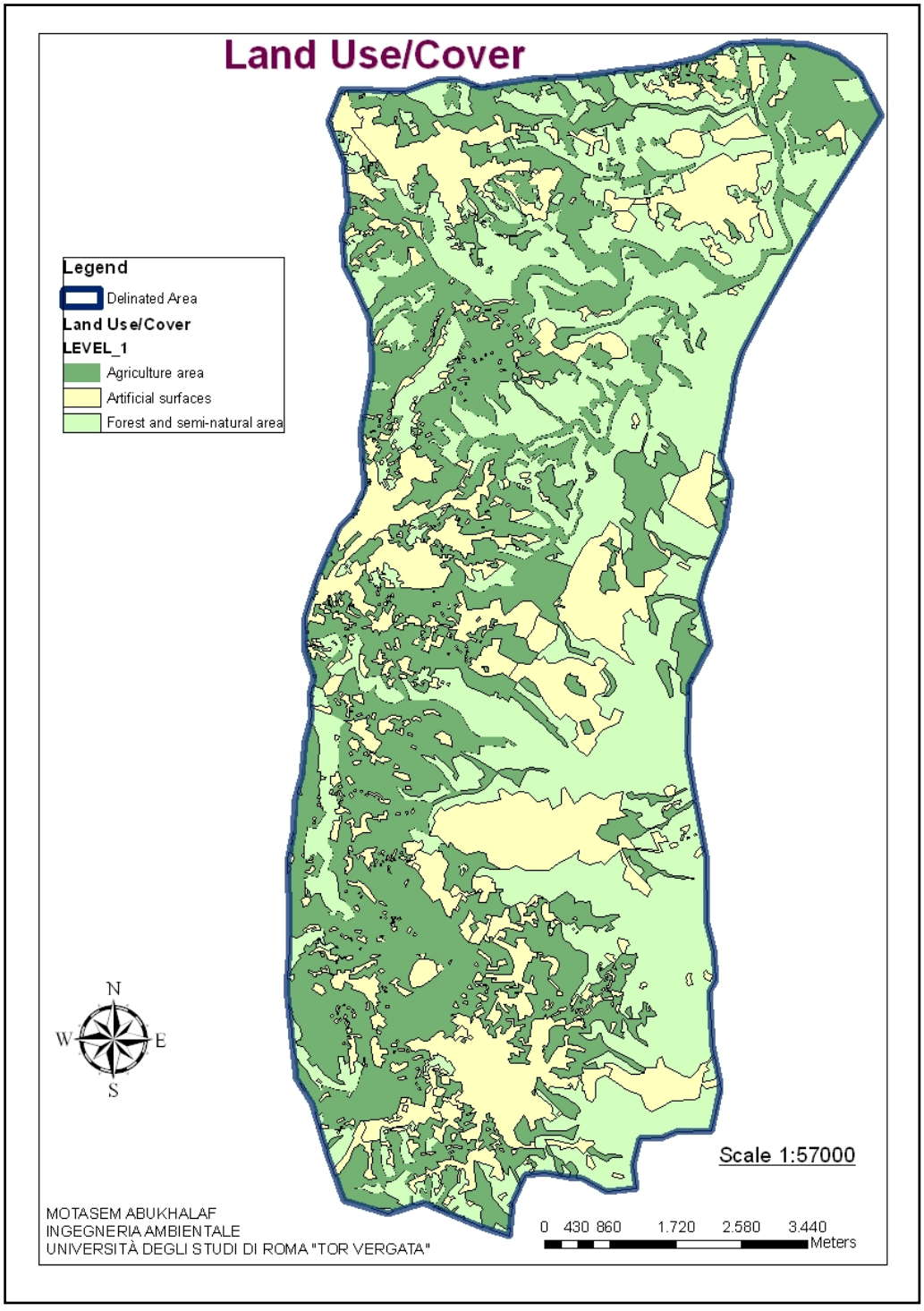


Figure 4.1: Land cover /use of the investigated area.

Table 4.1: Land cover/use of the investigated area.

Land Cover /use		Area (km^2)	
Agriculture area	Arable land	6.41	32.43
	Heterogeneous agricultural area	6.32	
	Permanent crops	19.55	
	Plastic houses	0.15	
Artificial Surfaces	indusrial commercial	0.98	18.72
	dumps and construction site	7.51	
	Urban fabric	10.22	
Forest and semi-natural area	open spaces with little or no vegetation	13.74	13.74

The remote sensing data showed that 32.4% of the Land cover of the study area were distributed on agricultural area while 18.72 % were artificial surfaces and13.74% were Forest and semi-natural area.

4.3.2 Topography.

The topographic features of the area were exhibited in the form of one of the Digital Terrain Model (DTM) derivatives of the area (elevation contours). Elevation contour lines were displayed in maps at a scale of 1/57,000 for the whole area . Figure 3 shows the elevation contour line at 5 and 50 m intervals respectively. It is clear that the elevation range of the area is between 680 to 1005 m above sea level (asl).

The studied area is occupying part of the middle and northern part of the Hebron District and represents the most area of the upper part of a known topographic unit. This part is constituted mainly of basins and narrow valleys and rocky area appearing as hills with a height of 50 to 150 m from the basins level. These basins are dominated by deep soils containing large percentage of stones and pebbles. The elevation of the area ranging from 800 to 1000 m above the sea level. This unit is considered as the largest structural unit in Palestine.

The erosion factors contributed in the complexity of the topographic features of this area. Differential erosion processes are controlled by resistance and thickness of rock strata. Resistant dolomites and hard limestone, intercalated with soft limestone, form terraced slopes. The quasi-impermeable marls are the most important aquifer strata. Because of its lithology, the region has Karstic landscape.

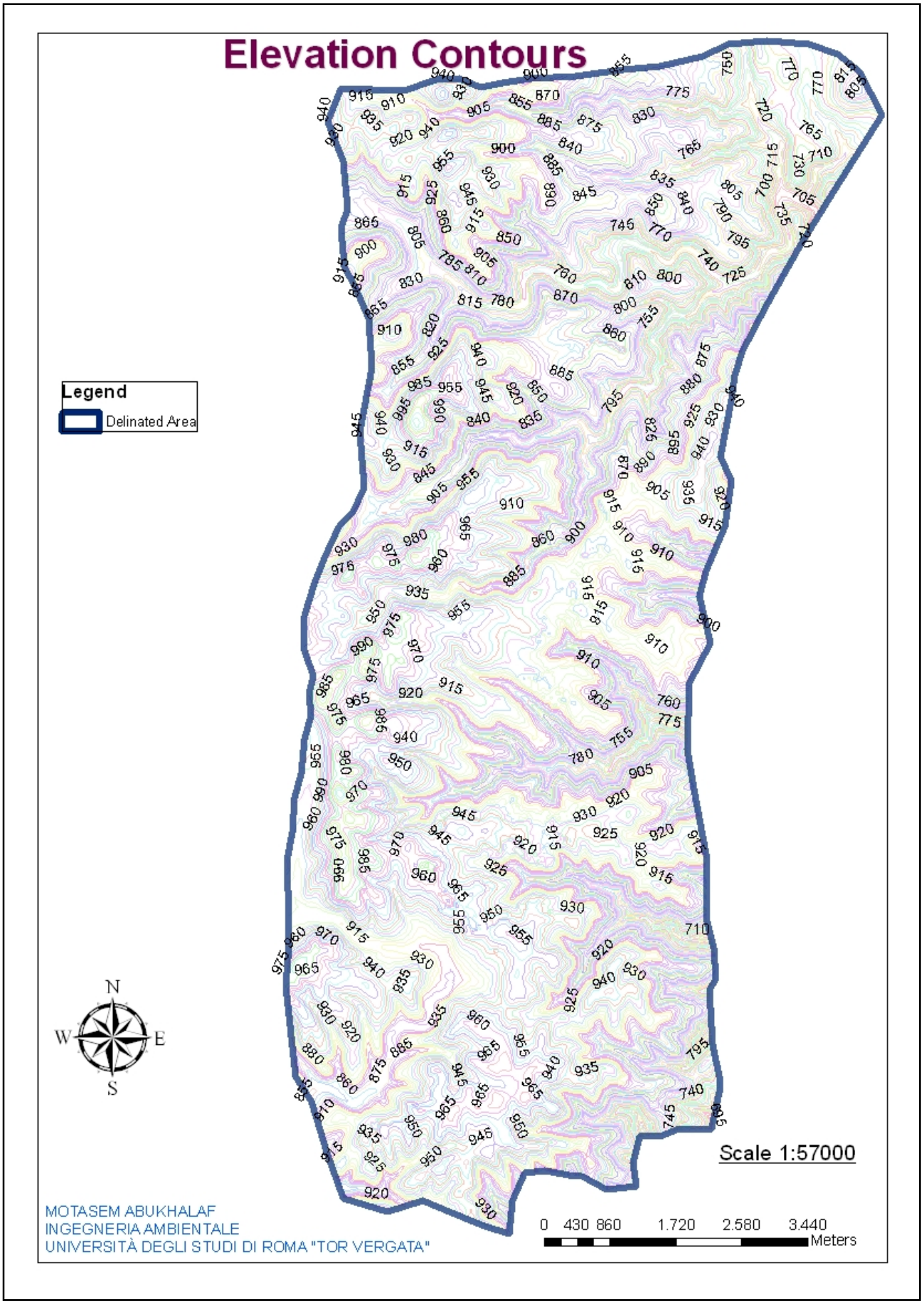


Figure 4.3: Elevation contours at 5 m intervals.

4.3.3 Climate.

Climate of the investigated area is a Mediterranean type with moderate rain in winter and dry hot summer. However, the aridity classification of the area shows that the climate is ranging from humid at the northern part (Beit Fajjar) of the area to moderately arid at the southern part (Bani Naim). Annual average rainfall is between 400 mm in the southern part to 600 mm in the northern part. Average summer (June-August) monthly temperature in the area reaches 21.7 °C; in winter (December to February) is about 8 °C; annual temperature range is 17-19 °C.

4.3.4 Geology.

Mainly constituted by limestone, dolomite, dolomitic limestone and marl of the Cenomanian age.

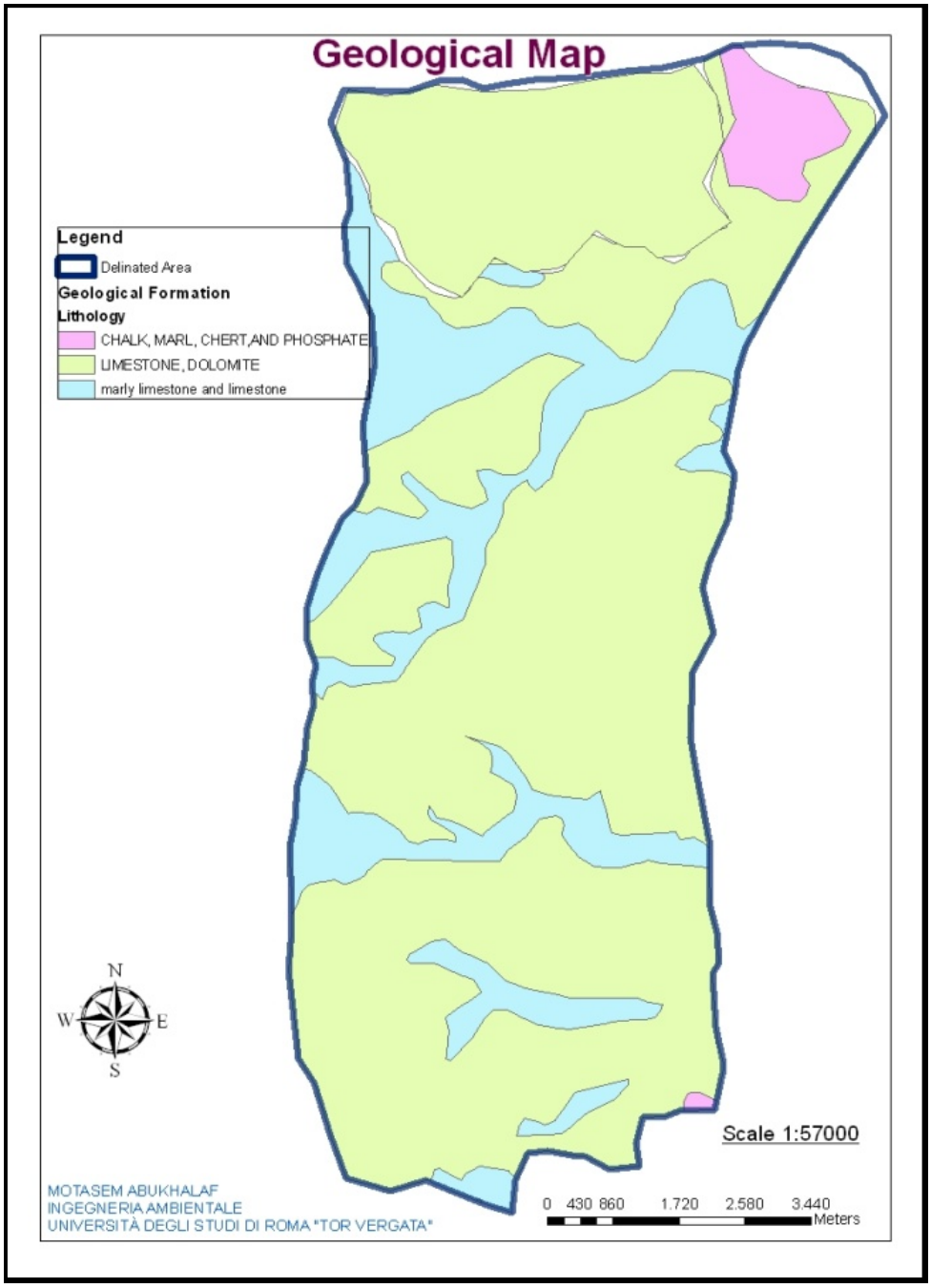


Figure 4.4: Geological map of the investigated area.

4.3.5 Soil.

The soil of the investigated area would be classified into the following types (see figure 4.5):
Terra Rossa, Mediterranean Brown Forest soil,Colluvial-Alluvial soils and Alluvial soils.
It can be shown that the quarries are mainly located on Terra Rossa soils.
The parent material Terra Rossa soil is mainly composed of hard limestone and dolomite with inclusions of chalk, marls and calcareous shales. It is typical of the central mountainous and hilly part of the West Bank.

Steep slopes comprise most of the unit area, but moderate slopes and small plateaus occur occasionally near summits and water divides. Karstic features characterize most of the unit area. Surface water run-off is less than 10% of the total rainfall.

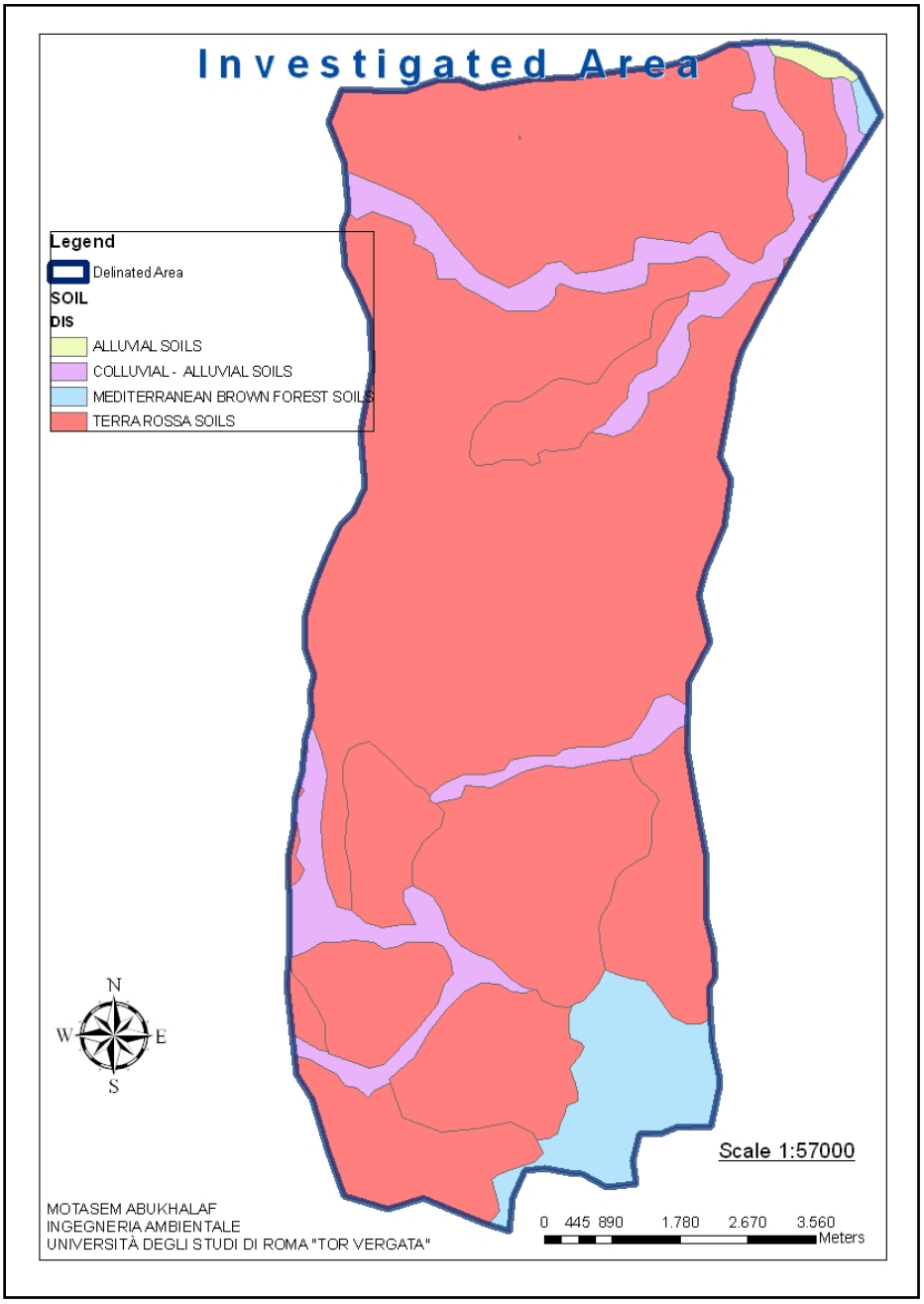


Figure 4.5. Soil map of the investigated area.

4.3.6 Palestinian Urbanized Area.

Palestinian built up area is delineated and shown at the investigated area. It is evident from the map that the built up area is concentrated at the western and southern parts of the investigated area (see figure 4.6). At the same time, sporadic houses are distributed in the eastern part intermingled with the quarries clusters.

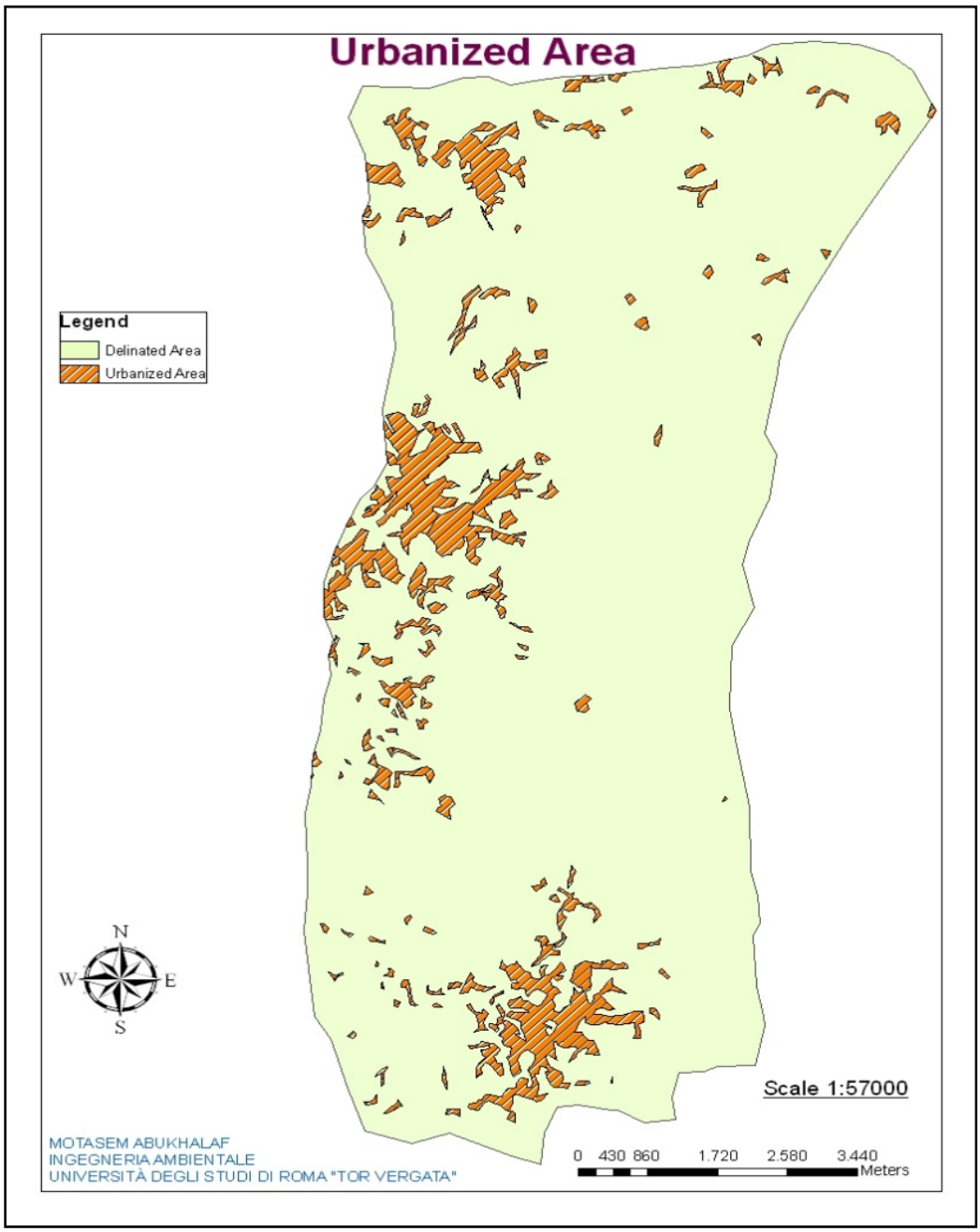


Figure 4.6: Palestinian Urbanized Area Map.

4.3.7 Roads.

The area has both main and local roads as shown in figure 4.7. The length of local roads is about 22,6 km while that of main (regional) roads is 17,3 km. Part of the main roads is now serving as a bypass road at the western part of the area. Only the paved local roads are considered in the mapping. The local roads delineation excluded also the internal roads inside the towns. Also, it is worth mentioning that new roads were constructed recently and not included in the map. It is evident that the eastern part at which the quarries are located does not have paved local roads.

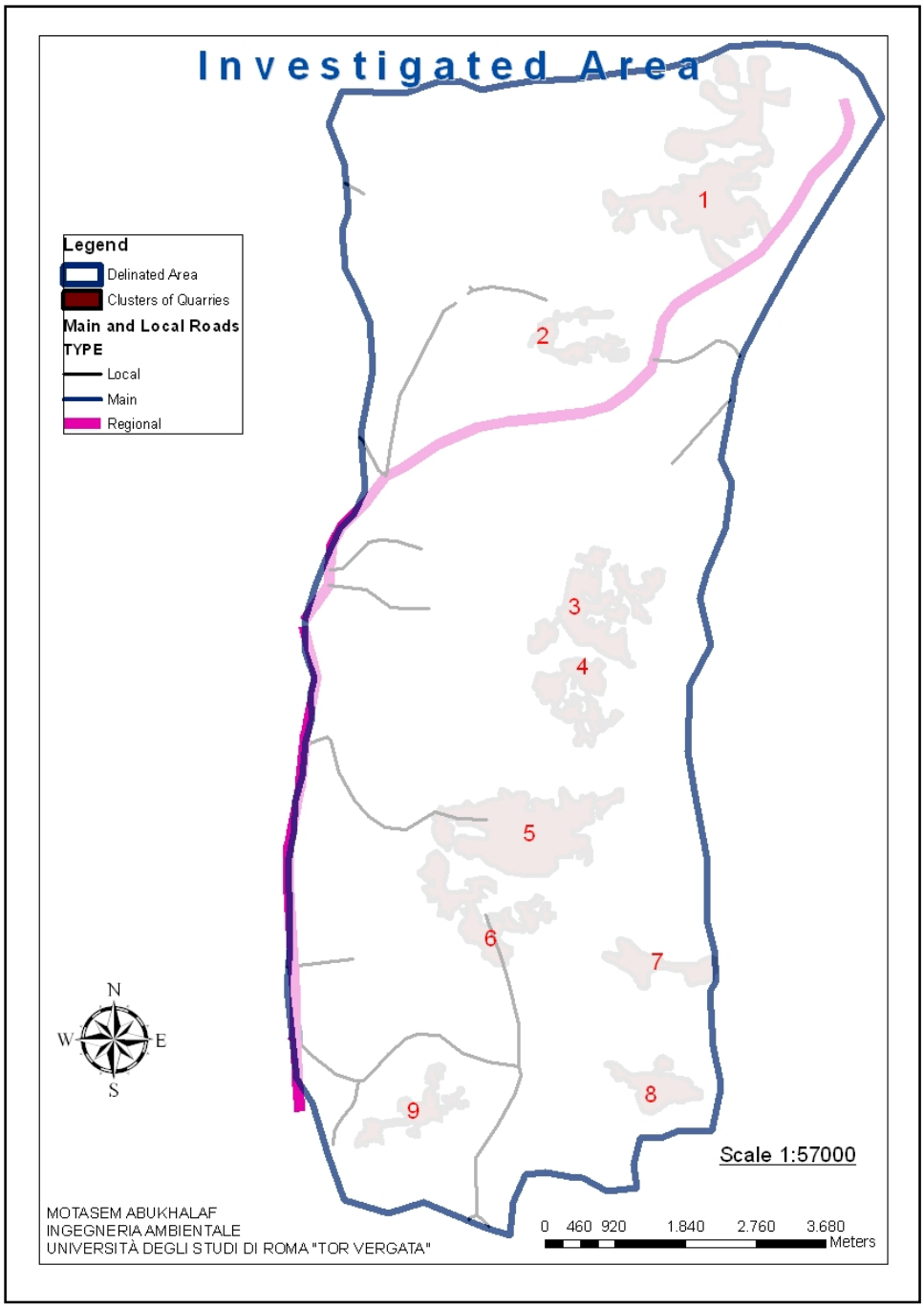


Figure 4. 7: Main and local roads map.

4.4. General Characteristics of the Quarries.

The status of quarries distribution among the area indicates that there are nine clusters of quarries (figure 4.8) in addition to sporadic quarries mainly adjacent to or inside the urbanized areas. Therefore, the general characteristics will be exhibited for both clusters and quarries outside clusters. The clusters are mainly located at the eastern part of the investigated area. The total area of these clusters is about 7.75 km^2 (about 13% of the investigated area). Various data and information were collected for area clusters of quarrying sites and/or for each quarry site either through fieldwork or by utilizing the remote sensing tools such as aerial photographs and satellite images.

Table 4.2 summarizes the area of the clusters:

Table 4.2: Area of quarries clusters.

Cluster No.	Area (km^2)
1	2.04
2	0.31
3	0.94
4	0.51
5	1.59
6	0.73
7	0.34
8	0.39
9	0.34
Total	**7.20**

There are also 40 Quarries outside clusters (Figure 4.9.b).The average surface area of a quarry is 2.5 donums(i.e. 2000 square meters), which means that the total estimated area of quarries outside cluster is 0.1 km^2 .

So the Total Area of cluster of quarries and quarries outside cluster is almost about 7.3 km^2 which is about 9.1% of the study area.

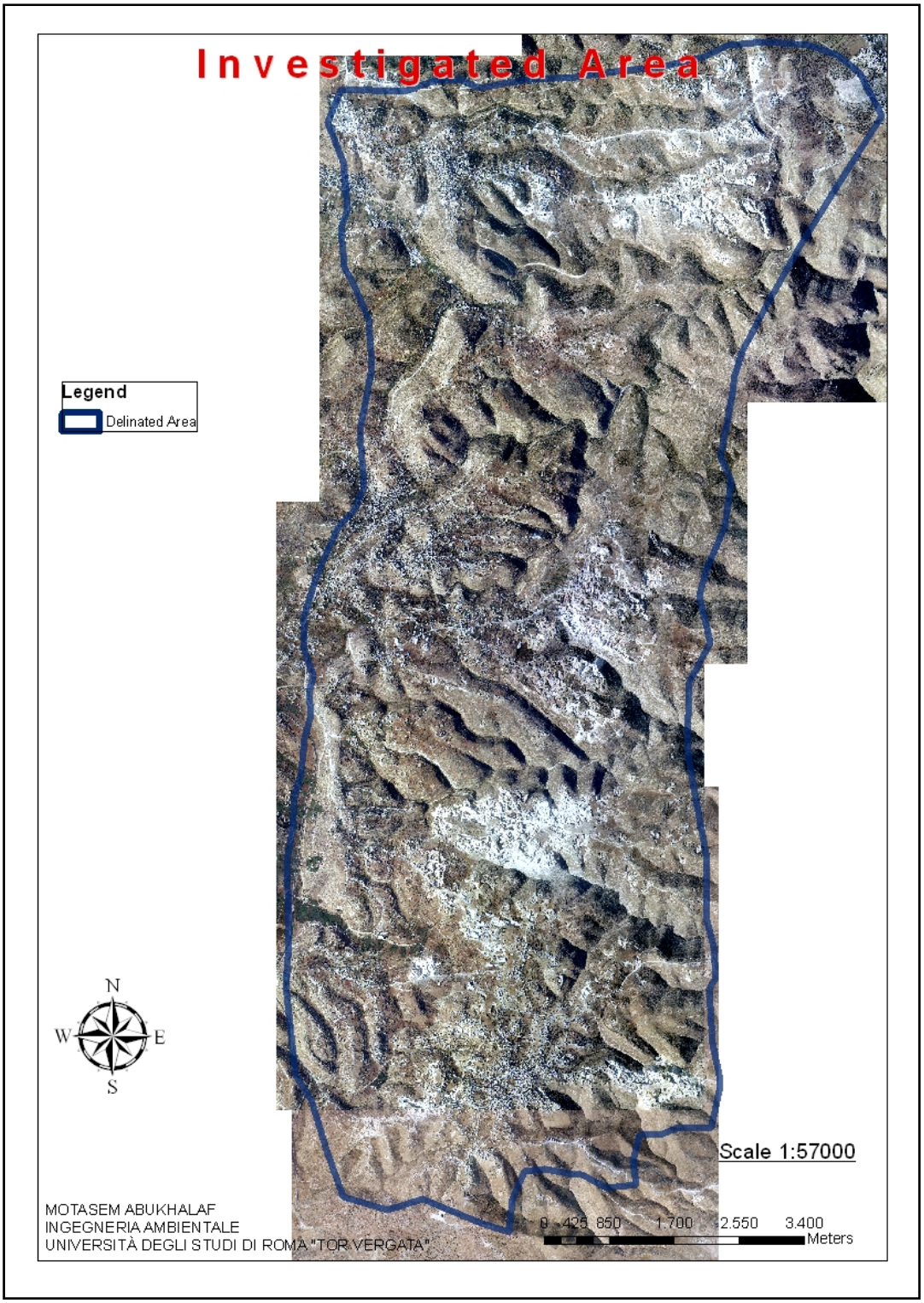


Figure 4.8: The whole investigated area map.

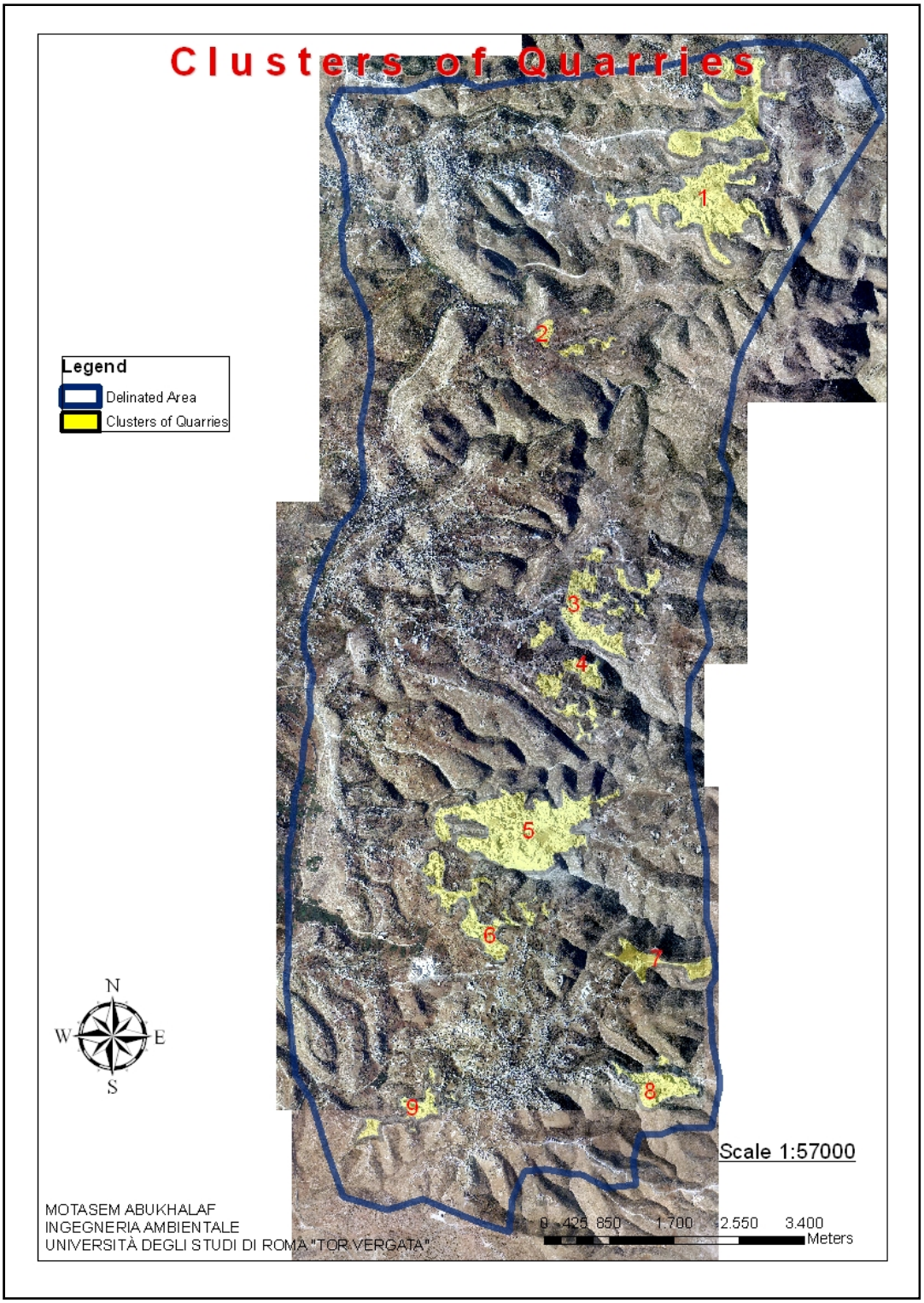


Figure 4.9.a: Clusters of quarries location map.

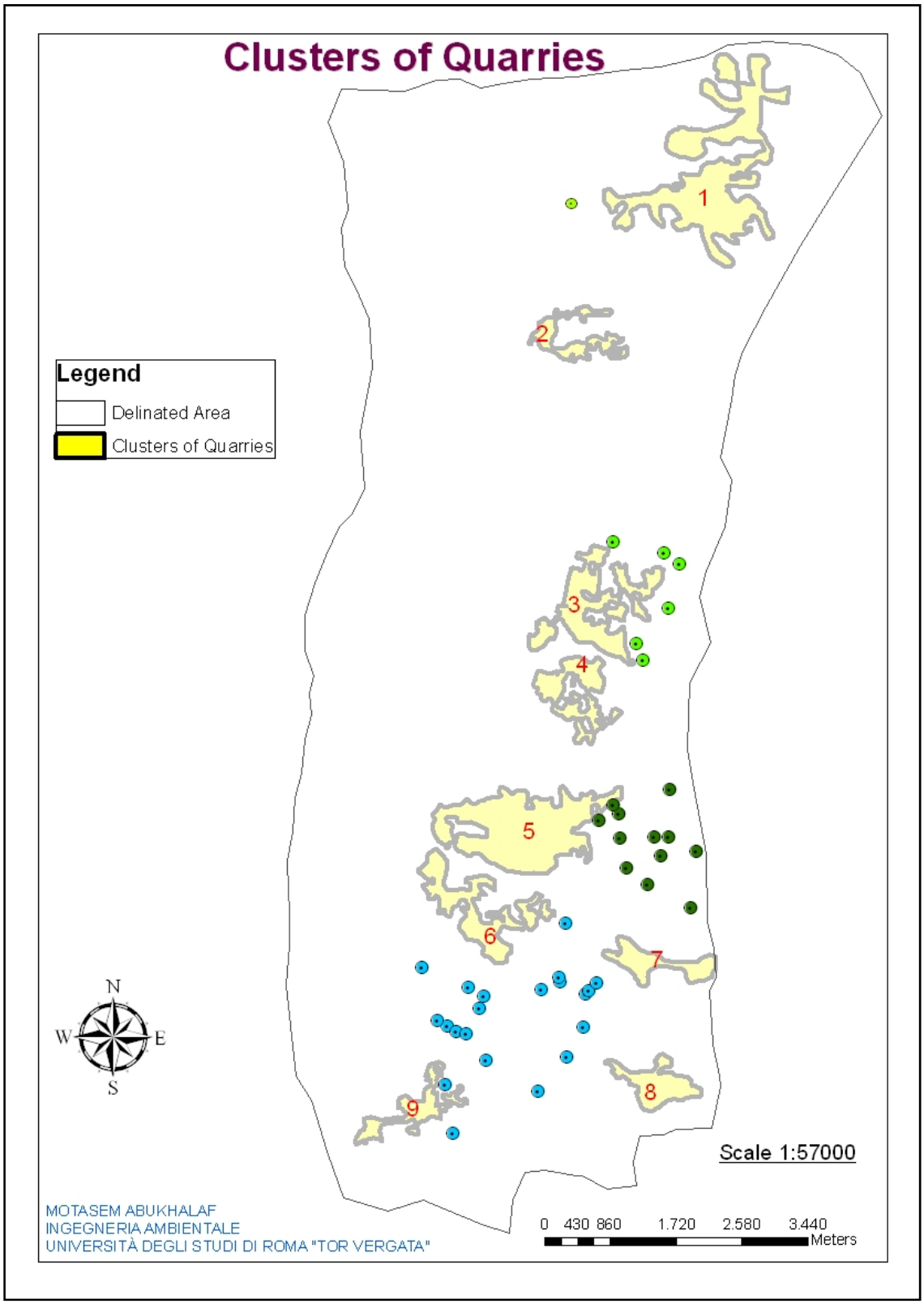


Figure 4.9.b: Clusters of quarries and quarries outside cluster location map .

4.4.1 Quarries Clusters.

Each cluster is the area of a combination of working and abandoned quarries adjacent to each other in addition to the area occupied by overburden waste and dumped piles adjacent to these quarries. As shown in figure 4.8, there are nine main clusters of quarries. These clusters are:

Beit Fajjar Cluster :-

It is located at the northeastern part of the investigated area. It occupies an area of approximately 2.04 km^2 . The elevation range of this cluster is from 725 to 830 m above the sea level (asl). It can be divided into two main blocks separated by cultivated drainage depression.

The land use of the surrounding area can be classified as a blend of grazing and sporadically cultivated land (natural area with some agricultural vegetation). The closest urbanized areas to this cluster are the village of Marah Rabah and the town of Beit Fajjar with the populations of 1320 and 11004 consequently. Other villages as Shuyukh Alaroub and Hamrush can be considered nearby the cluster with the population of 1378 and 78.
The geological formations of the cluster are marly limestone of the Upper Cenomanian age and dolomatic limestone from the Turonian age.
The main spoil type is Terra Rossa in addition to some alluvial soils in the eastern parts.
The elevation of ground water table under the cluster area is approximately 400m (asl).
It has about 34 quarries most of them are abandoned . The cluster has unpaved roads of about 11656 m . See Figures (4.10 a - h)

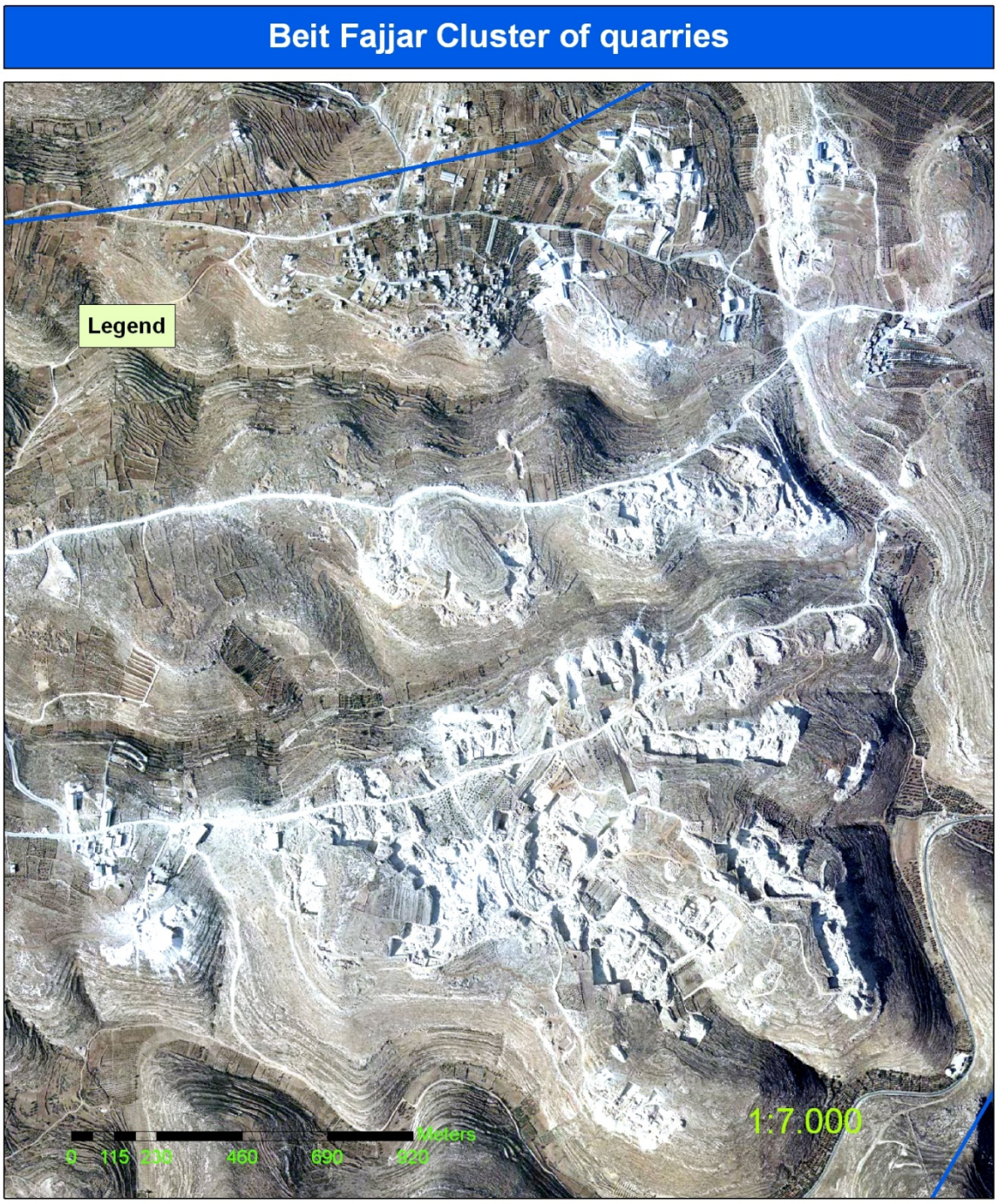


Figure 4.10.a: Beit Fajjar quarries area map.

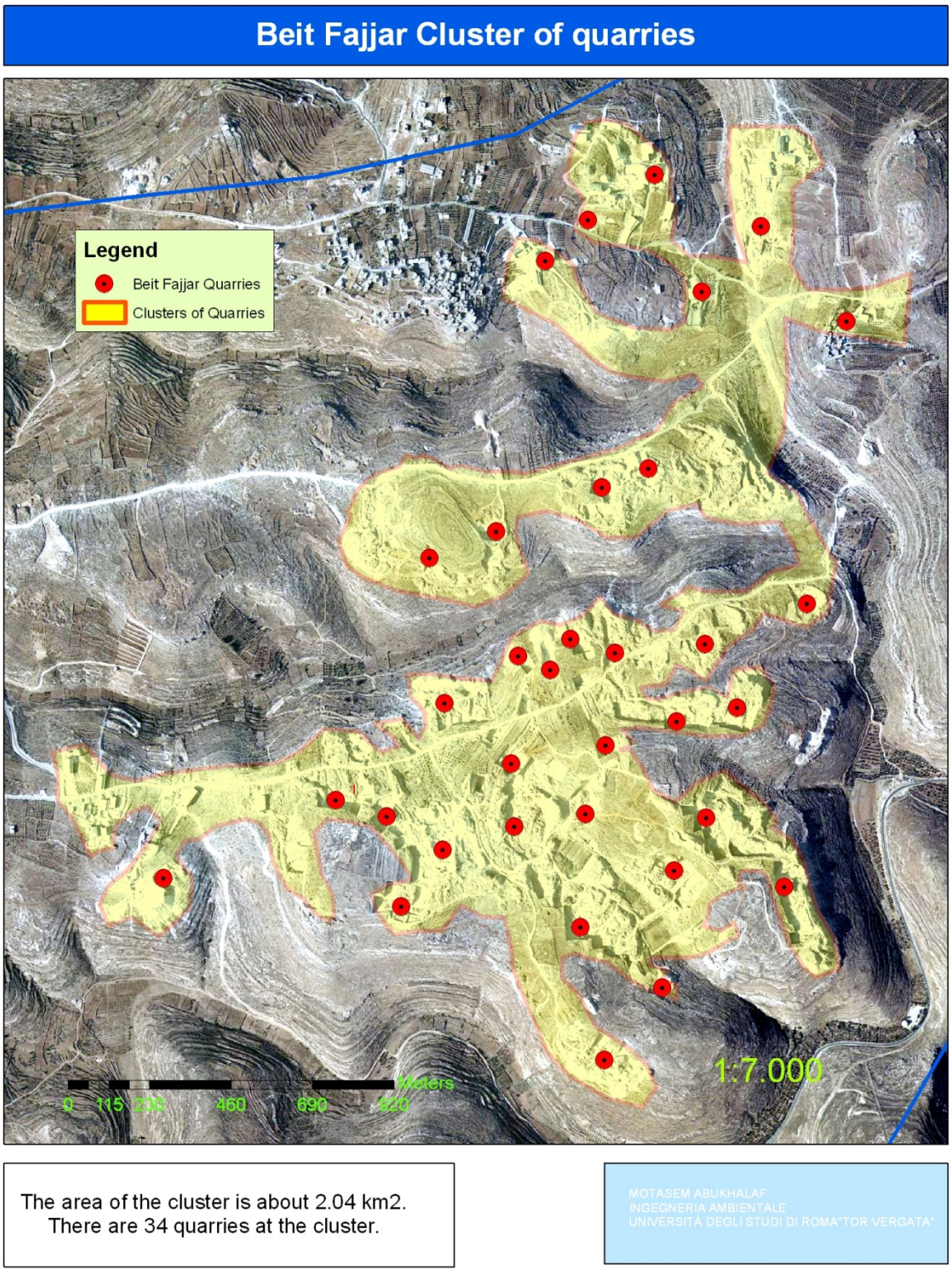


Figure 4.10.b: Beit Fajjar Cluster of quarries map.

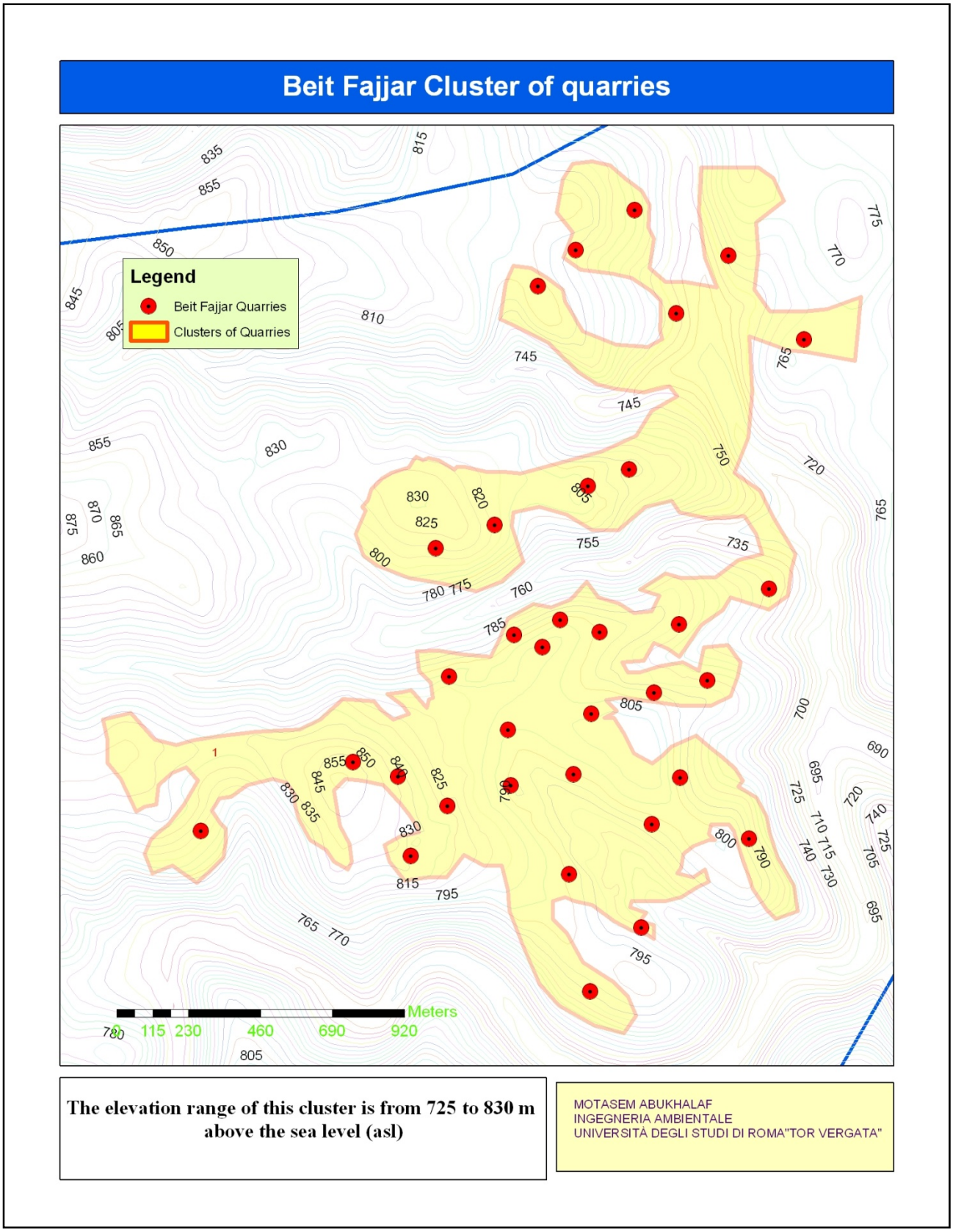


Figure 4.10.c: Beit Fajjar Cluster elevation contours map.

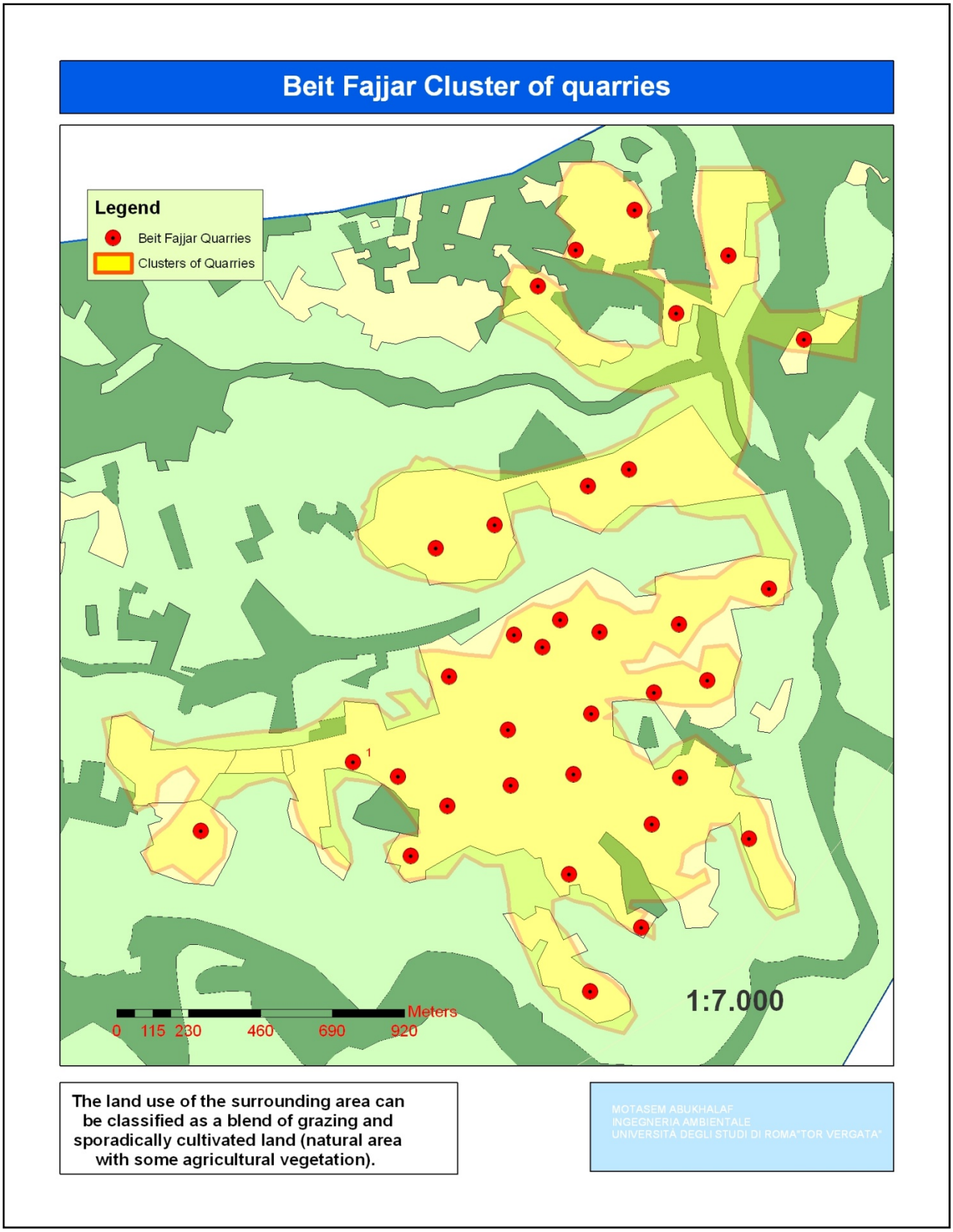


Figure 4.10.d: Beit Fajjar Cluster land cover/use map.

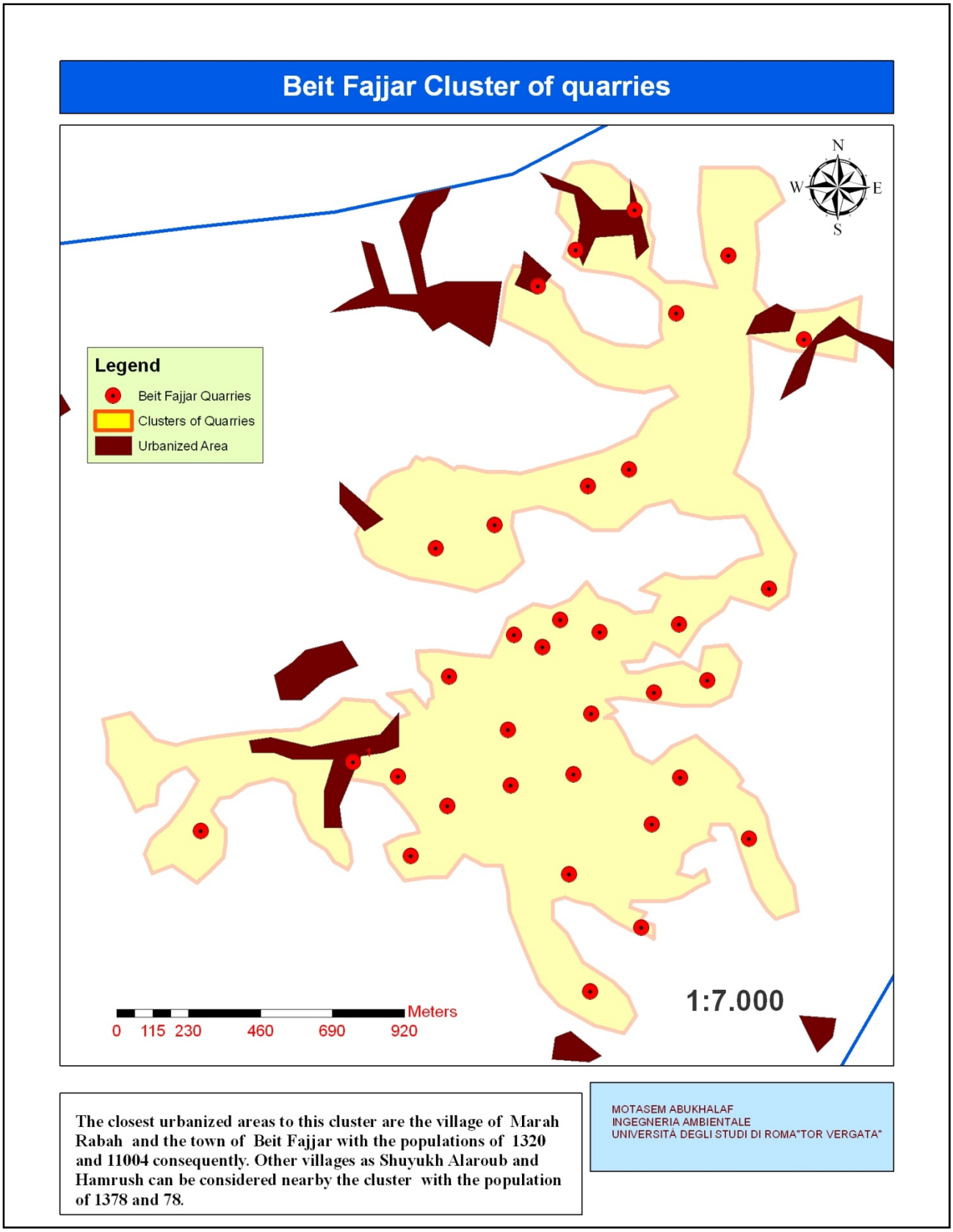


Figure 4.10.e: Beit Fajjar Cluster build up area map.

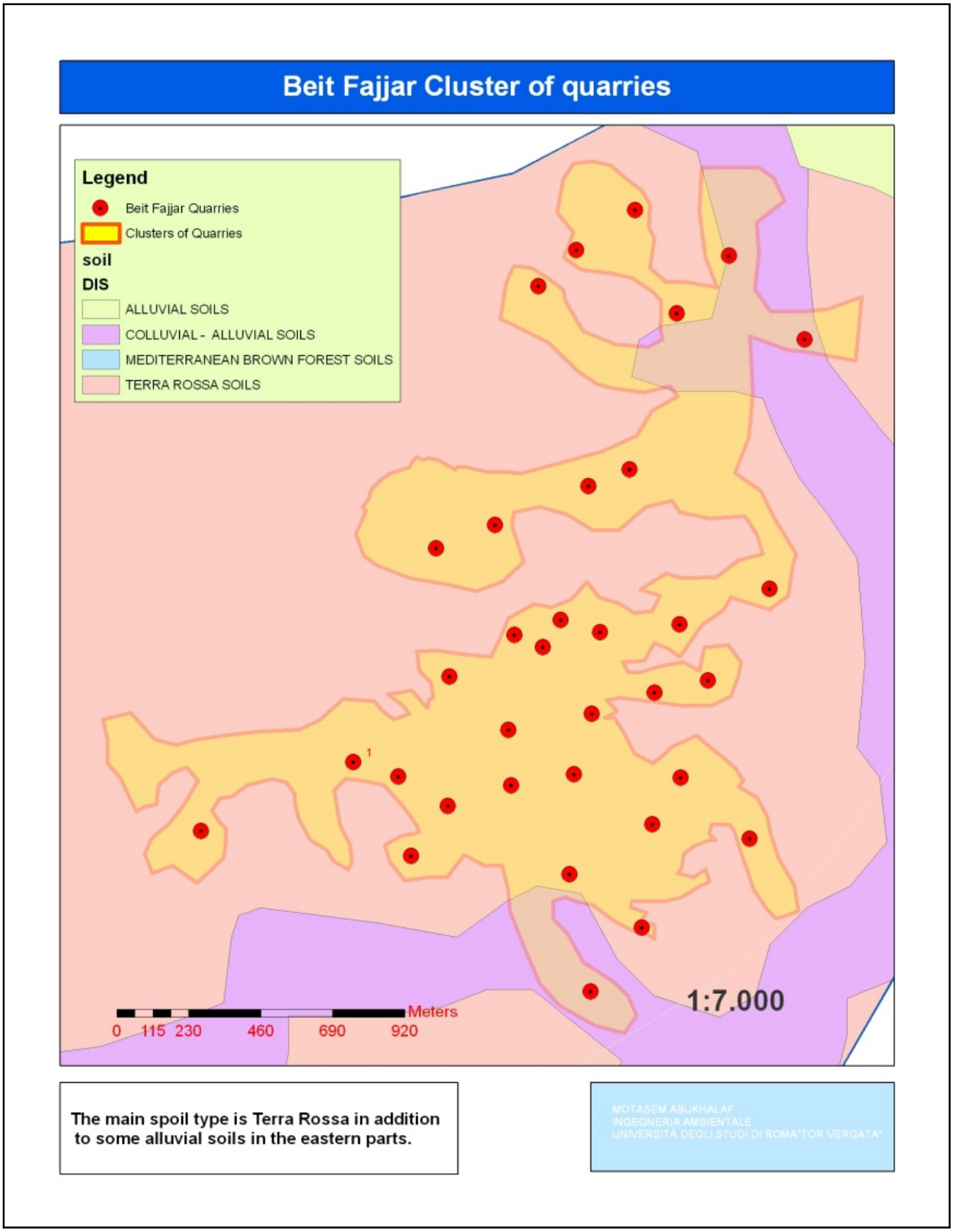


Figure 4.10.f: Beit Fajjar Cluster soil map.

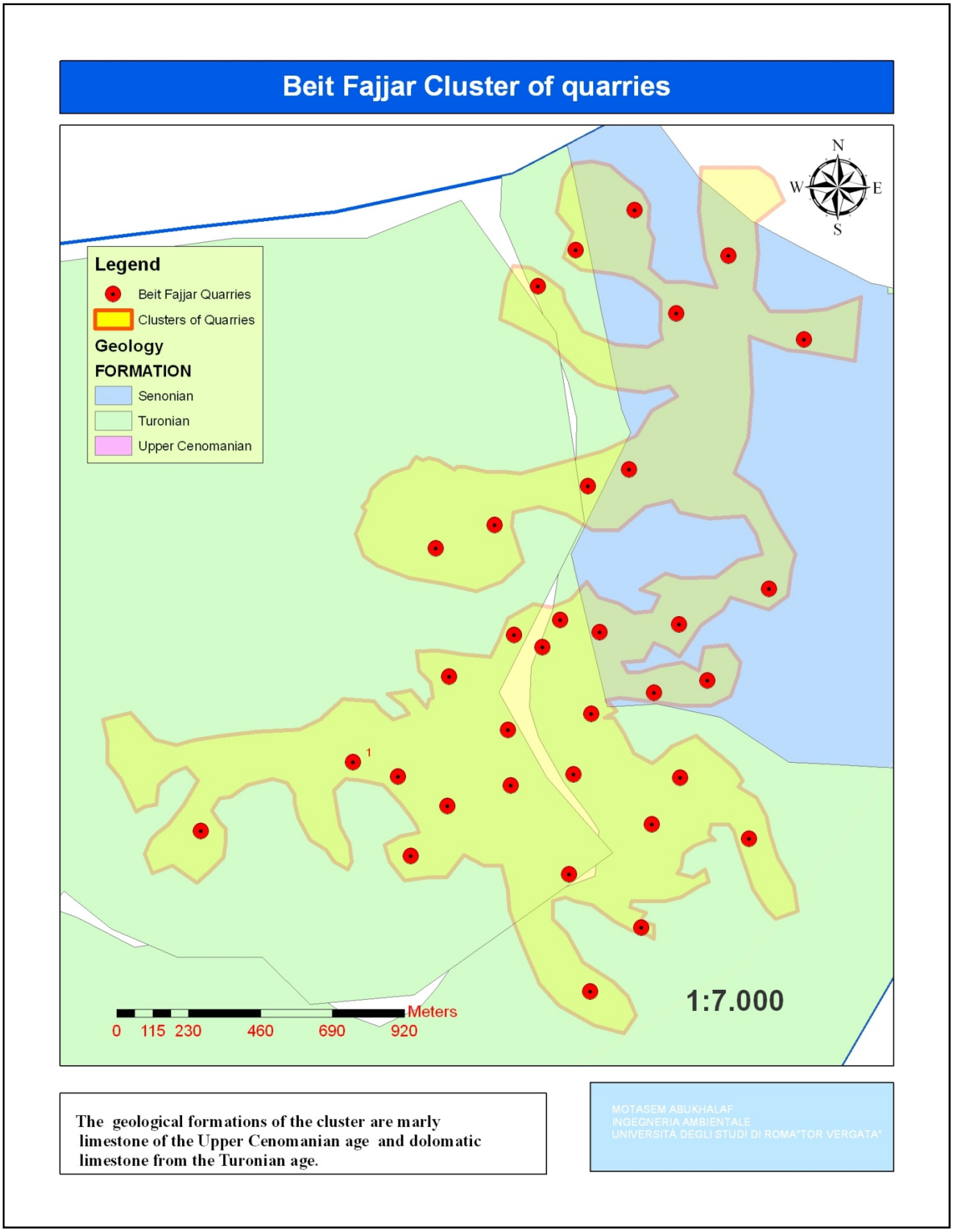


Figure 4.10.g: Beit Fajjar Cluster geological map.

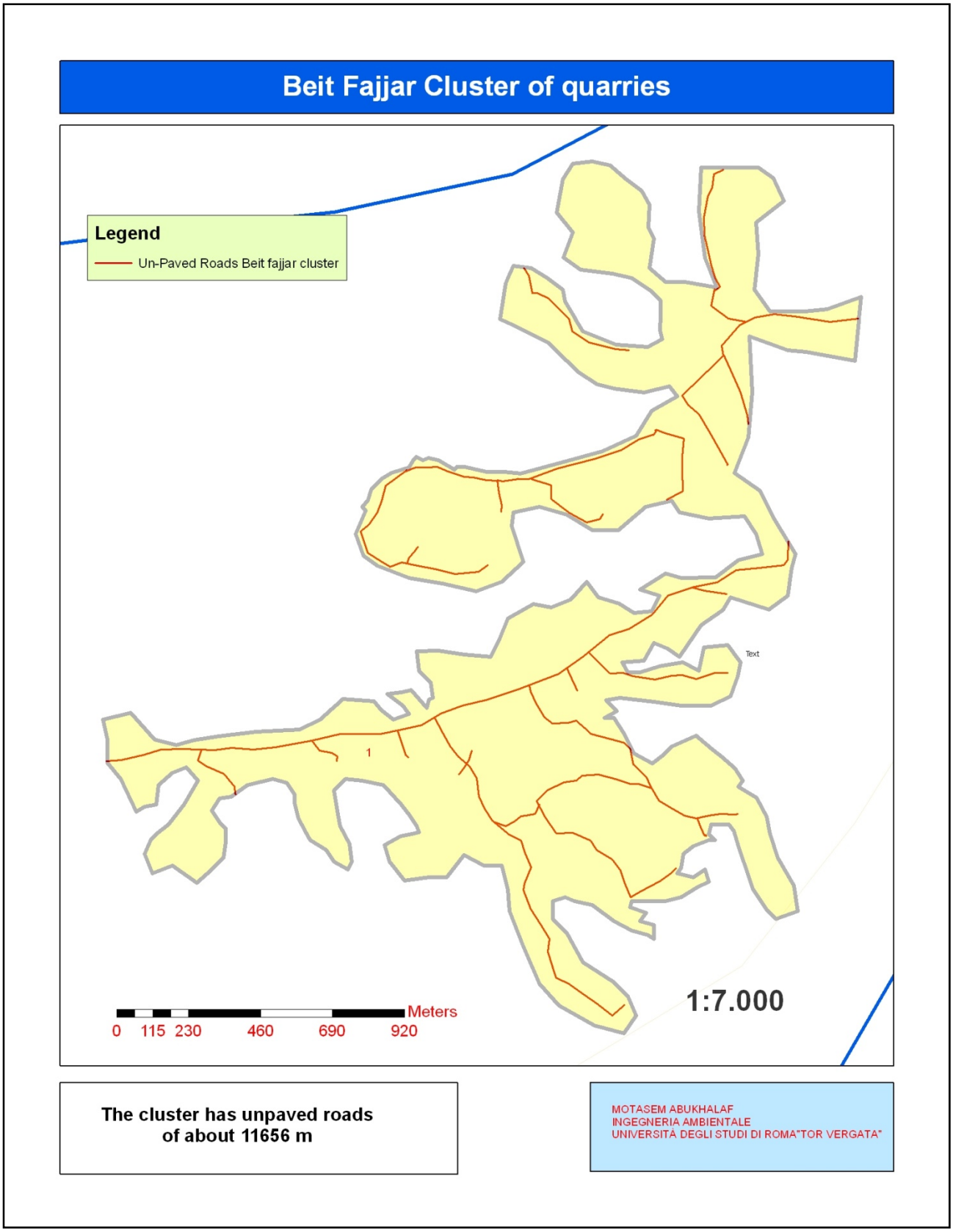


Figure 4.10.h: Beit Fajjar Cluster un-paved roads map.

Irbea Cluster:-

It is located at the middle northern part of the investigated area. It is a plateau or summit surface with an area of approximately 0.31 km^2 . The elevation range of this cluster is from 835 to 885 m above the sea level (asl). It can be divided into two main blocks separated by cultivated drainage depression.

The land use of the surrounding area can be classified as a blend of grazing and sporadically cultivated land (natural area with some agricultural vegetation). The closest urbanized area to this cluster is the villages of Quziba (1,75 km),O'rqan Trad (0.6 km),Shuyukh Alarroub (1,9 km) with a population of 475,509 and 1378 consequently. It is about half kilometer from the cluster. There are some sporadic houses nearby the cluster in addition to a small hamlet called Hamrush with a population of 78.
The geological formations of the cluster are marly limestone of the Upper Cenomanian age and dolomatic limestone from the Turonian age.
The elevation of ground water contours under the cluster area ranges from 400-500 m (asl).

It has about 20 quarries most of them are abandoned .The cluster has unpaved roads of about 3640 m .
Detailed maps are shown in Figures(4.11.a-i).

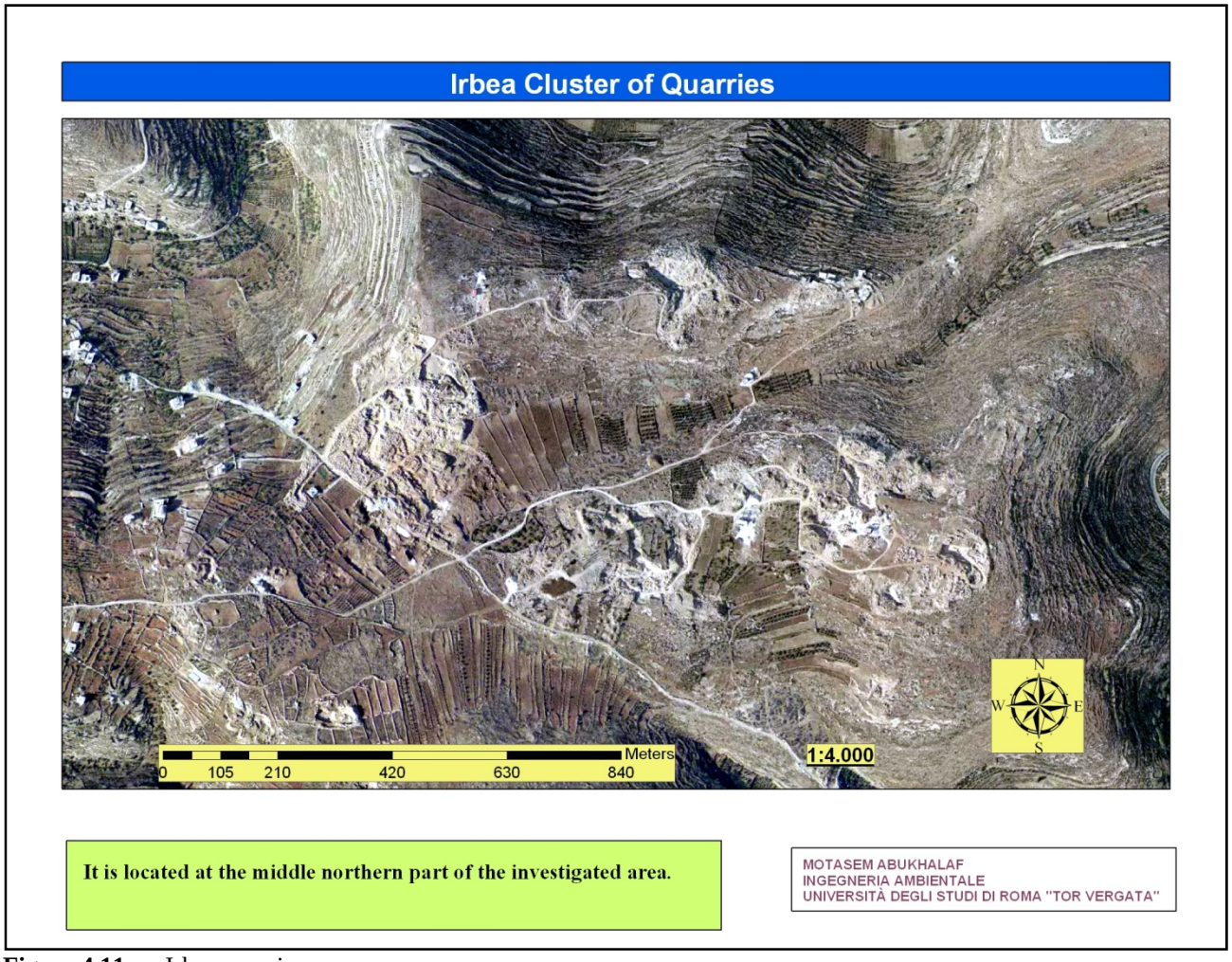


Figure 4.11.a: Irbea quarries area map

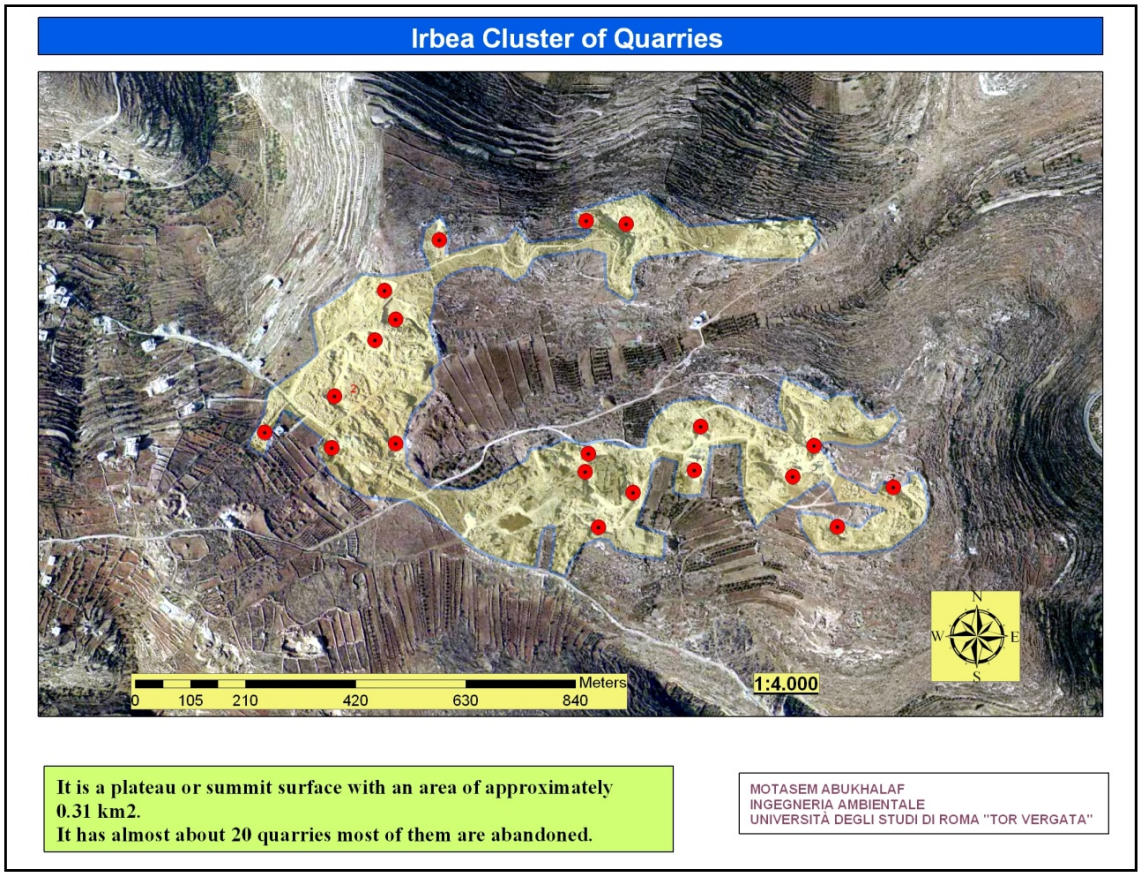


Figure 4.11.b: Irbea Cluster of quarries map.

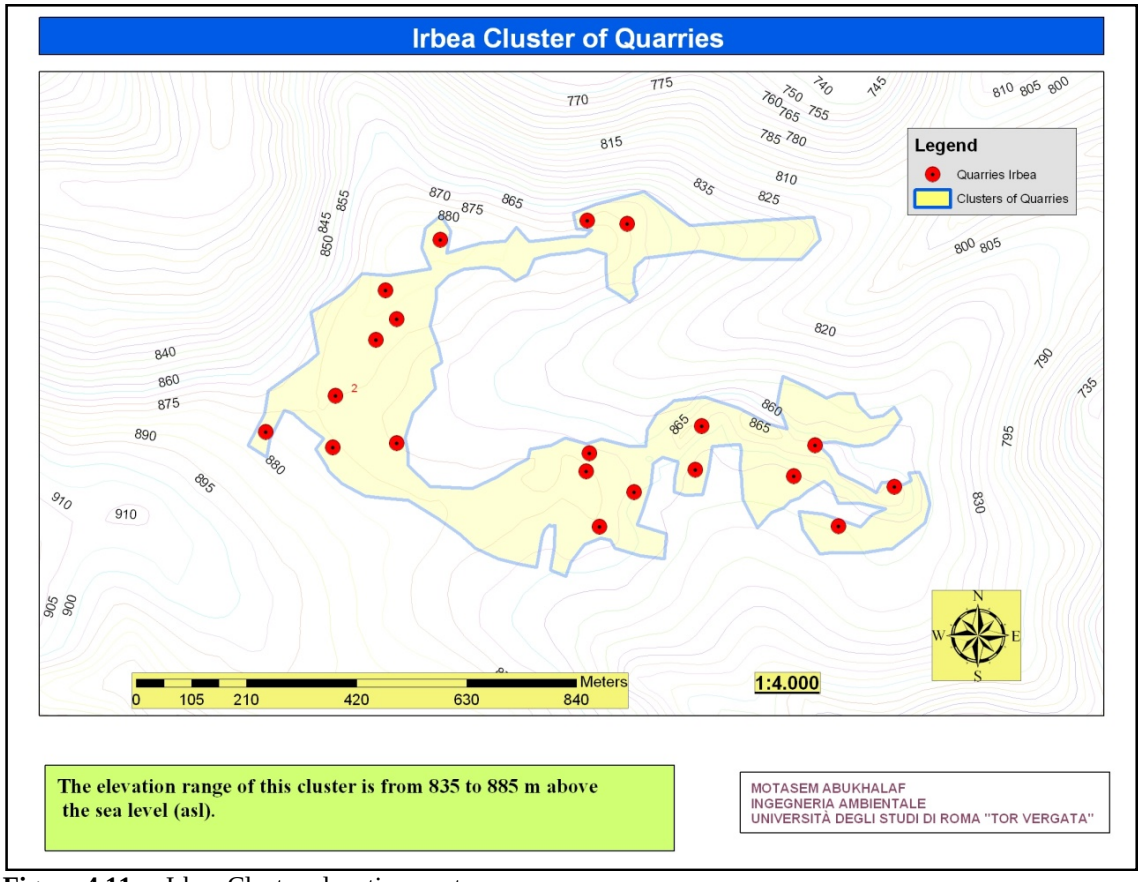


Figure 4.11.c: Irbea Cluster elevation contours map.

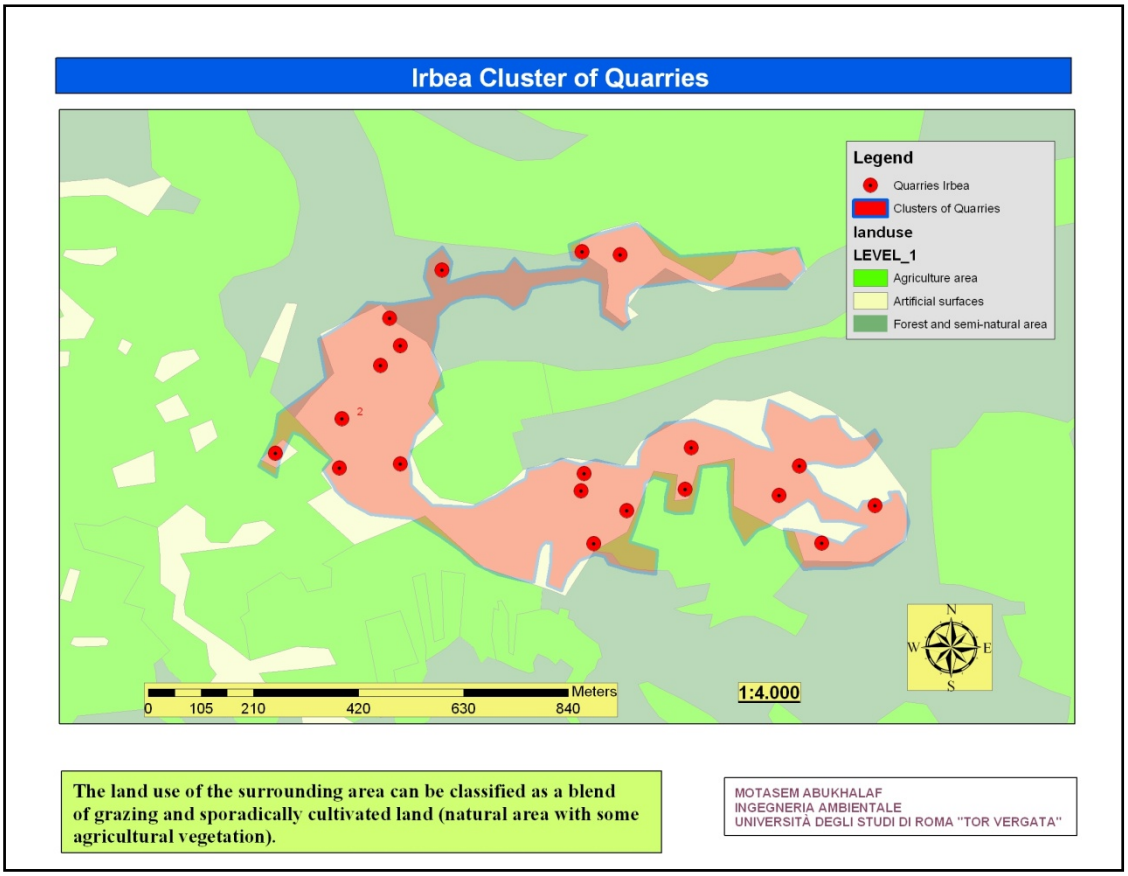


Figure 4.11.d: Irbea Cluster land cover/use map.

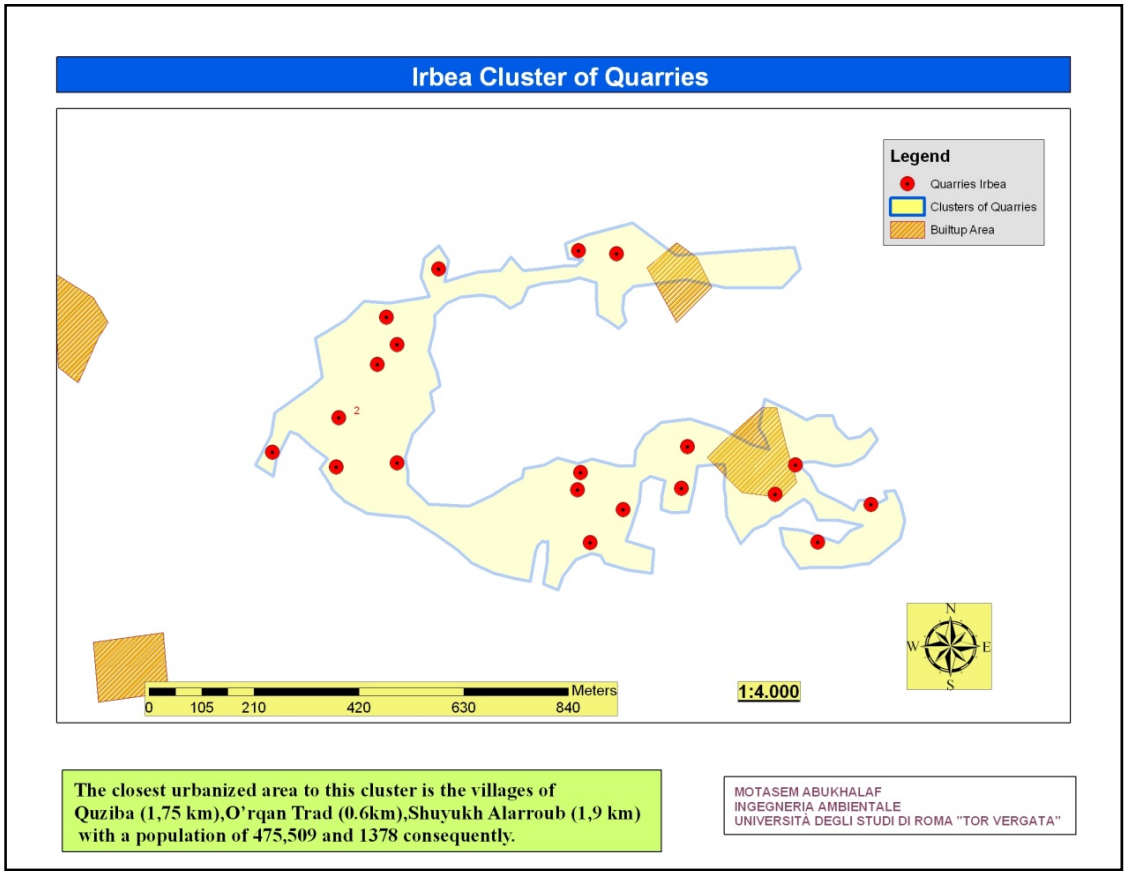


Figure 4.11.e: Irbea cluster build up area map.

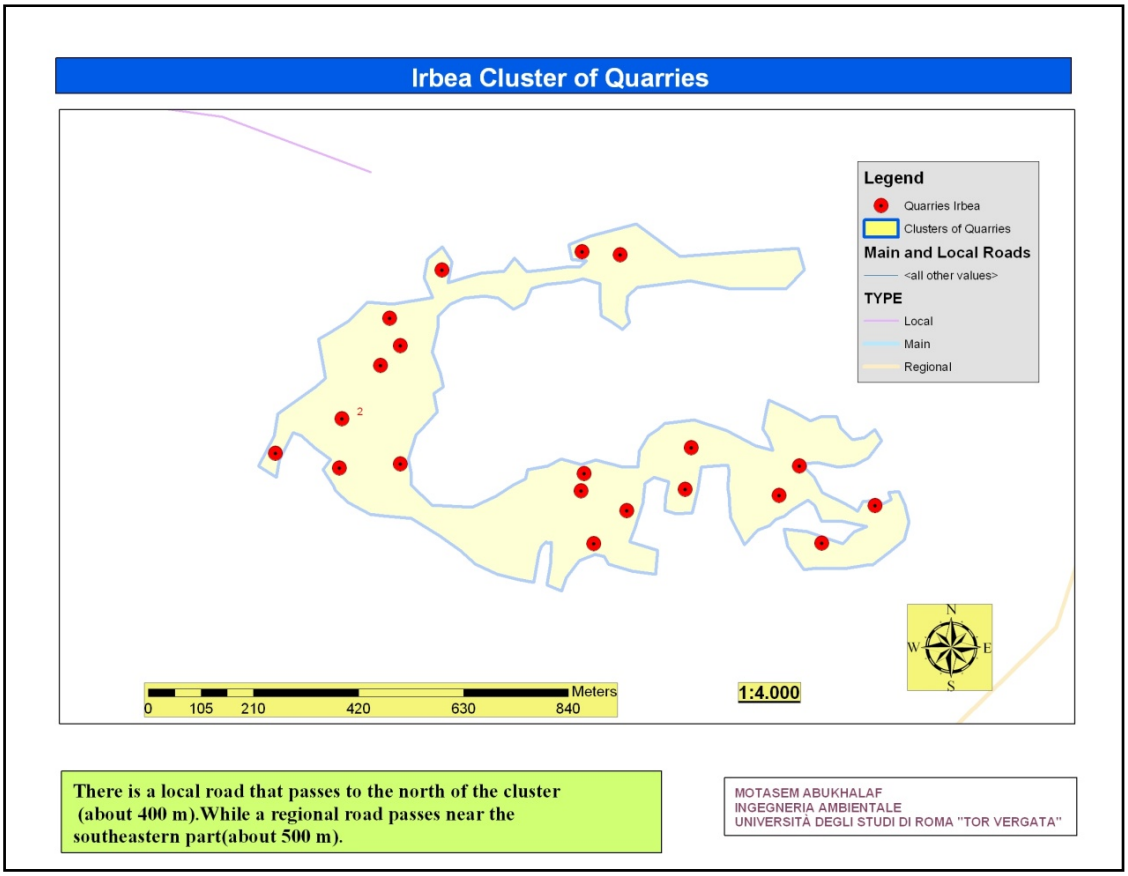


Figure 4.11.f: Irbea cluster Main and Local roads map.

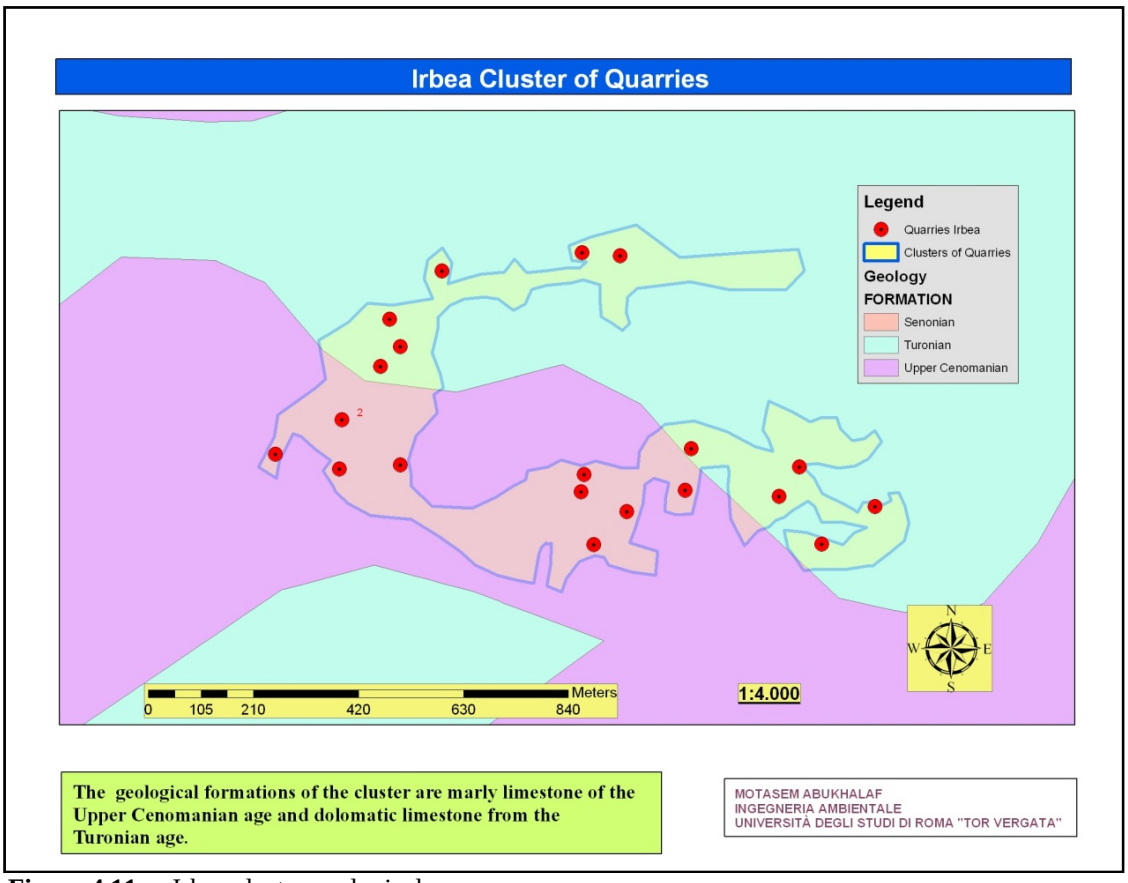


Figure 4.11.g: Irbea cluster geological map.

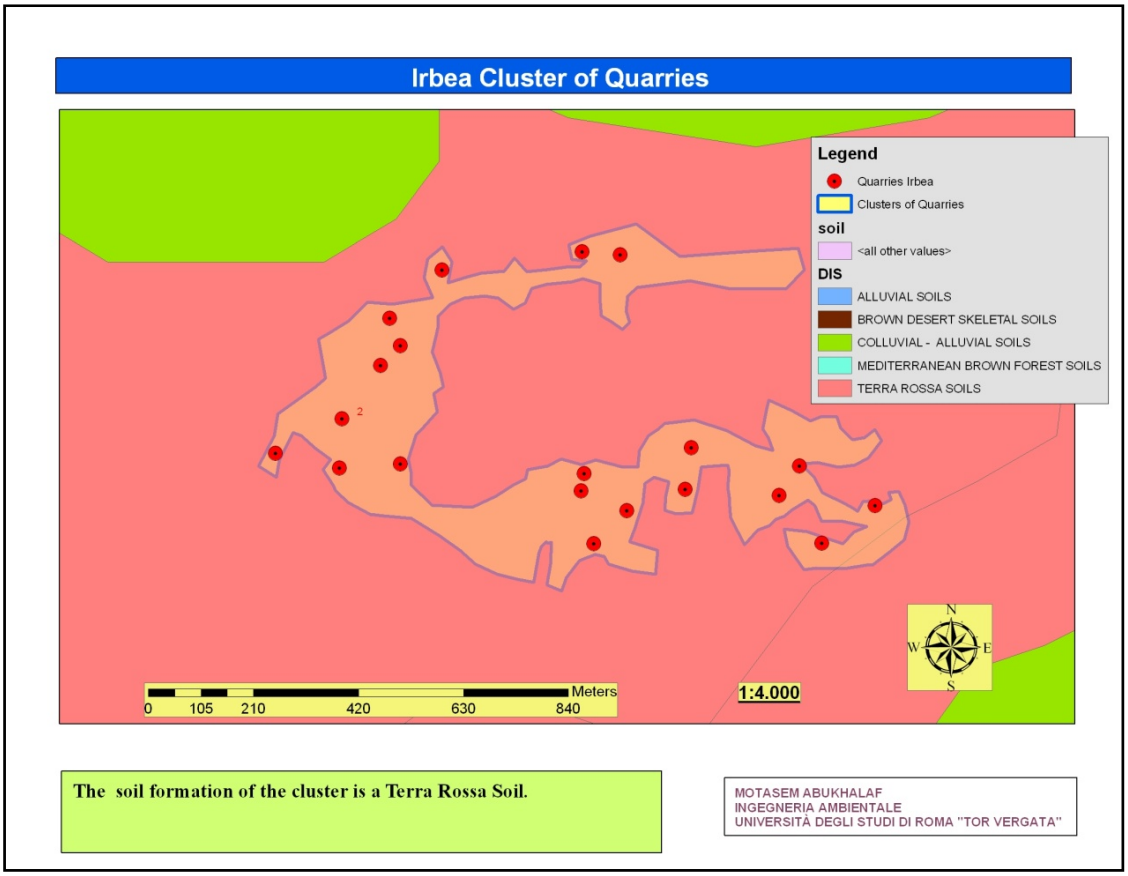


Figure 4.11.h: Irbea cluster soil map.

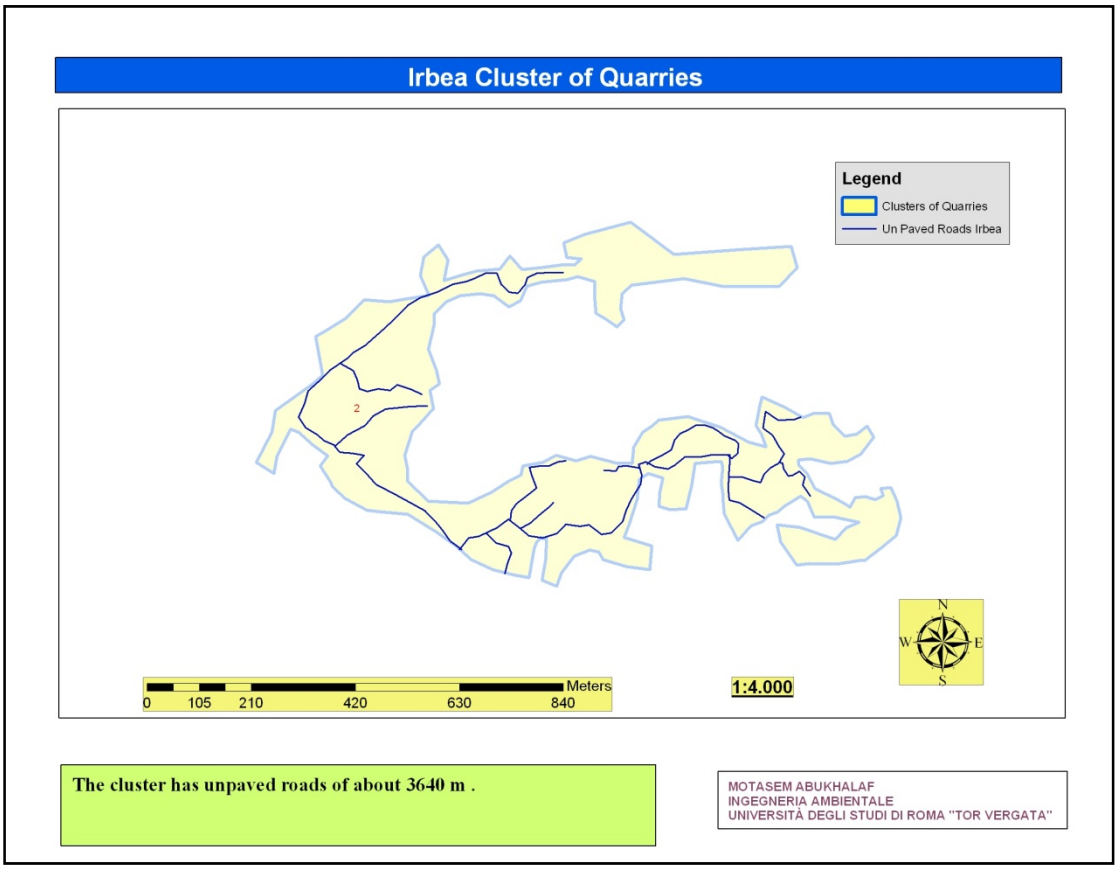


Figure 4.11.i: Irbea cluster un-paved roads map.

Shyoukh /north Cluster :-

It is located at the upper mid eastern part of the investigated area directly to the southeast of Shyoukh town. Its topography is a blend between plateaus and narrow valleys with moderately inclined slopes. It has an area of about 0.95 km^2 . The elevation range of this cluster is from 855 to 920 m above the sea level (asl).

The land use of the surrounding area can be classified mainly as natural grazing area with a few cultivated spots of arable land, orchards or grapes. The closest urbanized area to this cluster is the town of Shyoukh with a population of about 8,432. In addition to the villages Beit Enon and Ras Tawil with the populations of 2439 and 622 consequently.
The geological formation of the cluster is dolomatic limestone from the Turonian age.
The elevation of groundwater table under the cluster area ranges from 400 m (asl).
This cluster has about 45 quarries most of them are abandoned . The cluster has unpaved roads of about 5286 m .

Shyoukh /south Cluster :-

It is located at the upper mid eastern part of the investigated area directly to the southeast of Shyoukh town. Its topography is a blend between plateaus and narrow valleys with moderately inclined slopes. It has an area of about 0.51 km^2 . The elevation range of this cluster is from 805 to 915 m above the sea level (asl).

The land use of the surrounding area can be classified mainly as natural grazing area with a few cultivated spots of arable land, orchards or grapes. The closest urbanized area to this cluster is the town of Alshuyukh with a population of about 8,432. In addition to the villages Beit Enon and Ras Tawil with the populations of 2439 and 622 consequently.
The geological formation of the cluster is dolomatic limestone from the Turonian age.
The elevation of groundwater table under the cluster area ranges from 400 m (asl).

This cluster has about 22 quarries most of them are abandoned . The cluster has unpaved roads of about 4120 m .(see Figures 4.12.a-h).

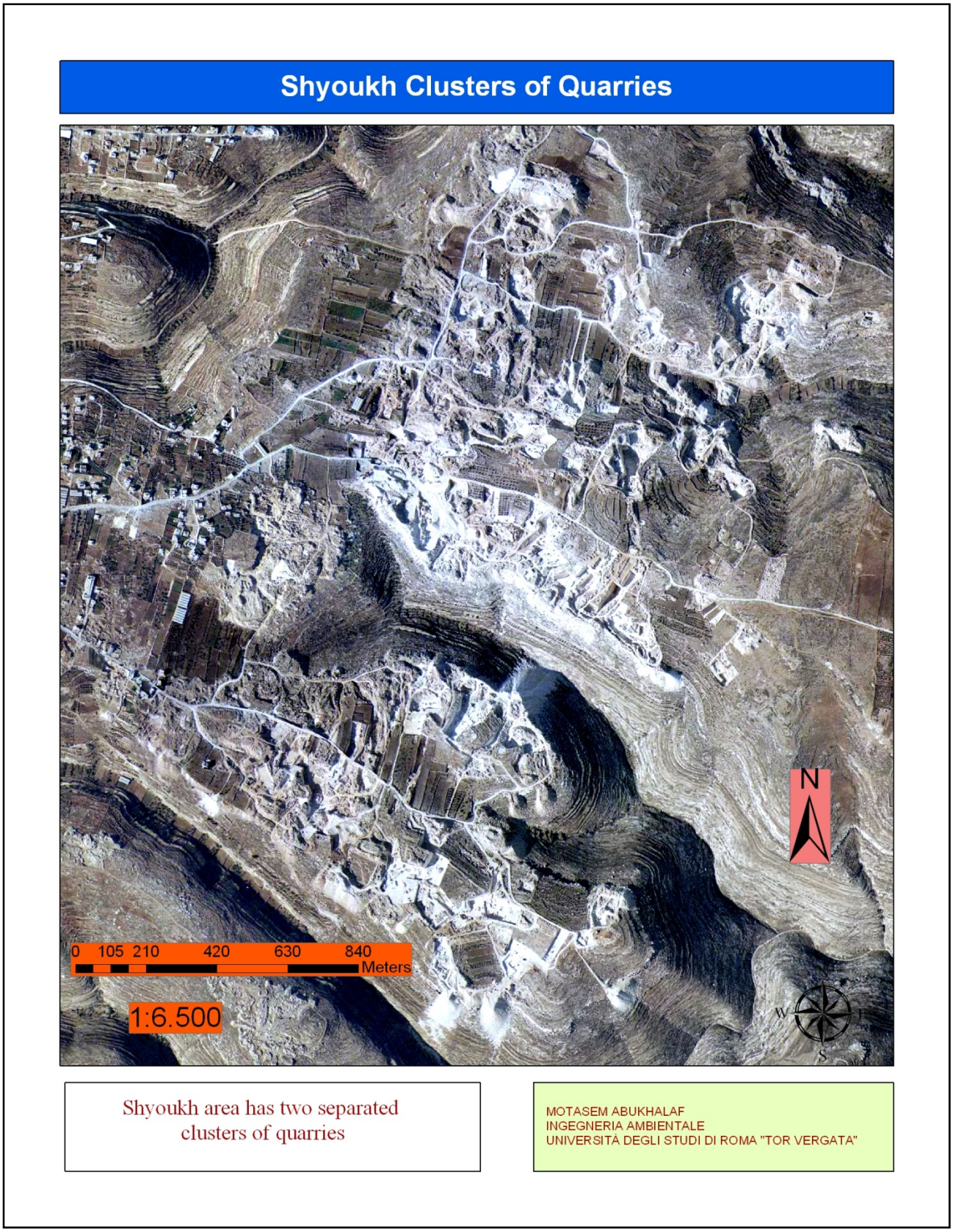


Figure 4.12.a: Shyoukh area quarries map.

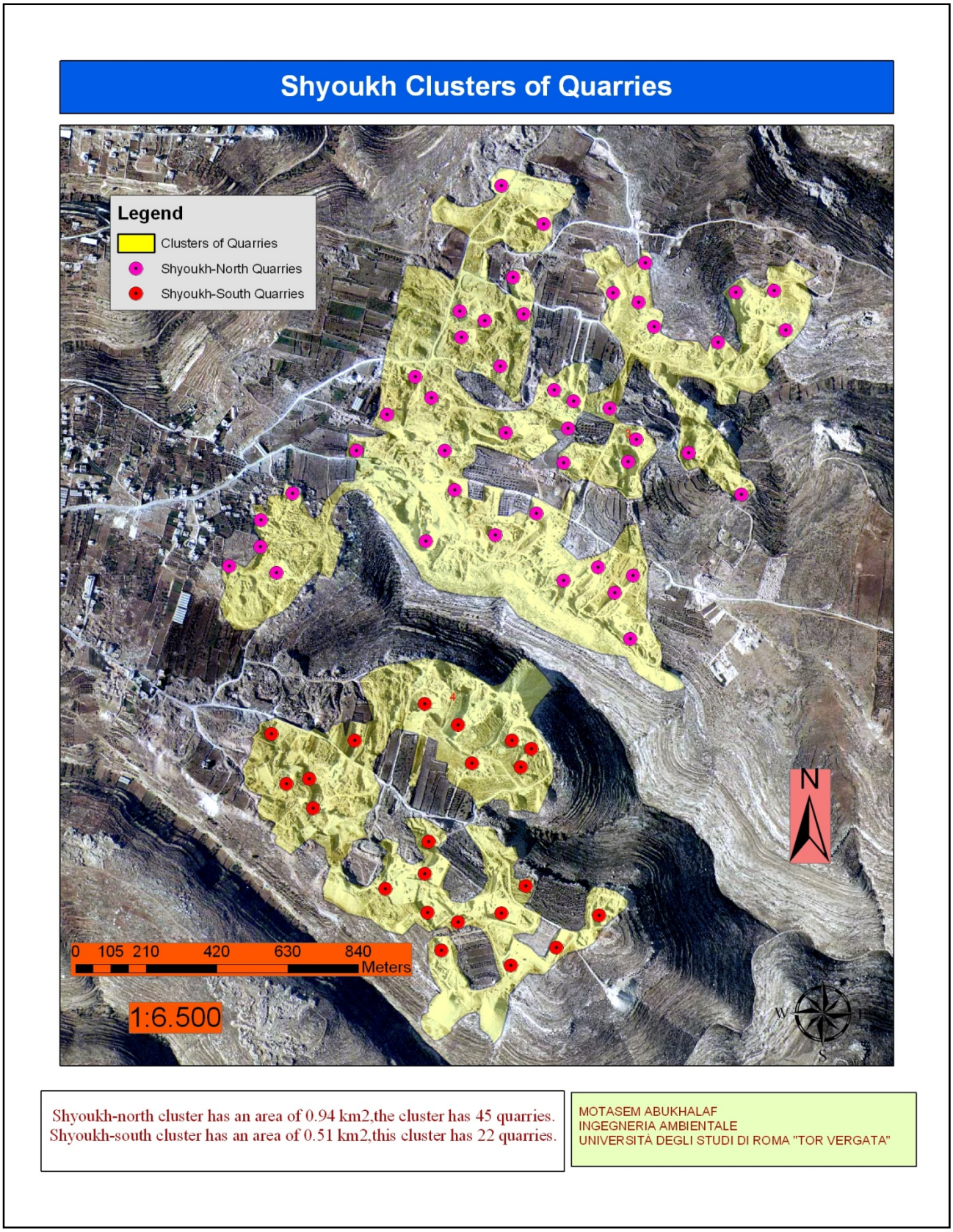


Figure 4.12.b: Shyoukh Clusters of quarries map.

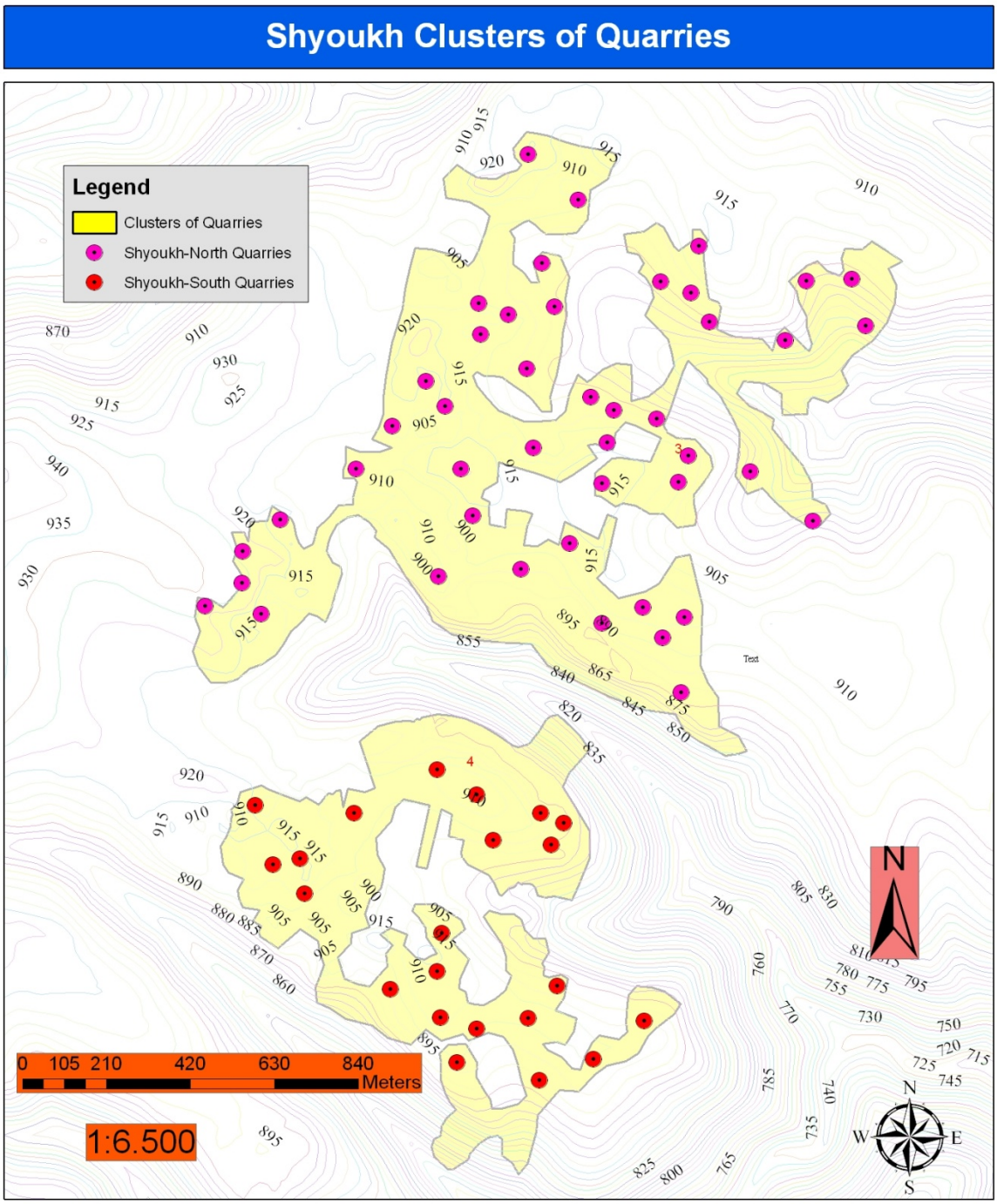


Figure 4.12.c: Shyoukh Clusters elevation contours map.

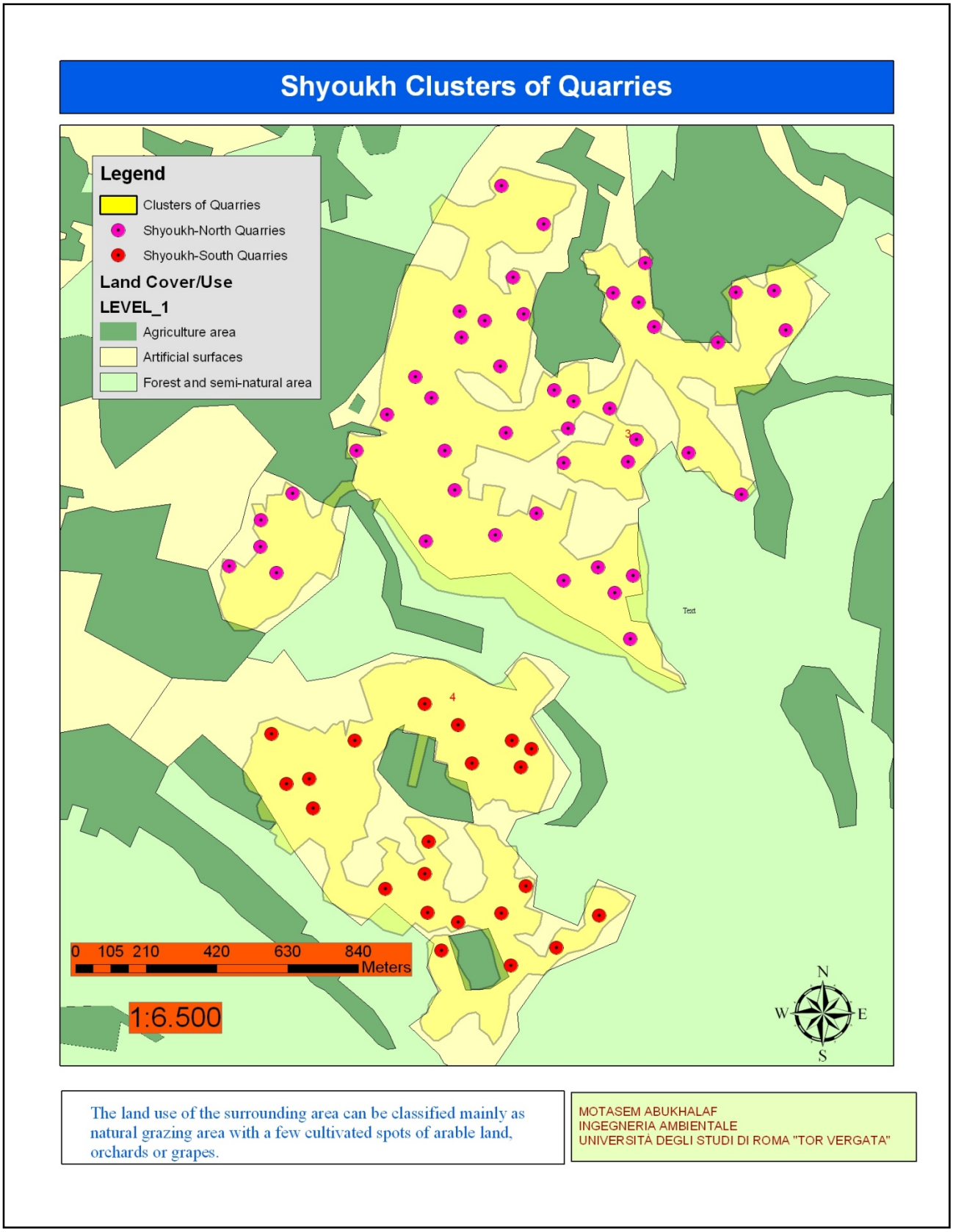


Figure 4.12.d: Shyoukh clusters land cover/use map.

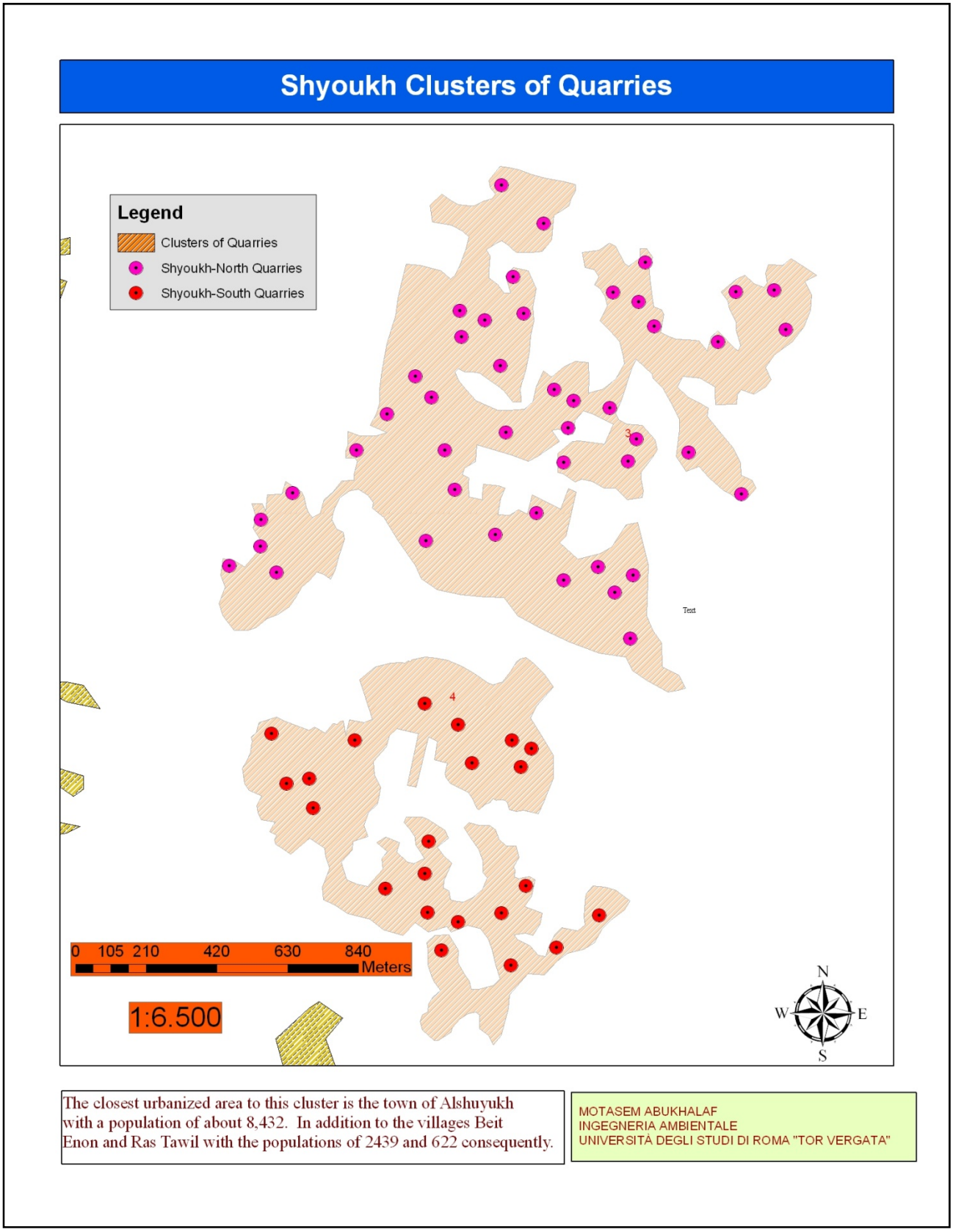


Figure 4.12.e: Shyoukh clusters build up area map.

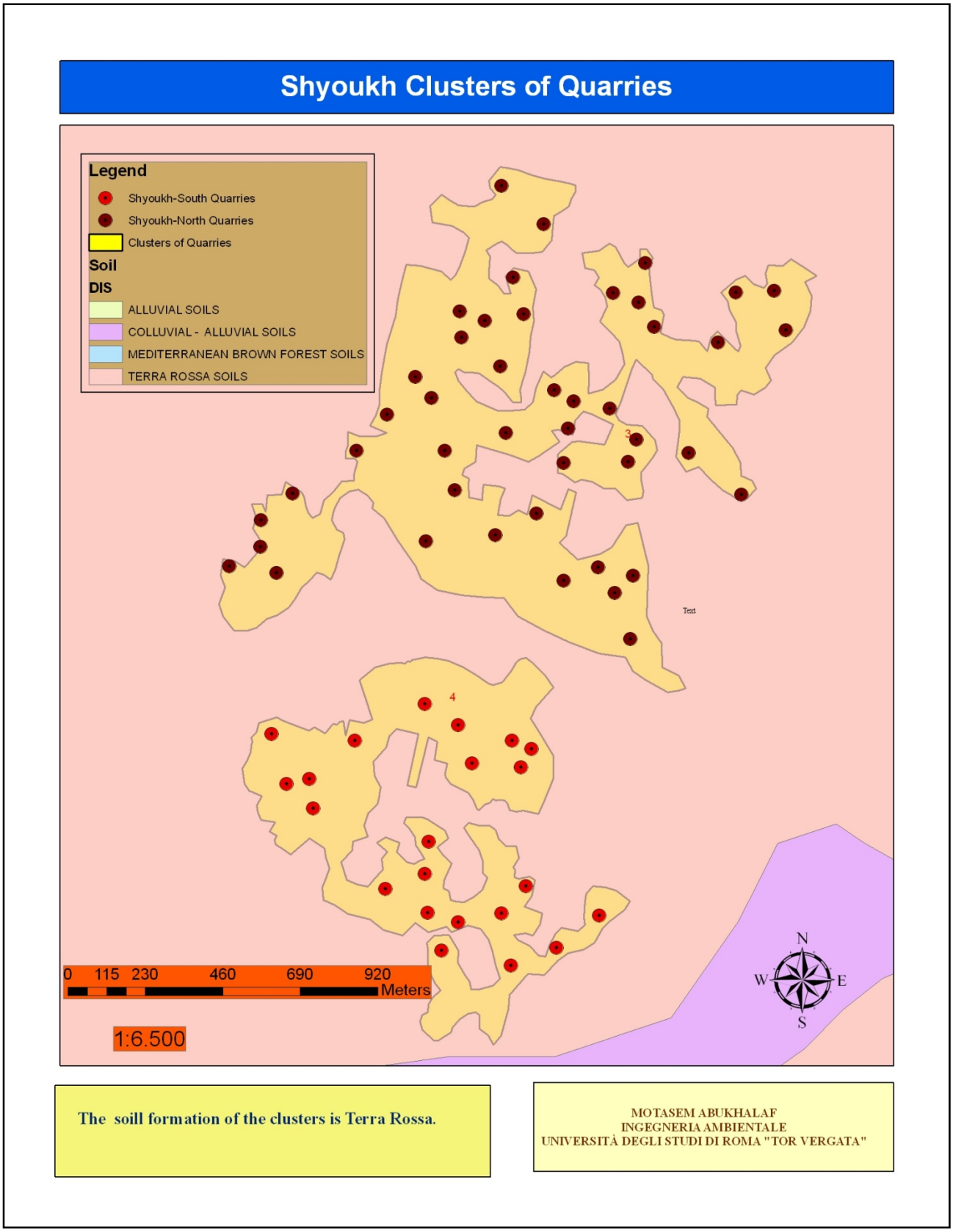


Figure 4.12.f: Shyoukh clusters soil map.

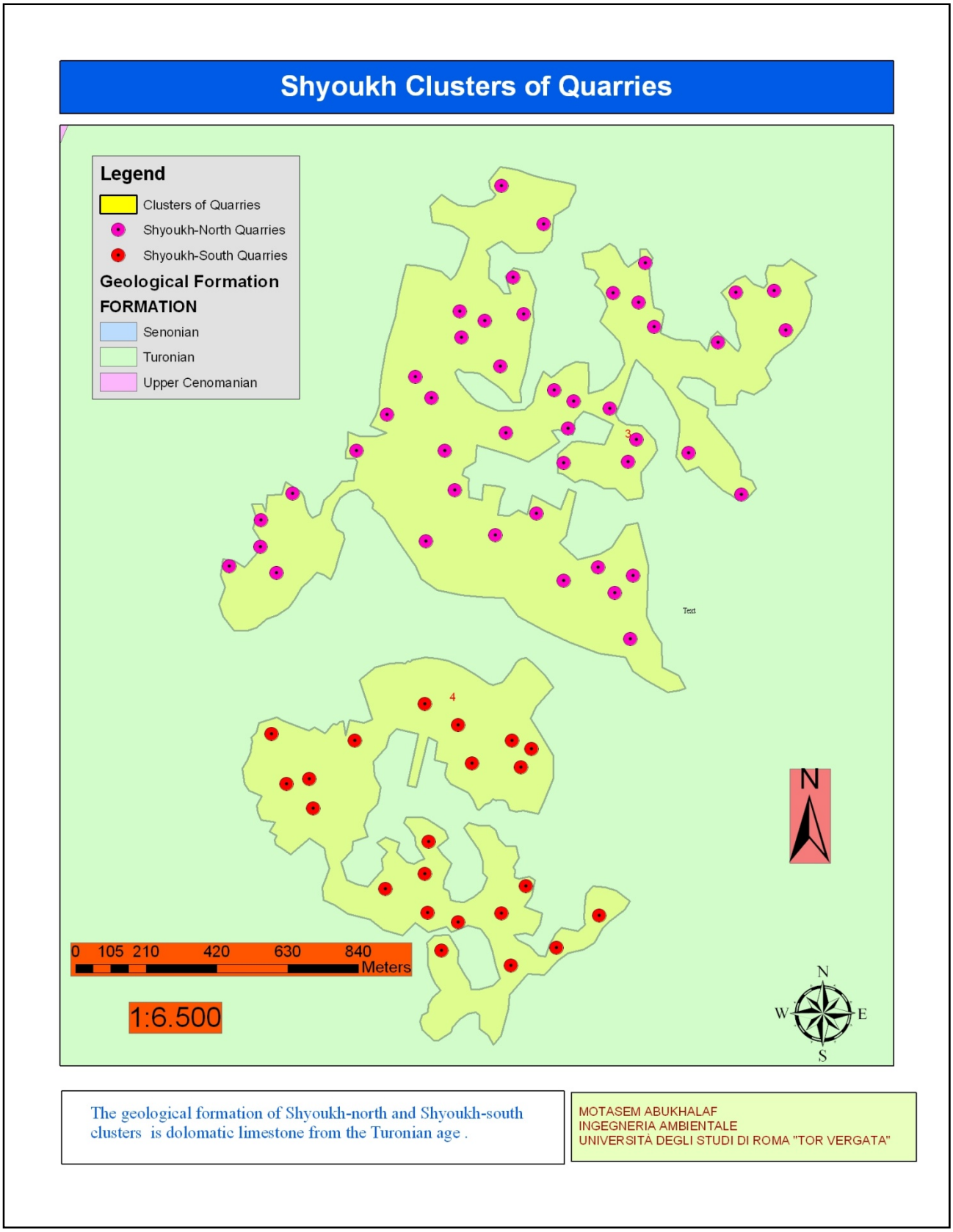


Figure 4.12.g: Shyoukh clusters geological map.

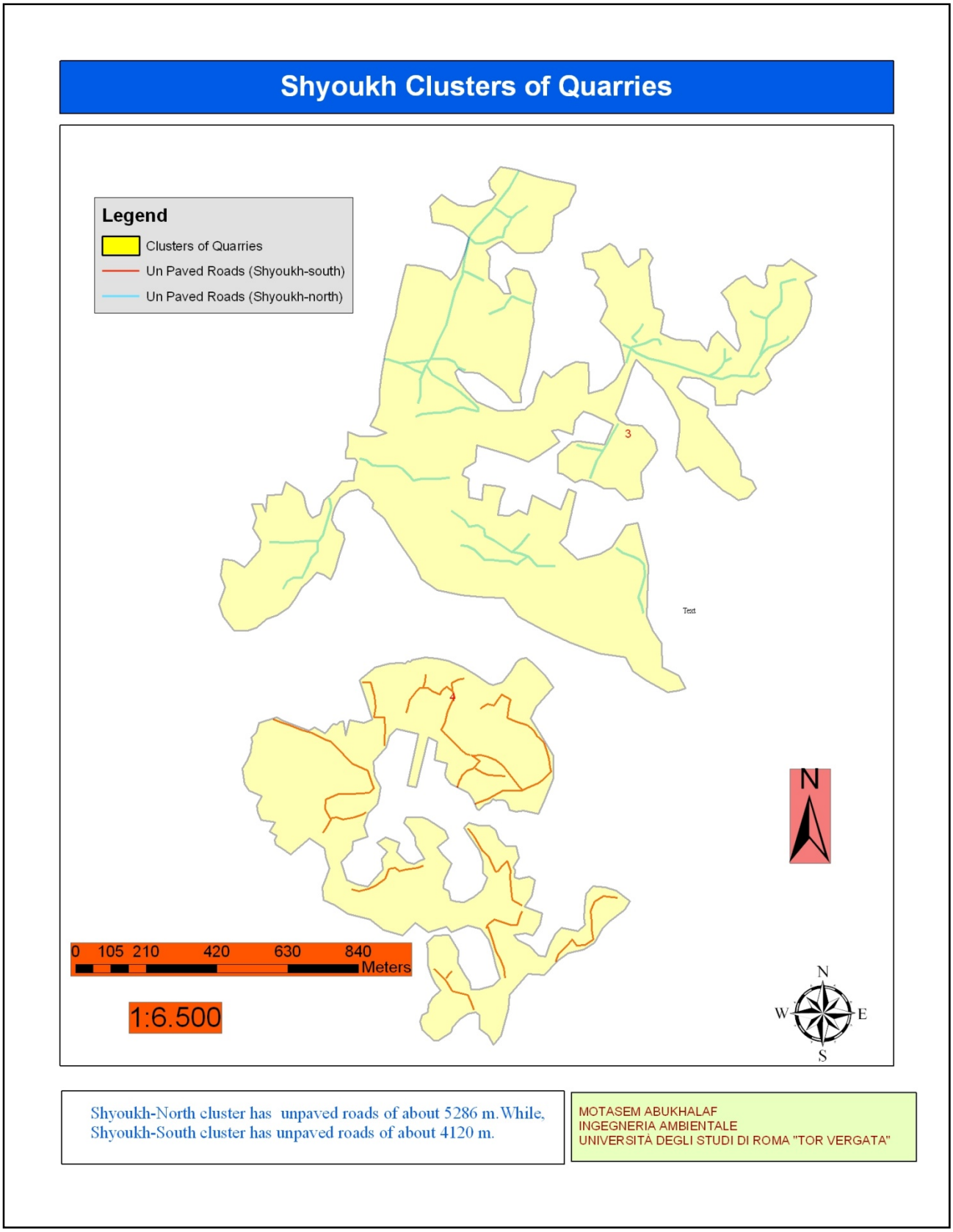


Figure 4.12.h: Shyoukh clusters un-paved roads map.

Injas Clusters :-

These three clusters can be considered as one cluster association separated into three parts by a drainage depression extrapolated to valley at its end and another valley. They are located at the lower mid eastern part of the investigated area. The area of these clusters is called Injasa and its stone is famous with this name. The area of these three clusters (1,2 and 3) is about 2.66 km^2 (1.59, 7.3 and 0.34 km^2 respectively). The clusters 1 and 2 topography is similar to that of Shyoukh clusters. The topography of cluster no.3 is harsh one at its northern part with less inclined slopes approaching plateau at its southern part. The elevation range of these clusters is from(865 to 980 m asl), (925to 970 m asl), (810 to 930 m asl)consequently. The cluster (Injas 1) has 62 quarries, while clusters (Injas 2) and (Injas 3) has 26 and 9 quarries respectively.
The land use of the surrounding area can be classified mainly as natural grazing area with more cultivated spots of arable land, orchards or grapes than that found at Shyoukh clusters, some sporadic houses in addition to cutting stone plants are located adjacent to the southern part of these clusters. The closest urbanized area to these clusters is the town of Bani Naim with a population of about 18,883.Other urbanized area are close to these cluster such as Masafer Bani Naim and Alo'daiseh with the population of about 234 and 1474.
The geological formation of the cluster no.1 and cluster no.2 are marly limestone of the Upper Cenomanian age, whereas the geological formation of the cluster no.3 is dolomatic limestone from the Turonian age.
The elevation of groundwater table under cluster no.1 and no.2 is 400 m (asl).While it is 300 m (asl) under cluster no.3.

These clusters are shown in figure 13. The upper cluster (no.1) has 62 quarries with unpaved roads of about 6505 m . The lower cluster (no.2) has 26 quarries with unpaved roads of about 4039 .The smallest eastern cluster (no.3) has 9 quarries, with unpaved roads of about 1787 m .

More details can be shown in Figures (4.13.a – j).

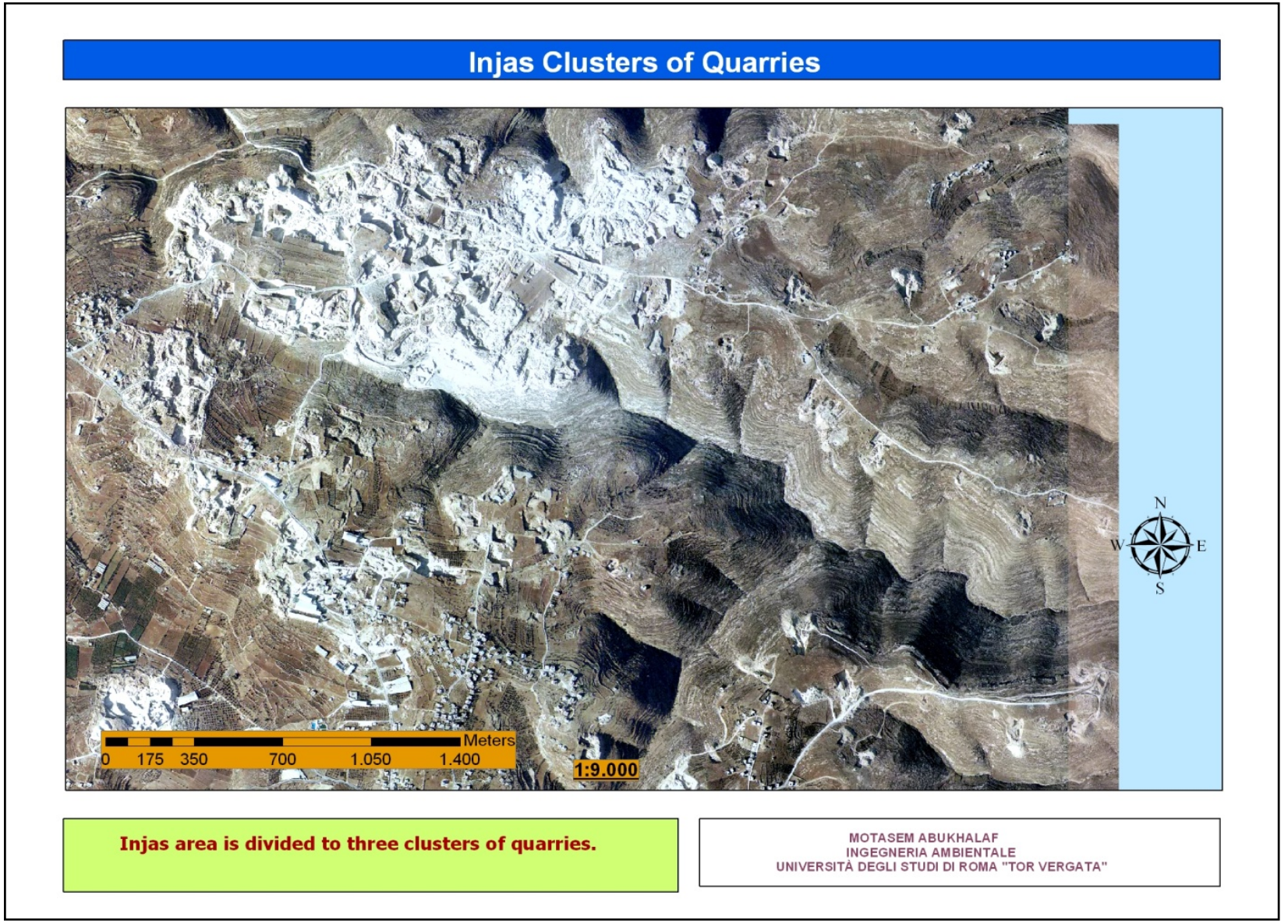


Figure 4.13.a: Injas quarries area map.

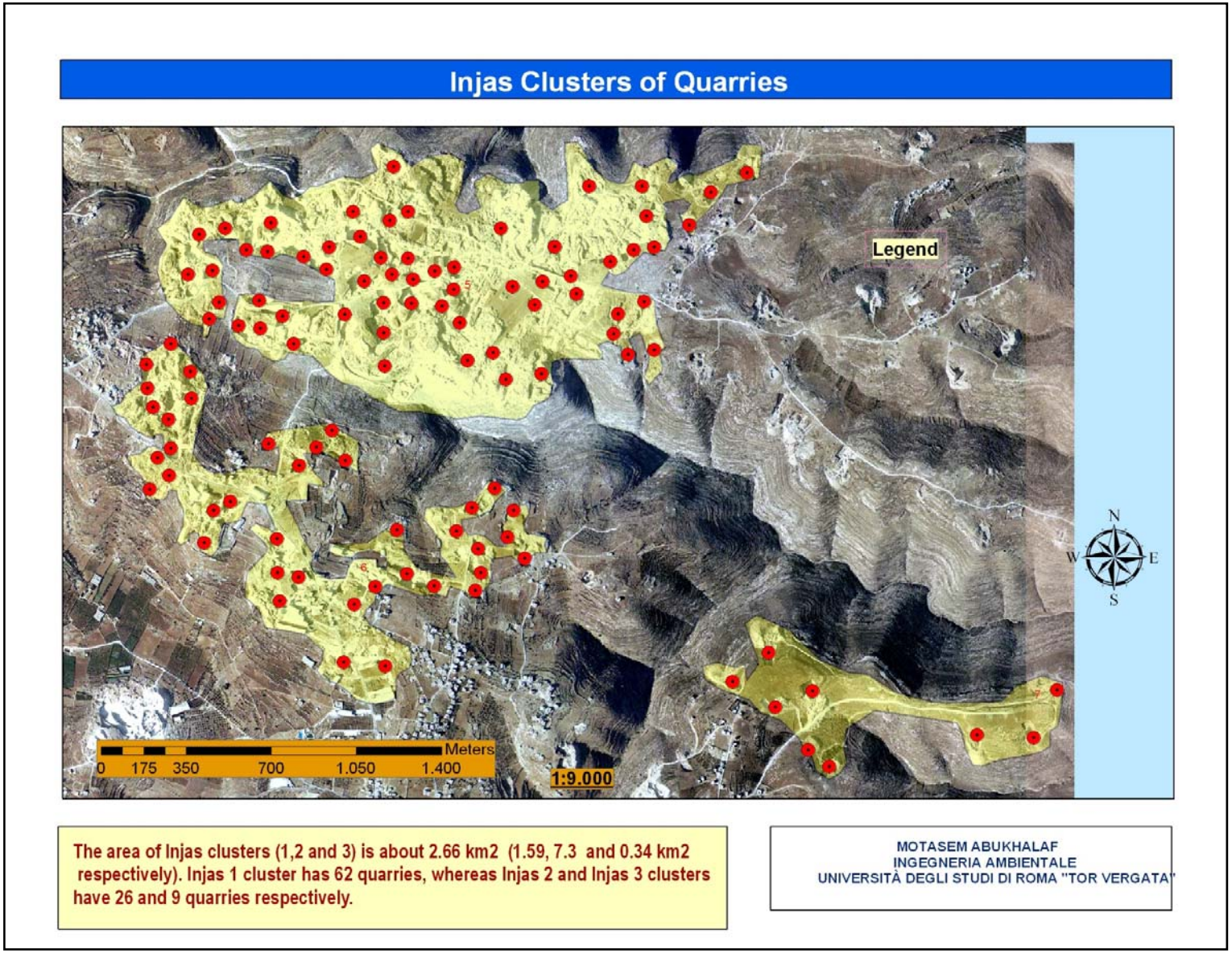


Figure 4.13.b: Injas clusters of quarries map.

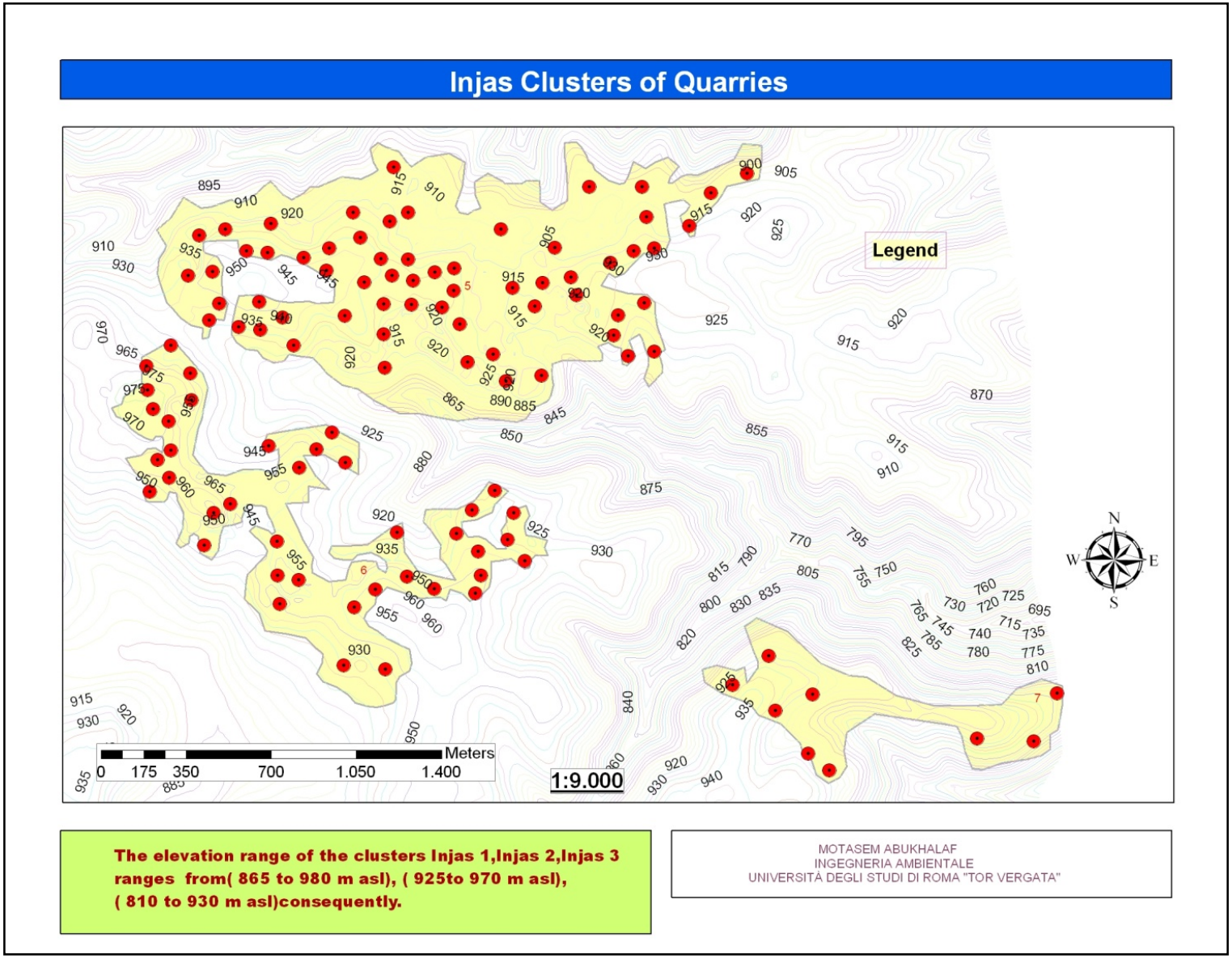


Figure 4.13.c: Injas clusters elevation contours map.

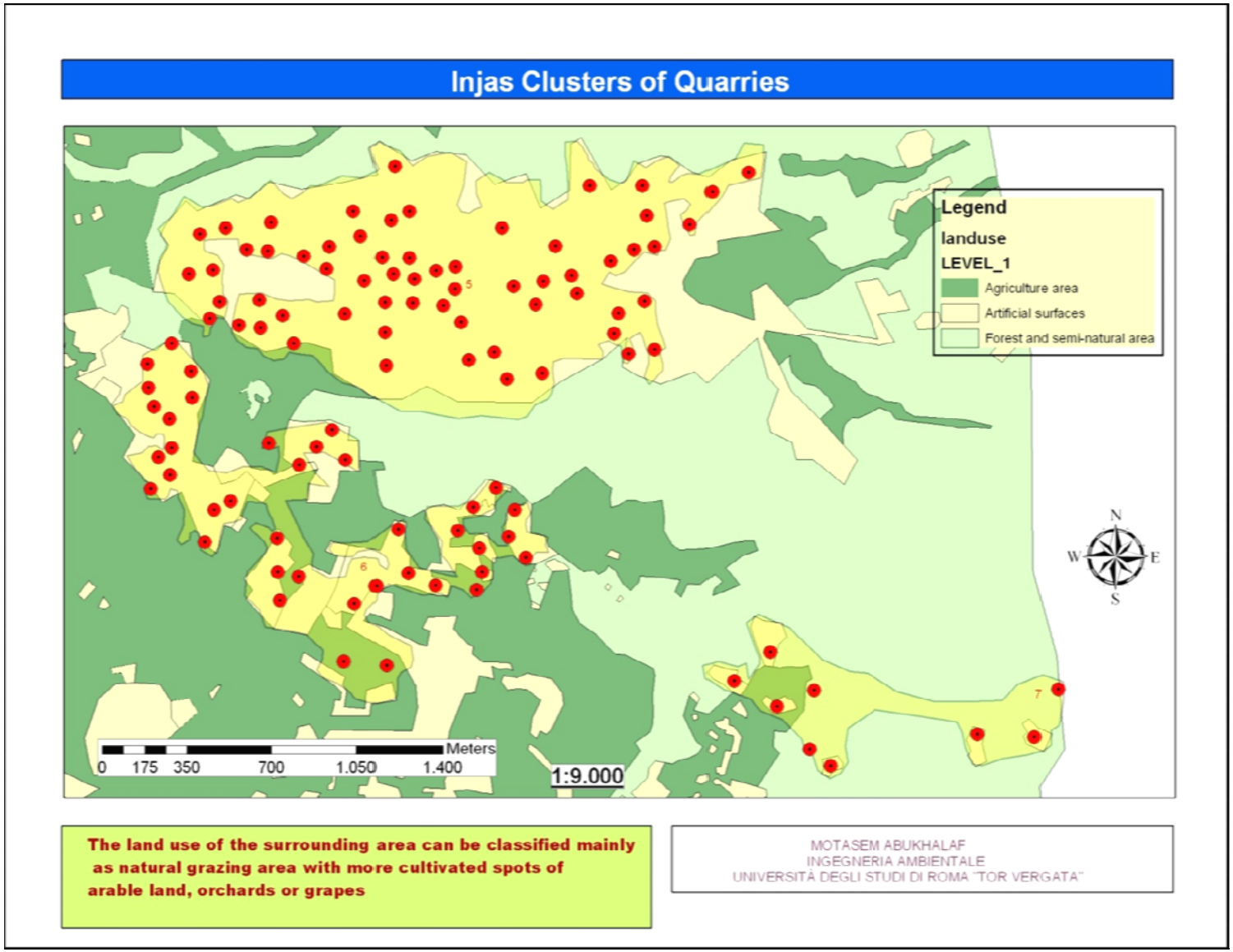


Figure 4.13.e: Injas clusters land cover/use map.

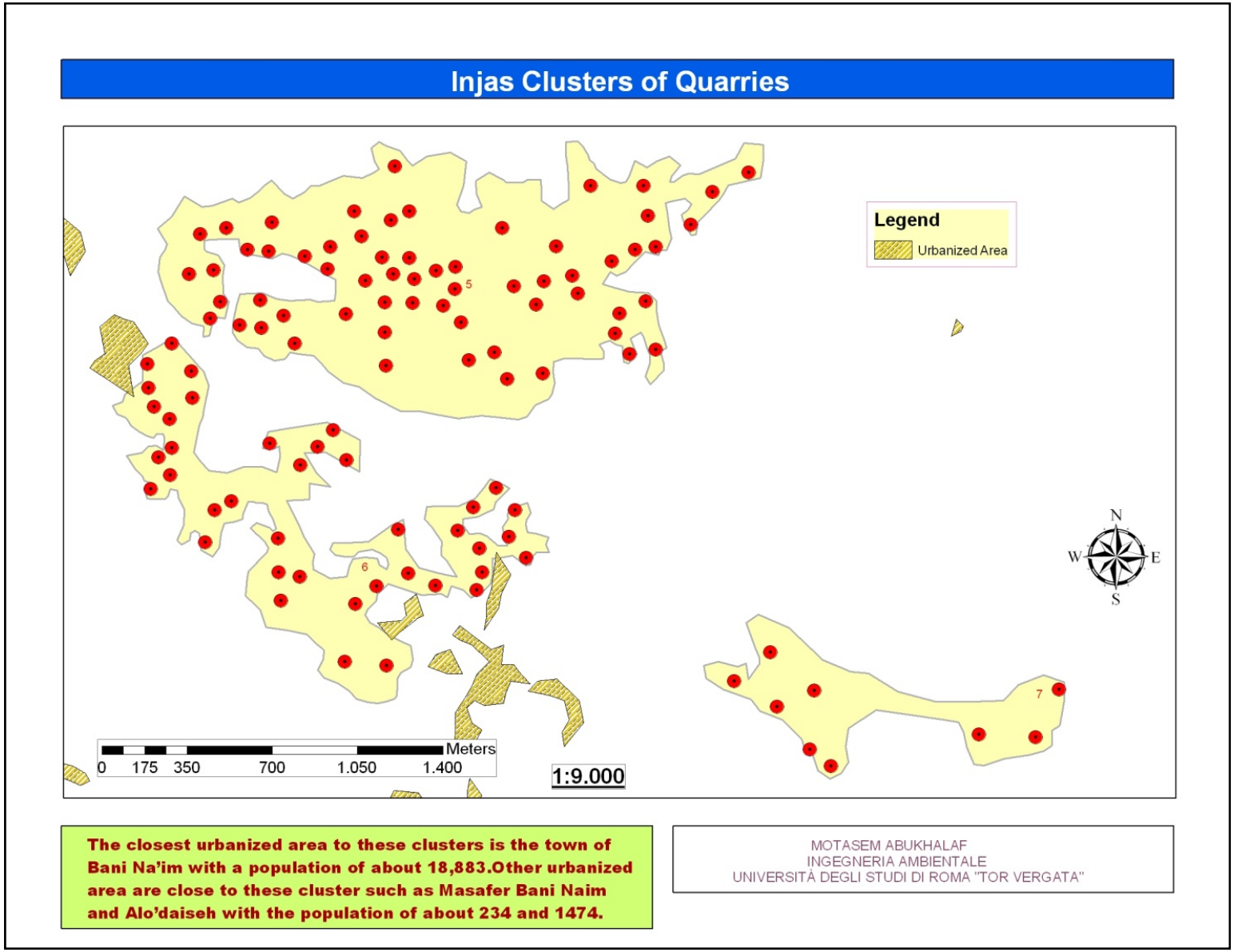


Figure 4.13.f: Injas clusters build up area map.

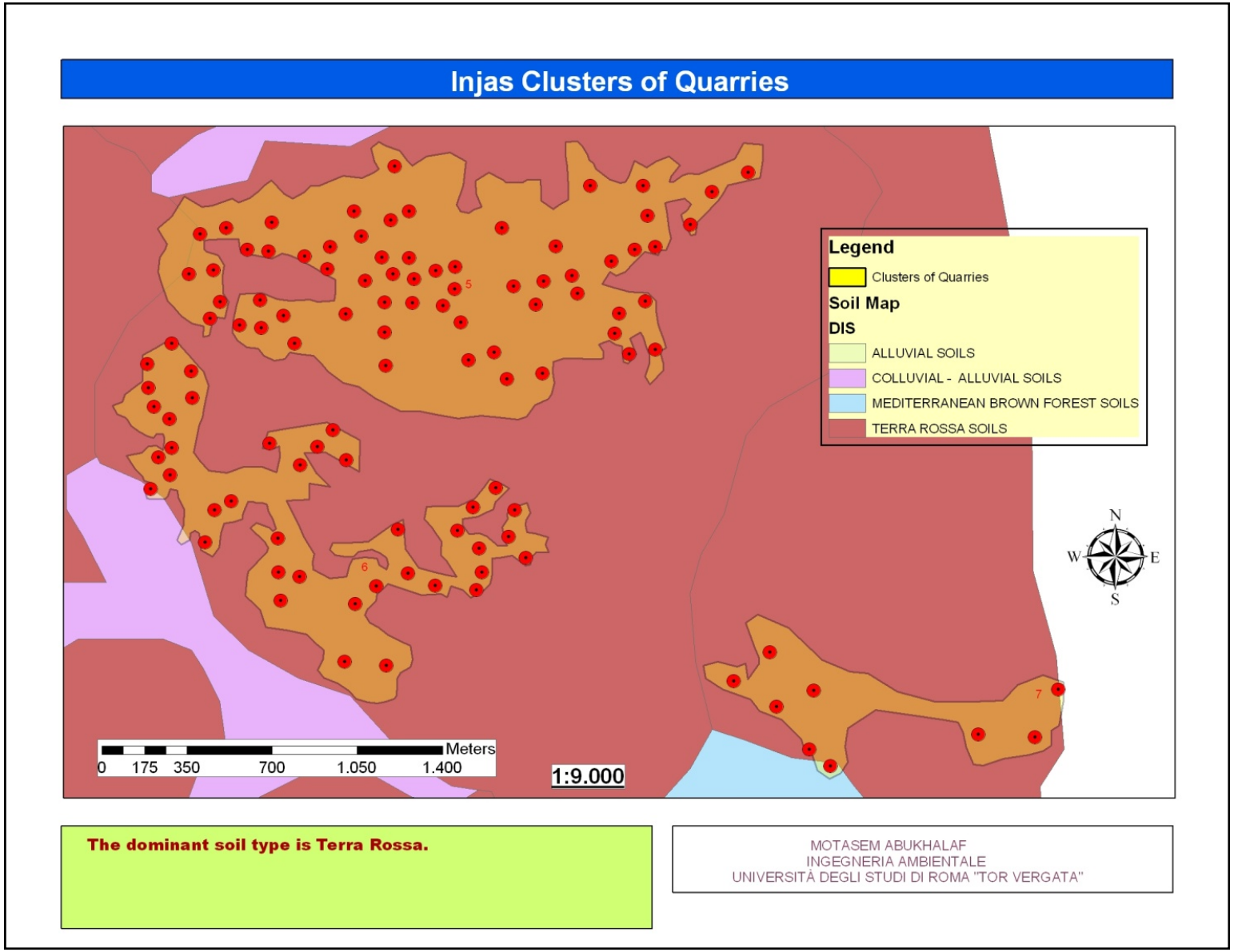


Figure 4.13.g: Injas clusters soil map.

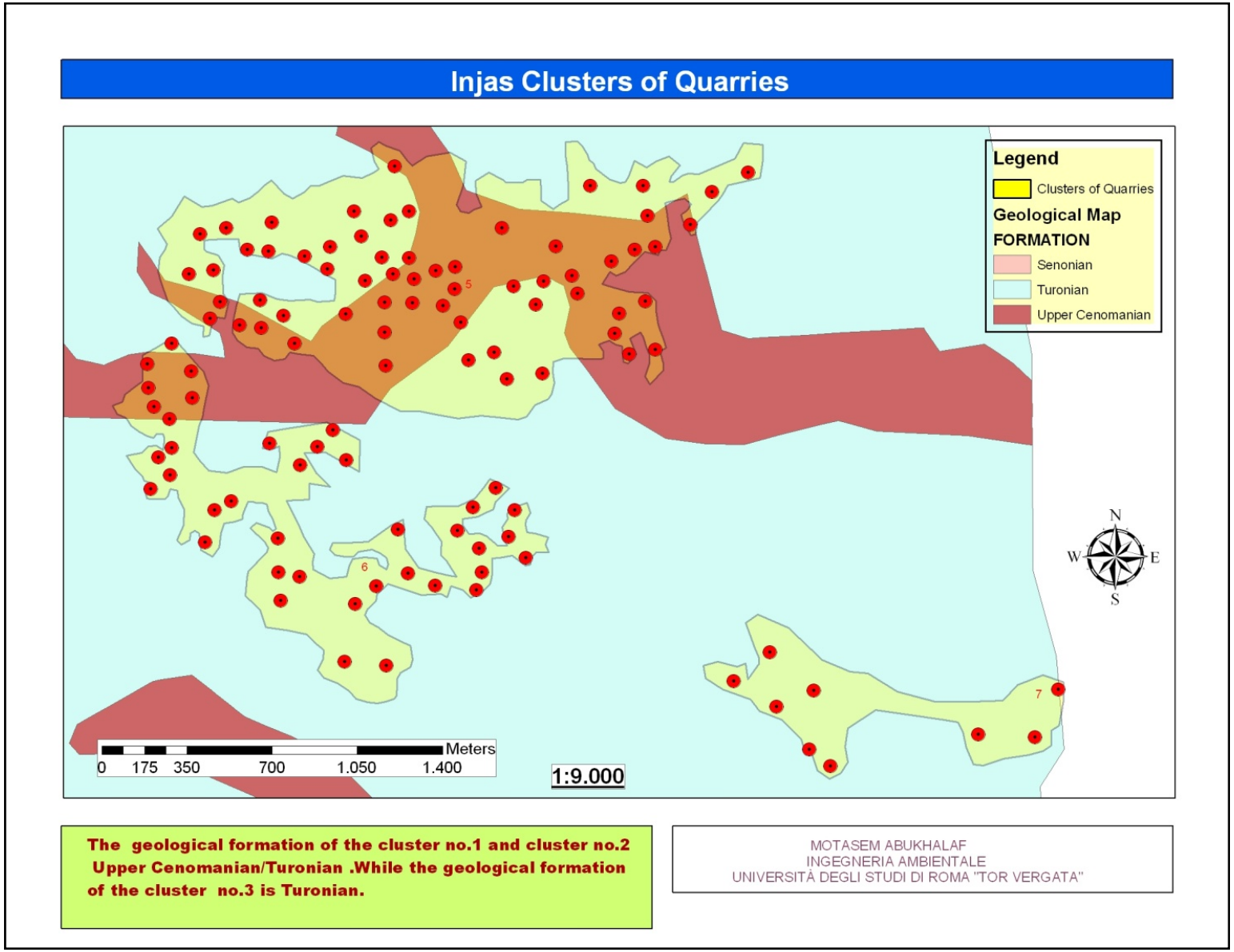


Figure 4.13.h: Injas clusters geological map.

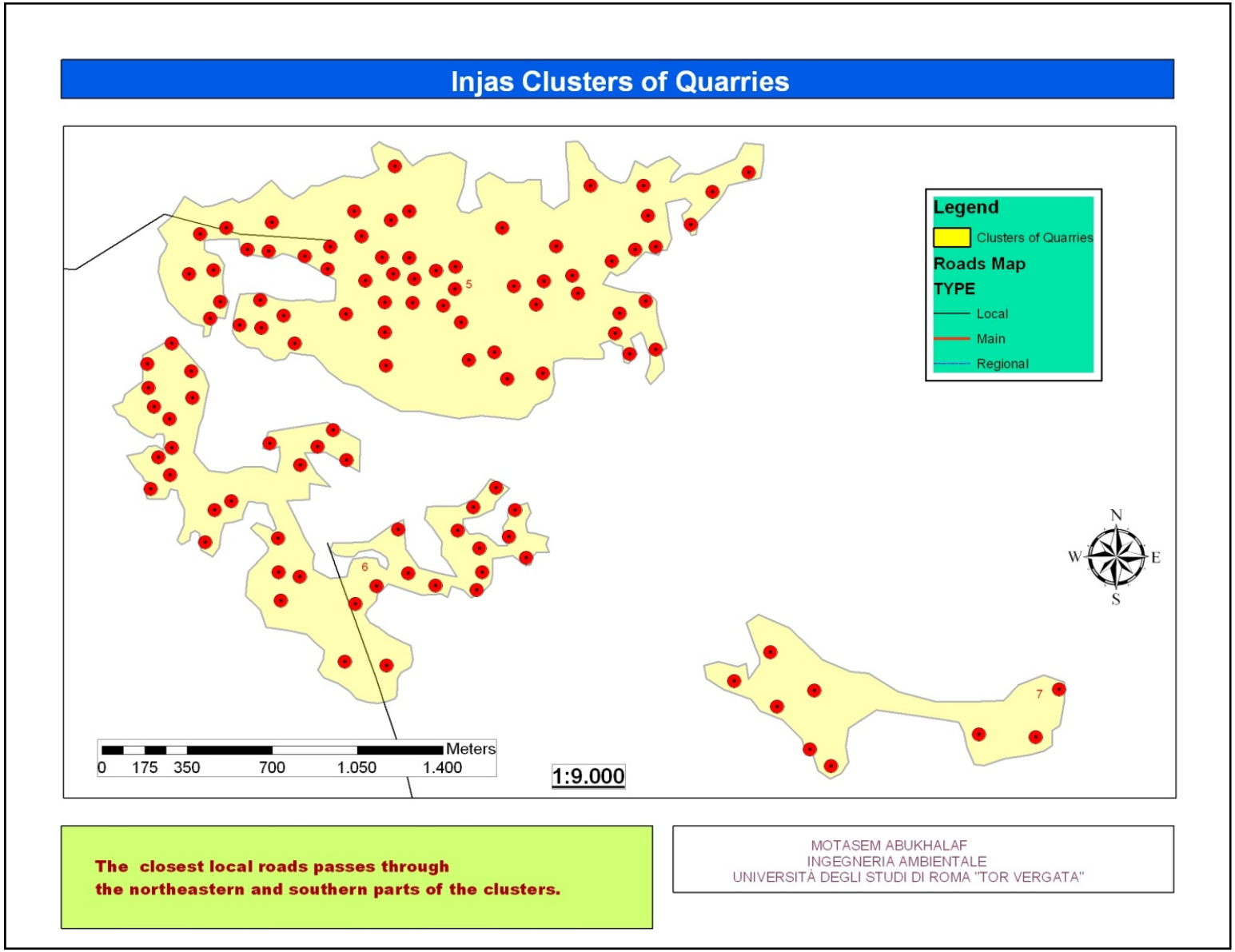


Figure 4.13.i: Injas clusters main and local roads map.

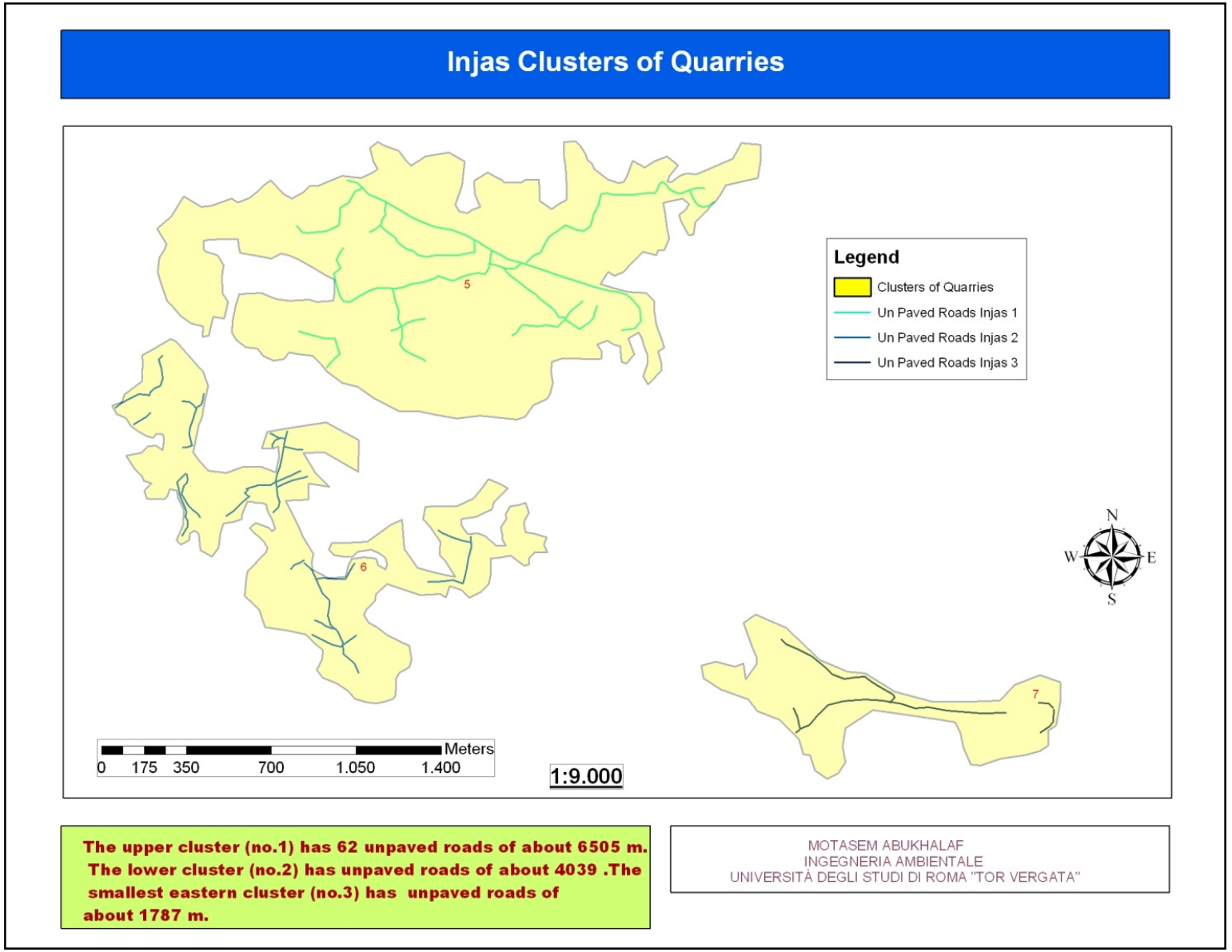


Figure 4.13.j: Injas cluster un-paved roads map.

Sour Mayen Cluster :-

It is located at the southeastern part of the investigated area to the east of Bani Naim town. Its topography is harsh one with deep narrow valleys and strongly inclined slopes. It has an area of about 0.39 km^2 . The elevation range of this cluster is from 780 to 920 m above the sea level (asl).

The land use of the surrounding area can be classified mainly as natural grazing area to the east and south, urbanized area to the north and west .The closest urbanized area (less than 500 m) to the west of this cluster is the town of Bani Naim with a population of about 18,883. The geological formation of the cluster is of the Turonian age. whereas elevation of ground table under the cluster is 300 m (asl).

The dominant soil type of the cluster area is a Mediterranean brown forest soil .
This cluster has about 11 quarries most of them are abandoned . The cluster has unpaved roads of about 3709 m .
More details can be shown in Figures (4.14.a – h).

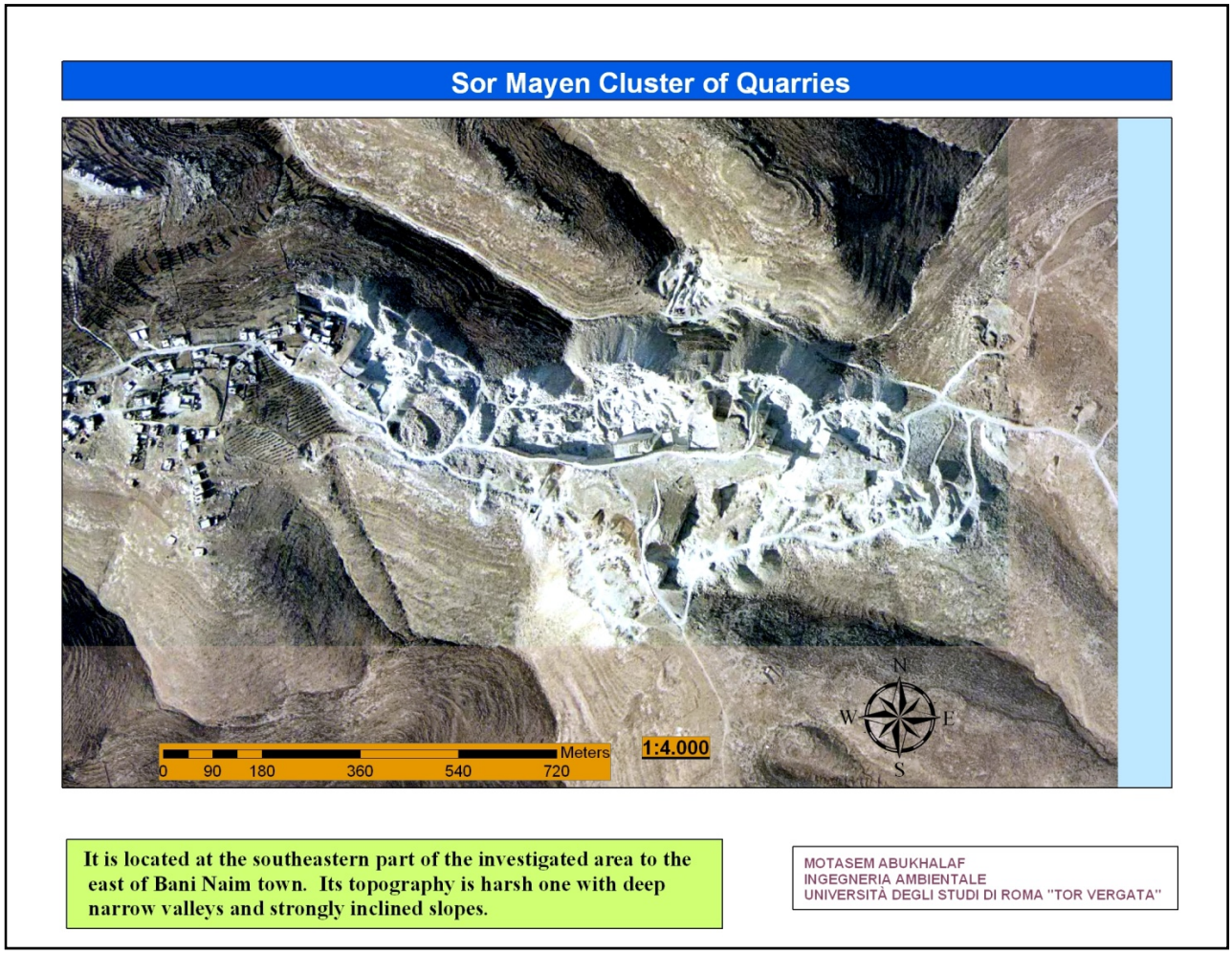


Figure 4.14.a: Sour Mayen area map.

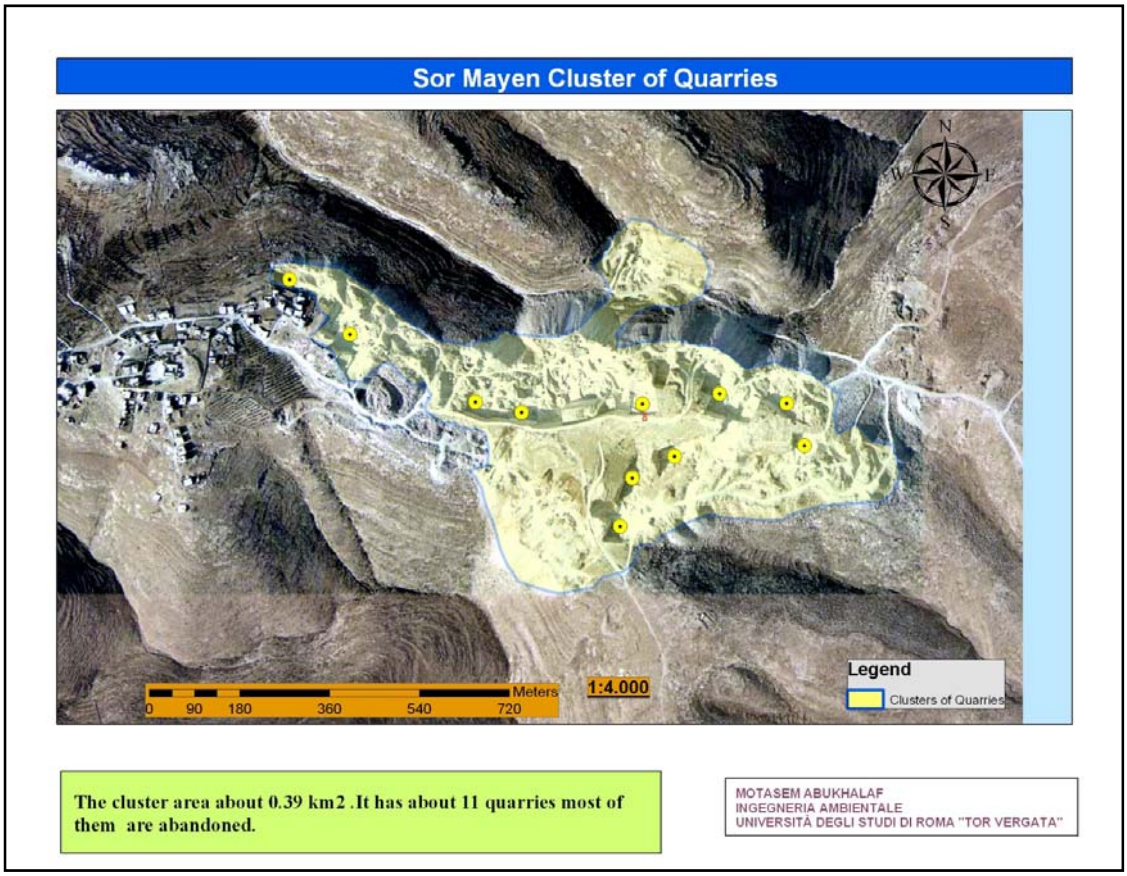


Figure 4.14.b: Sour Mayen cluster of quarries map.

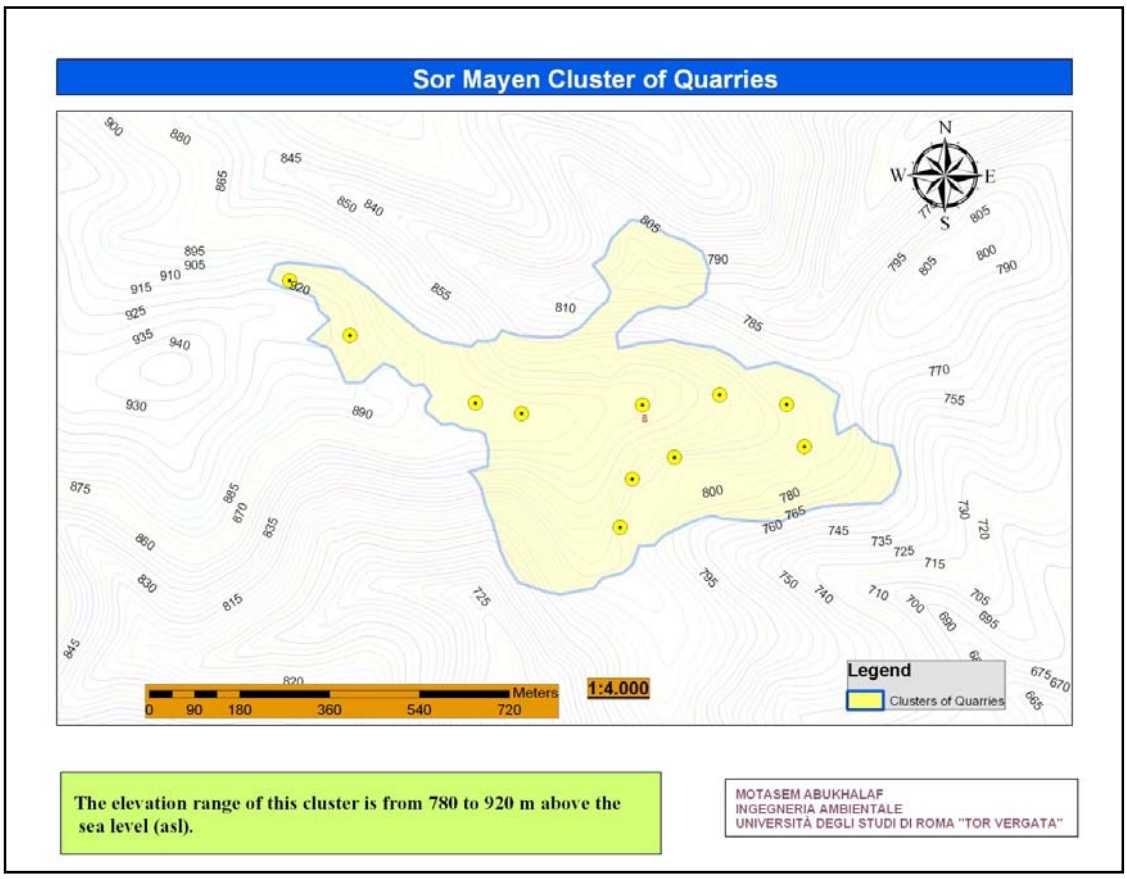


Figure 4.14.c: Sour Mayen cluster elevation contours map.

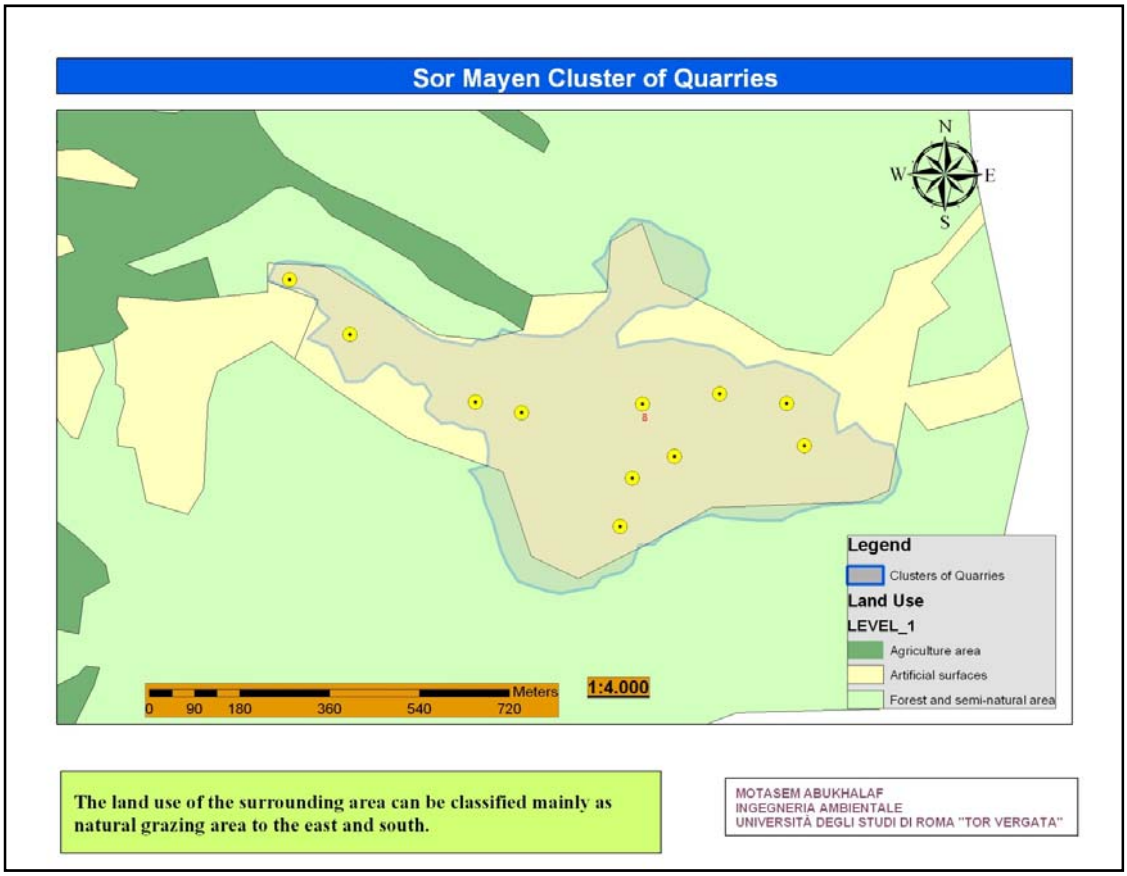


Figure 4.14.d: Sour Mayen cluster land cover/use map.

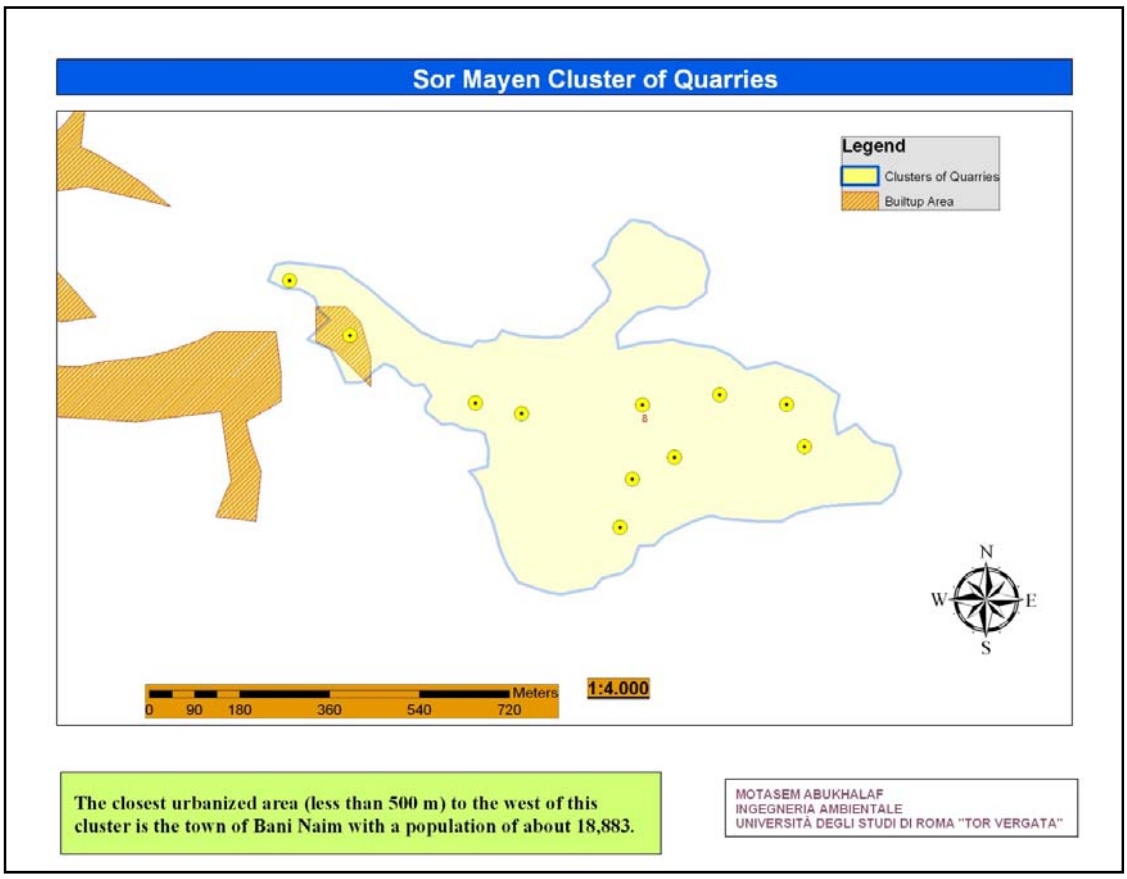


Figure 4.14.e: Sour Mayen cluster build up area map.

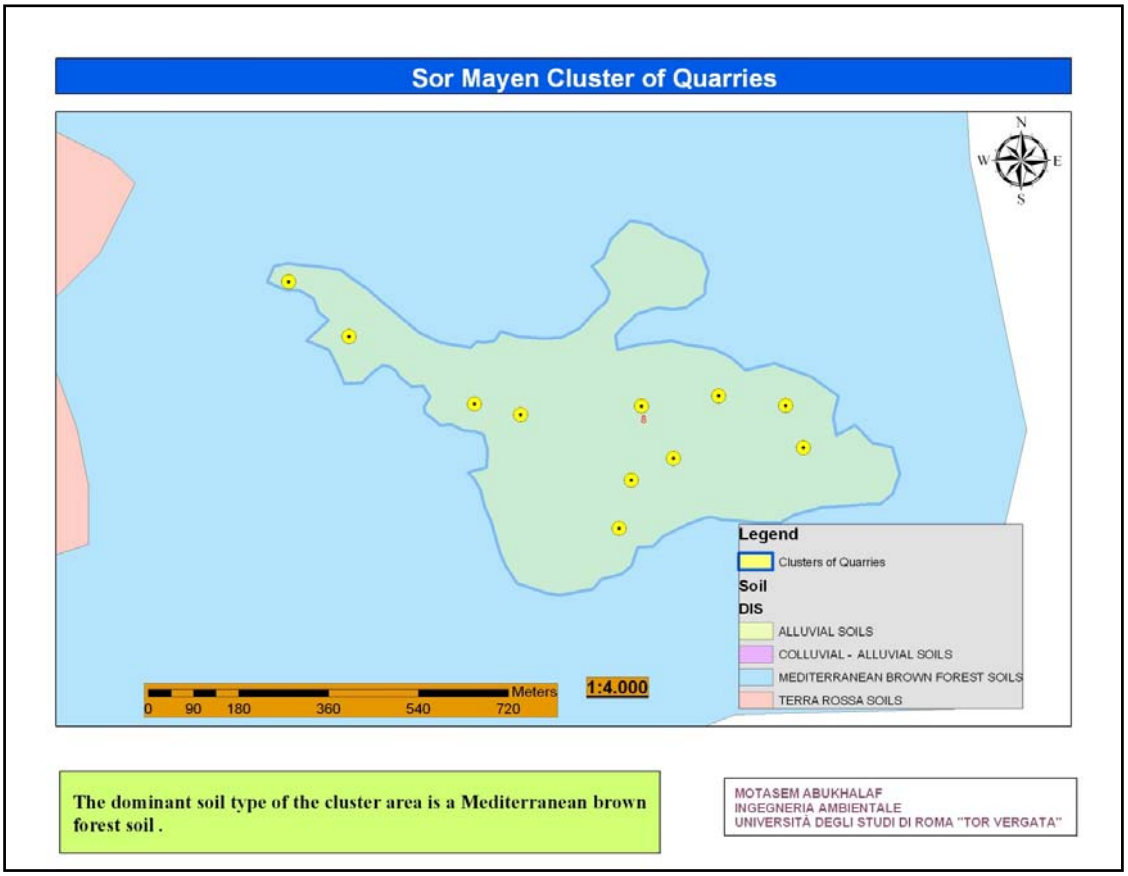


Figure 4.14.f: Sour Mayen cluster soil map.

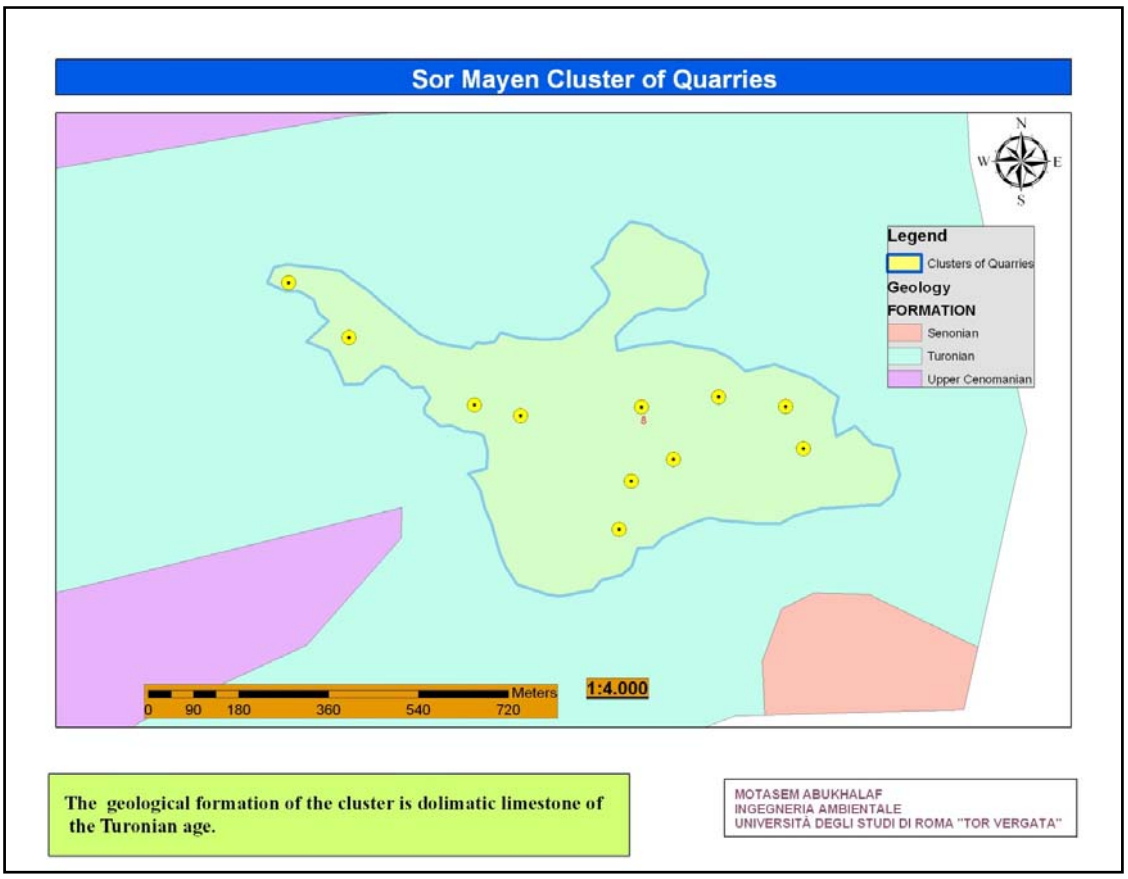


Figure 4.14.g: Sour Mayen cluster geological map.

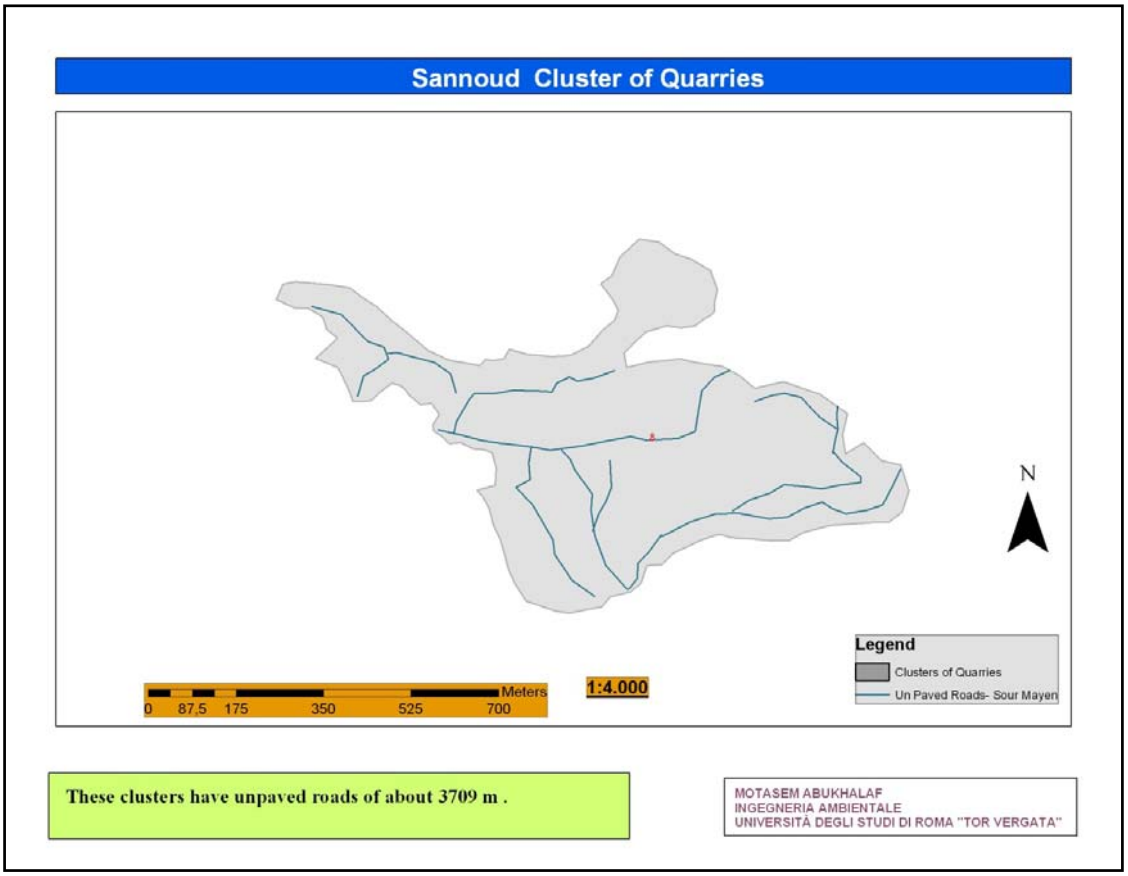


Figure 4.13.h: Sour Mayen cluster un-paved roads map.

Sannoud Cluster :-

It is located at the western part of Bani Na'im town. It is a blend of quarries and cutting stone plants. Its topography is composed of flat summit surface with slightly inclined slopes. It has an area of about 0.35 km^2 . The elevation range of this cluster is from 860 to 960 m above the sea level (asl). The land use of the surrounding area can be classified mainly as cultivated and urbanized area. The closest urbanized area (less than 100 m) to this cluster is the town of Bani Naim with a population of about 18,883. We can say that this cluster is surrounded by houses.
The soil formation of the cluster area is Terra Rossa ,whereas geological formation of the cluster is dolimatic limestone of the Turonian age.
The elevation of ground table under the clusterarea ranges from 300 -400 m (asl).

The nearest local road to the cluster is (Arabiyeh) which locates at 350 m north to the cluster. The road Bani Naim-Hebron locates at600m to the west.
The cluster has about 23 quarries most of them are abandoned .The cluster has unpaved roads of about 3396 m.
More details can be seen in Figures(4.15.a-i).

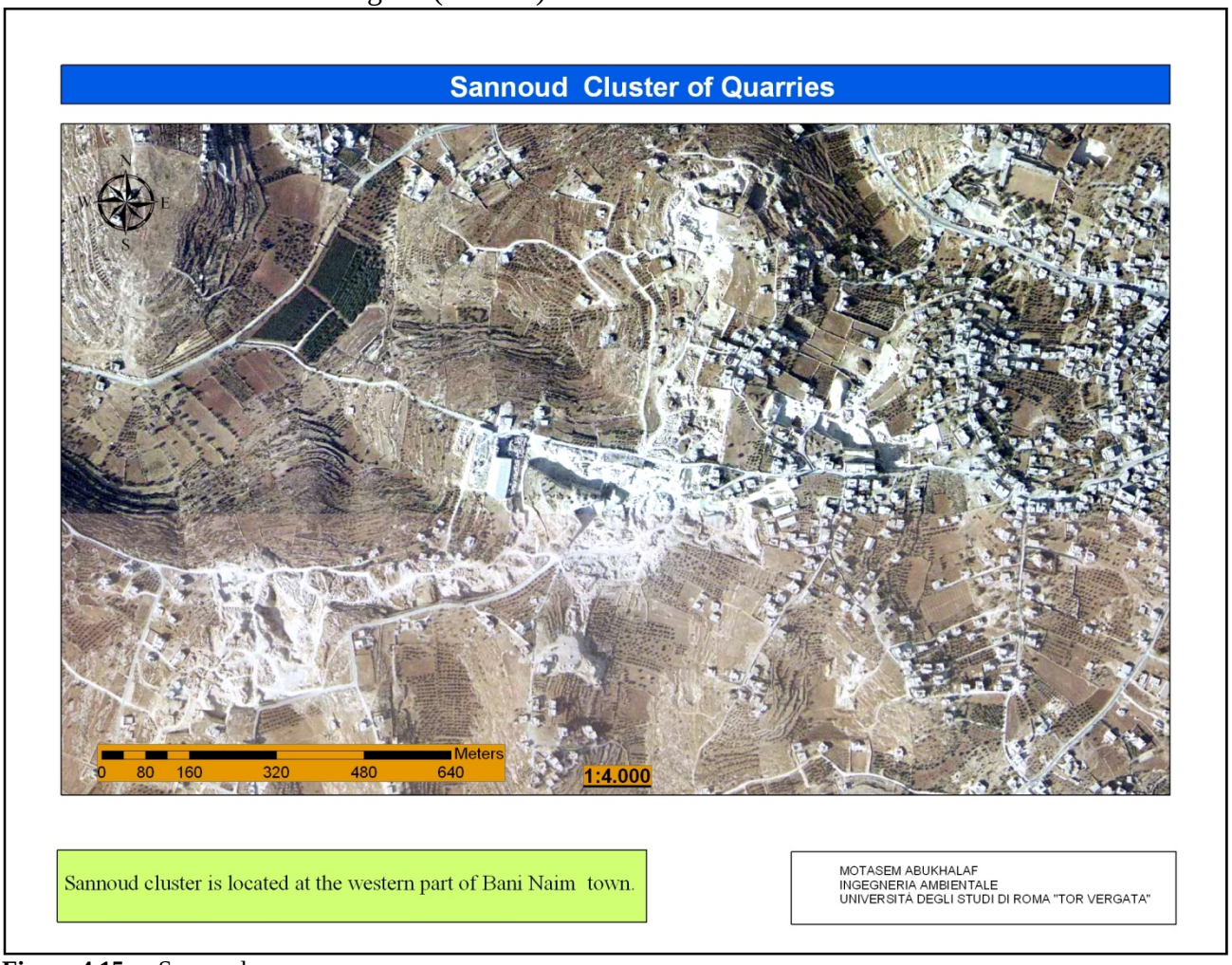


Figure 4.15.a: Sannoud area map.

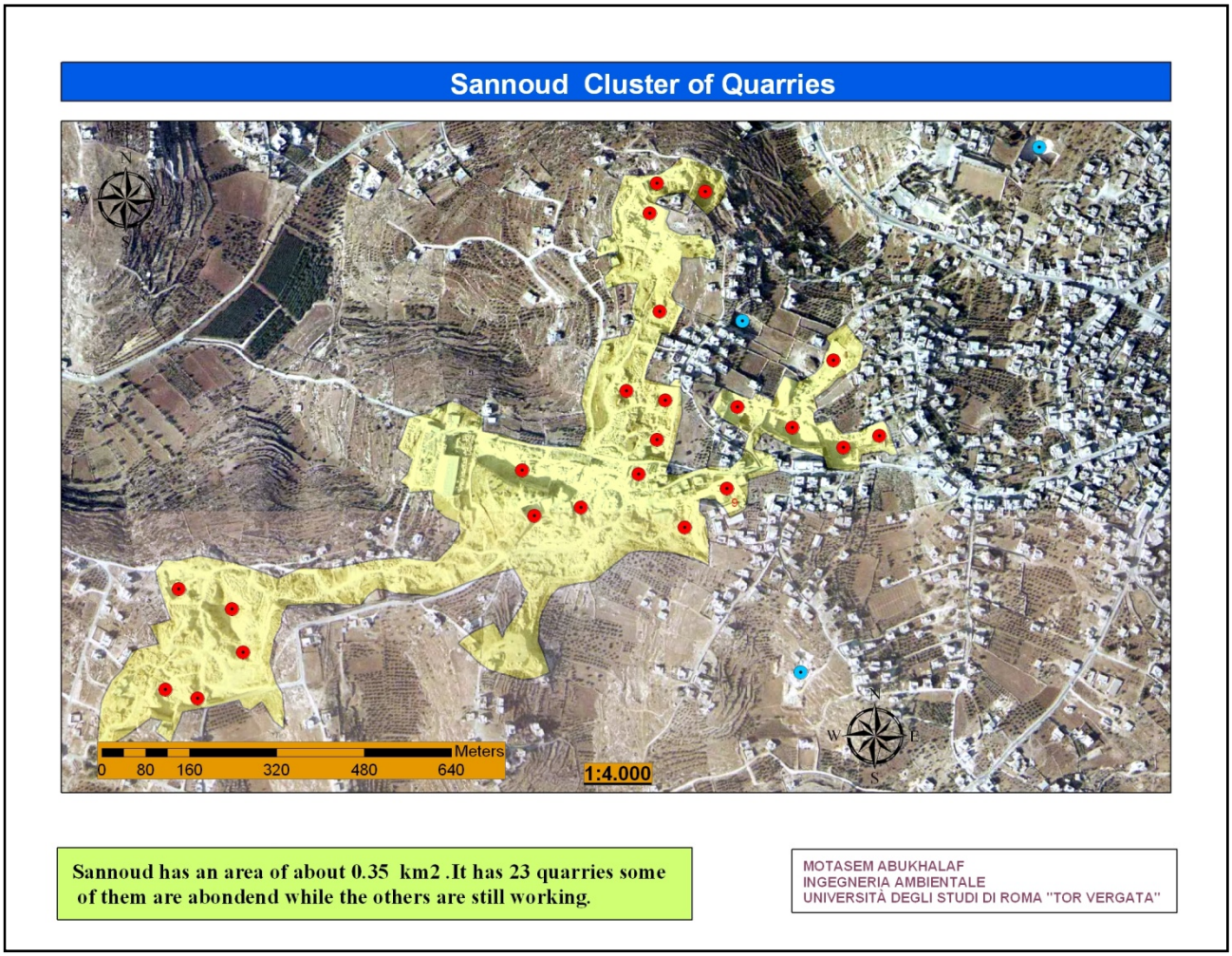


Figure 4.15.b: Sannoud cluster of quarries map.

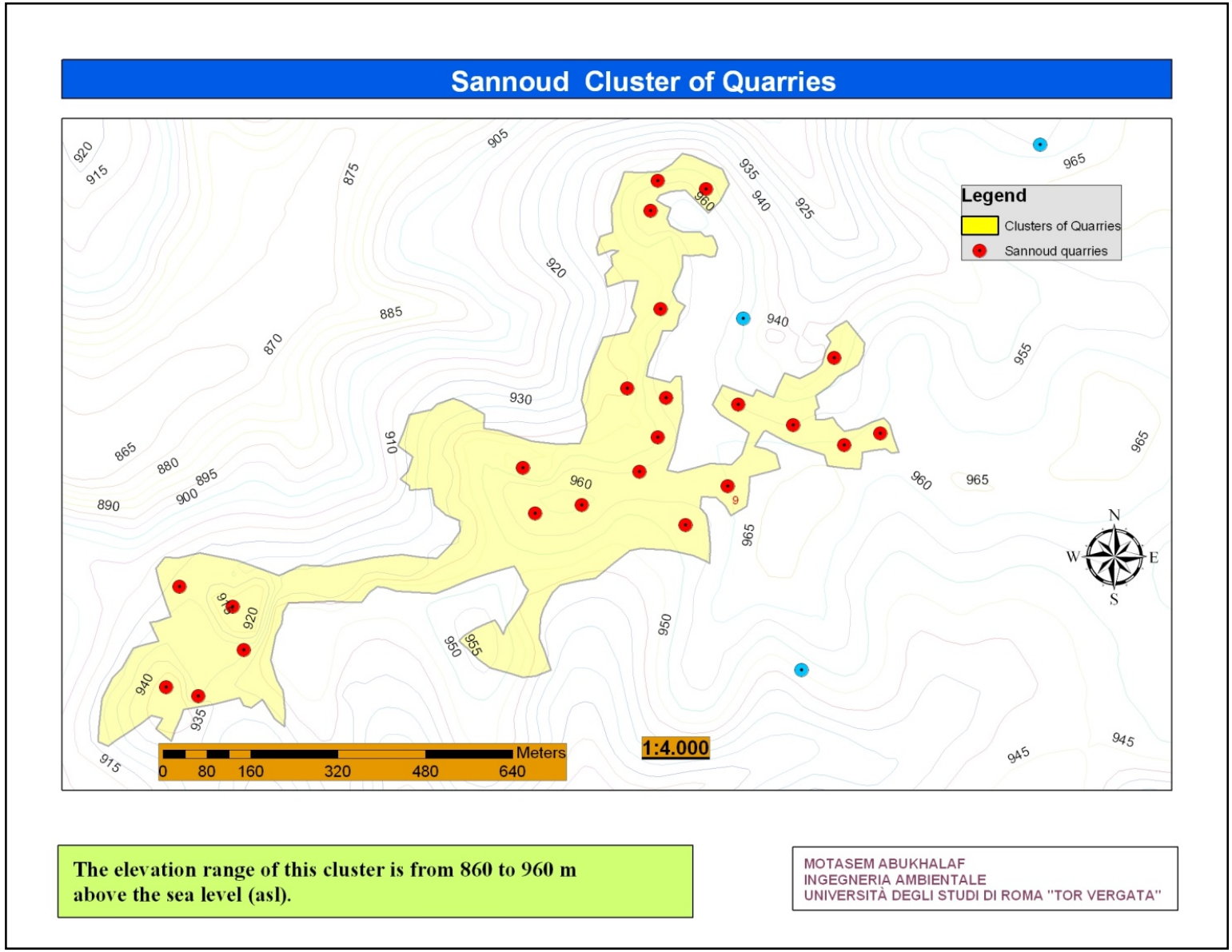


Figure 4.15.c: Sannoud cluster elevation contours map.

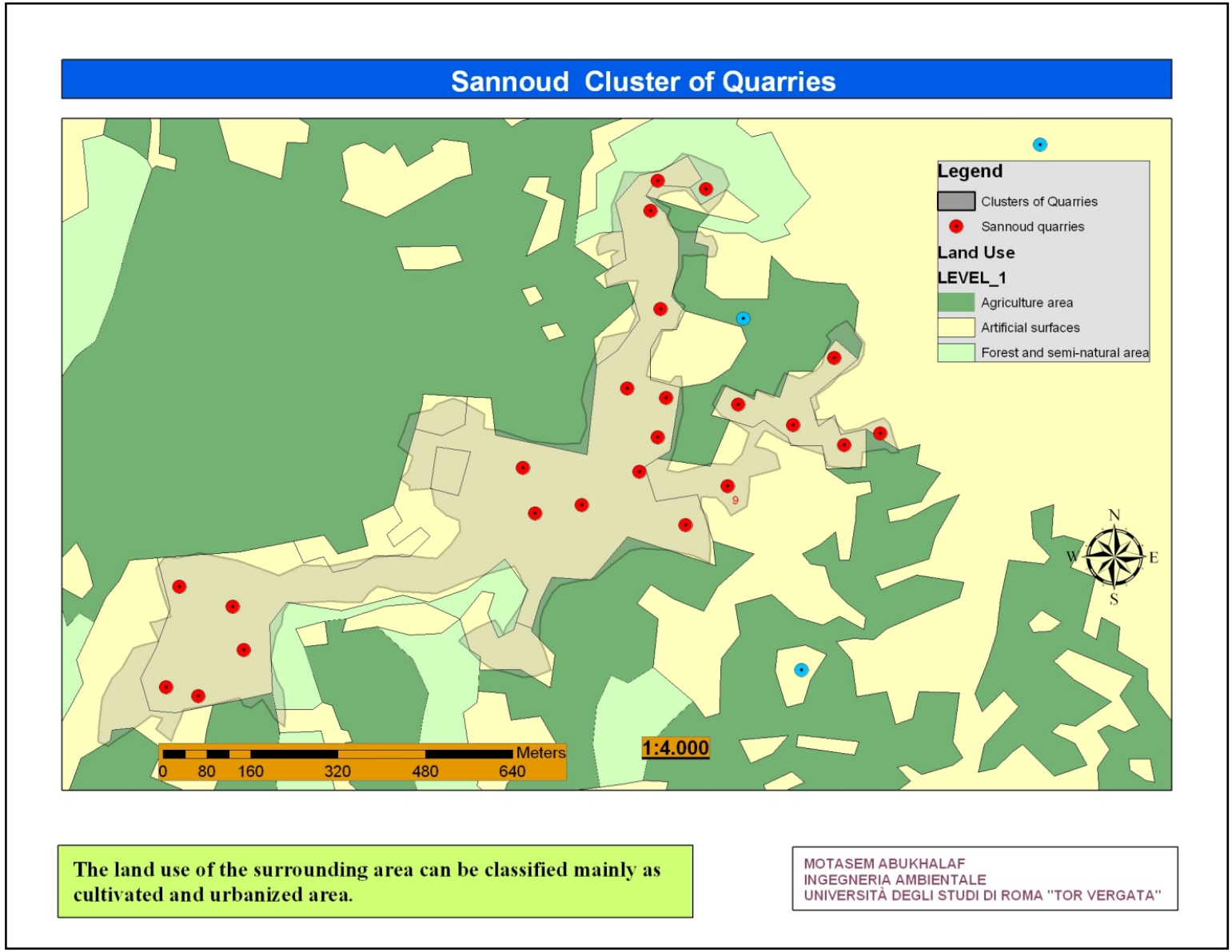


Figure 4.15.d: Sannoud cluster land cover/use map.

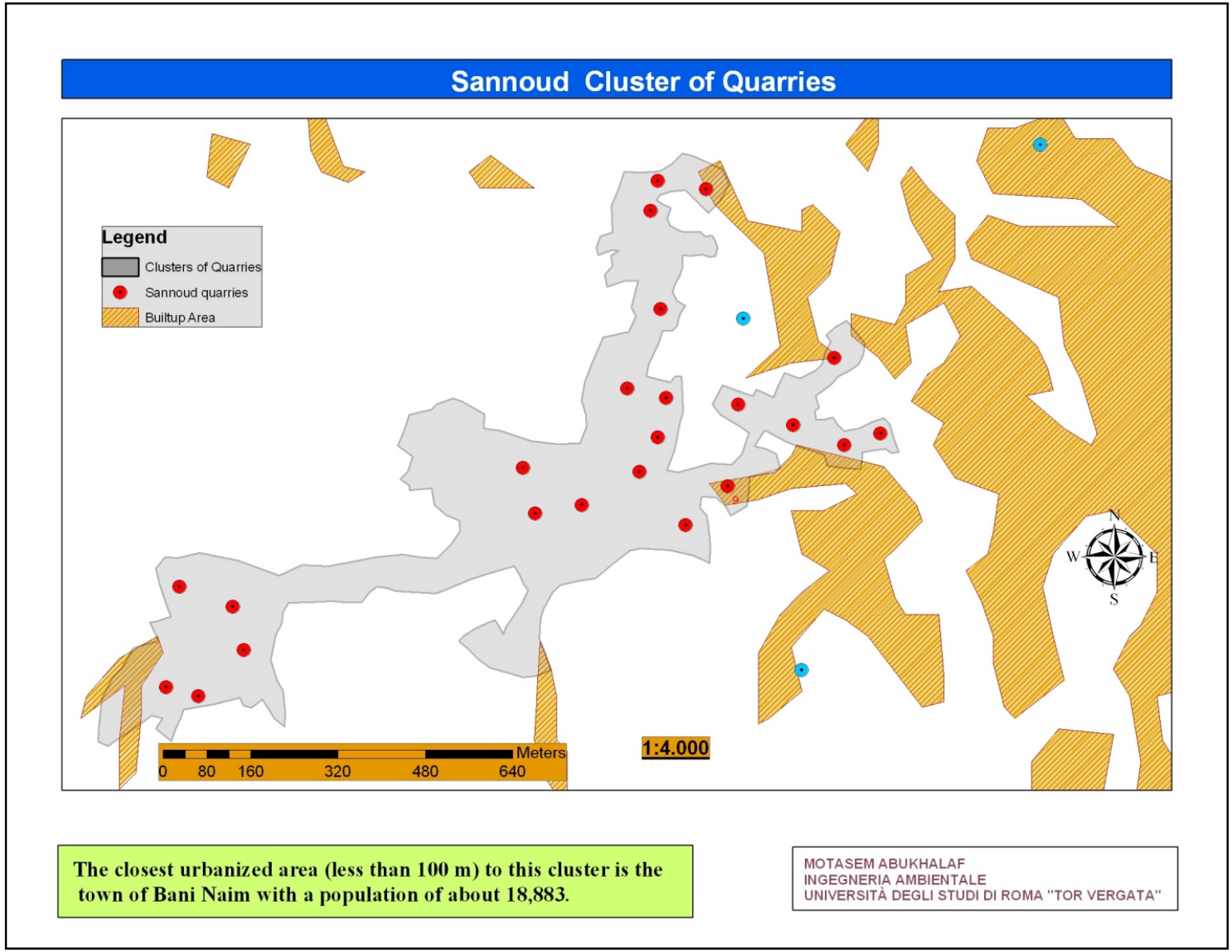


Figure 4.15.e: Sannoud cluster build up area map.

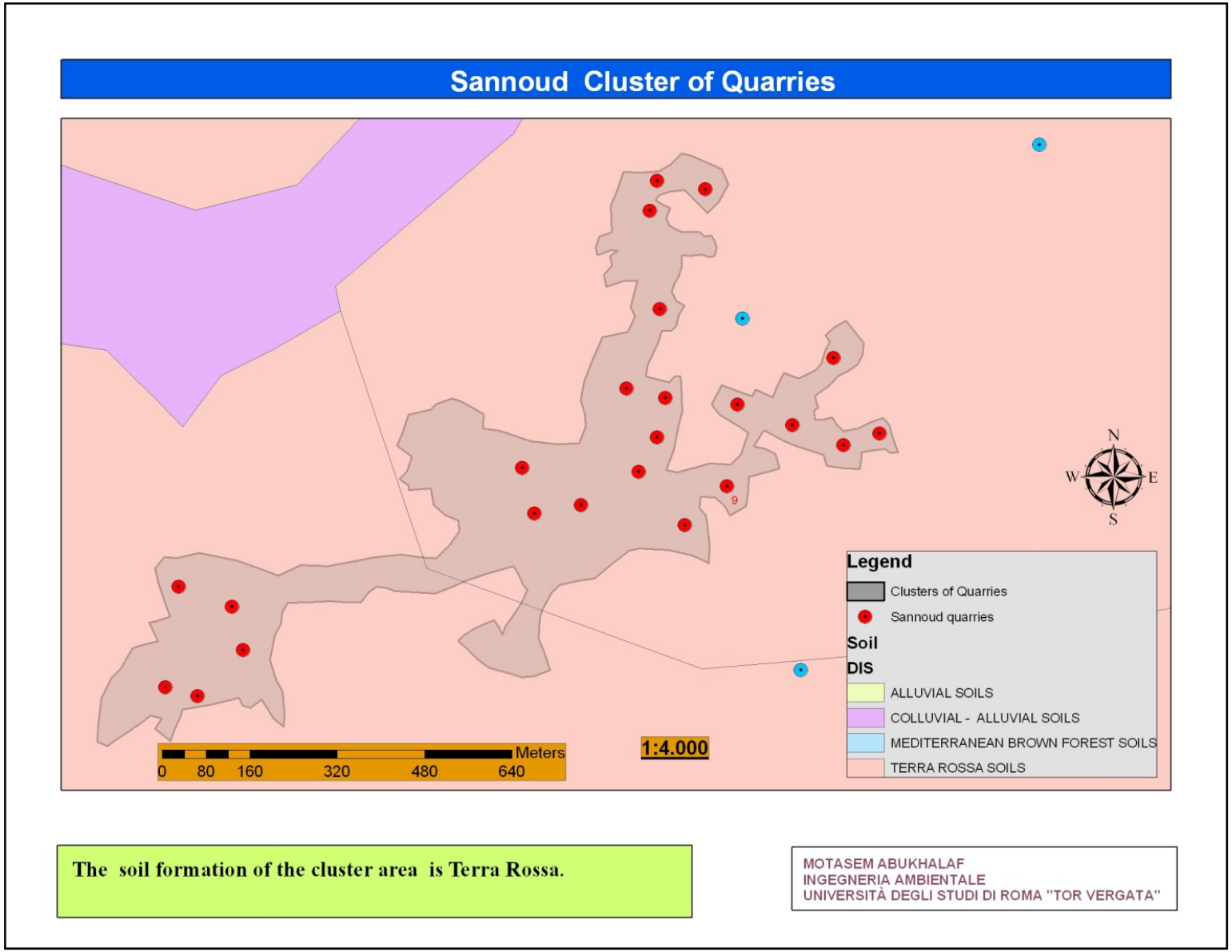


Figure 4.15.f: Sannoud cluster soil map.

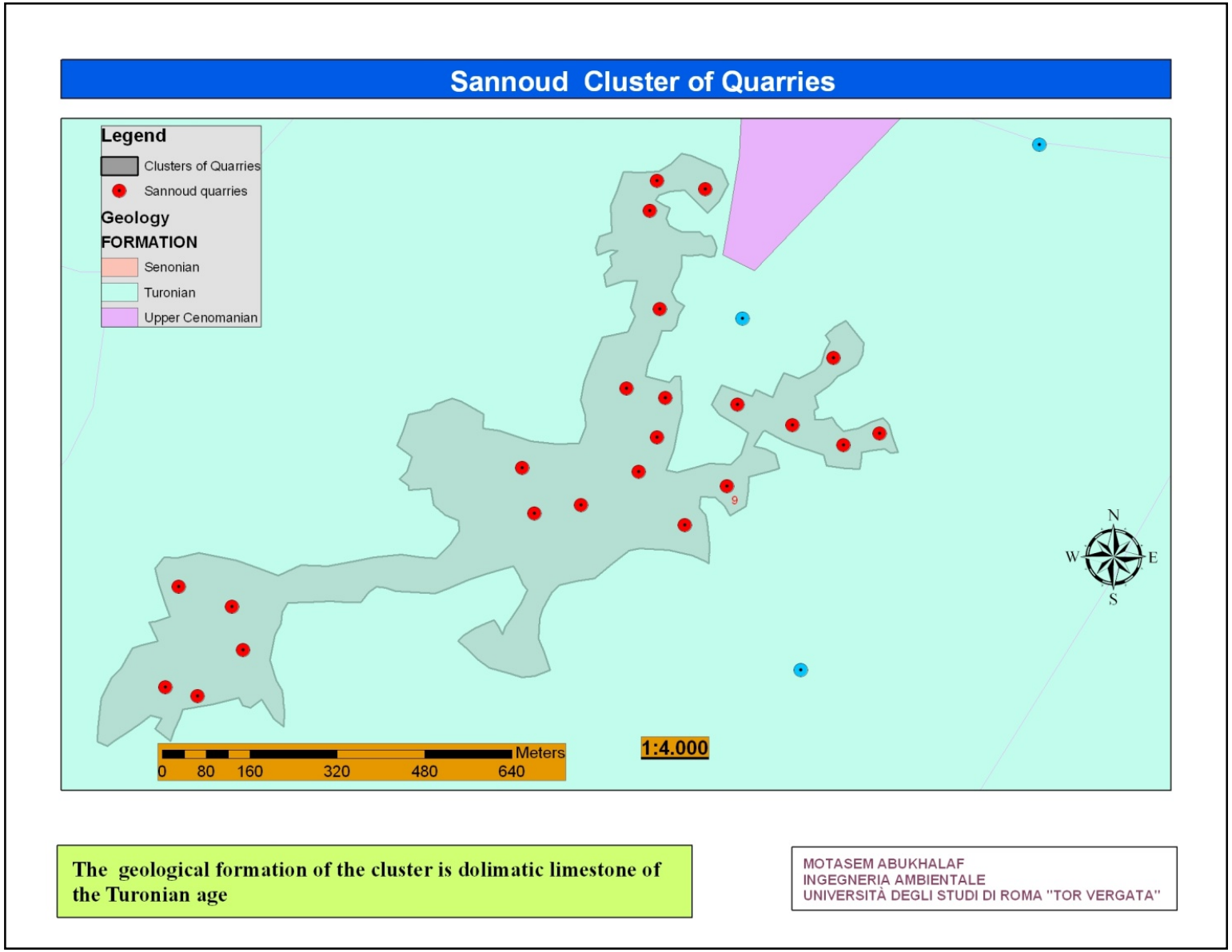


Figure 4.15.g: Sannoud cluster geological map.

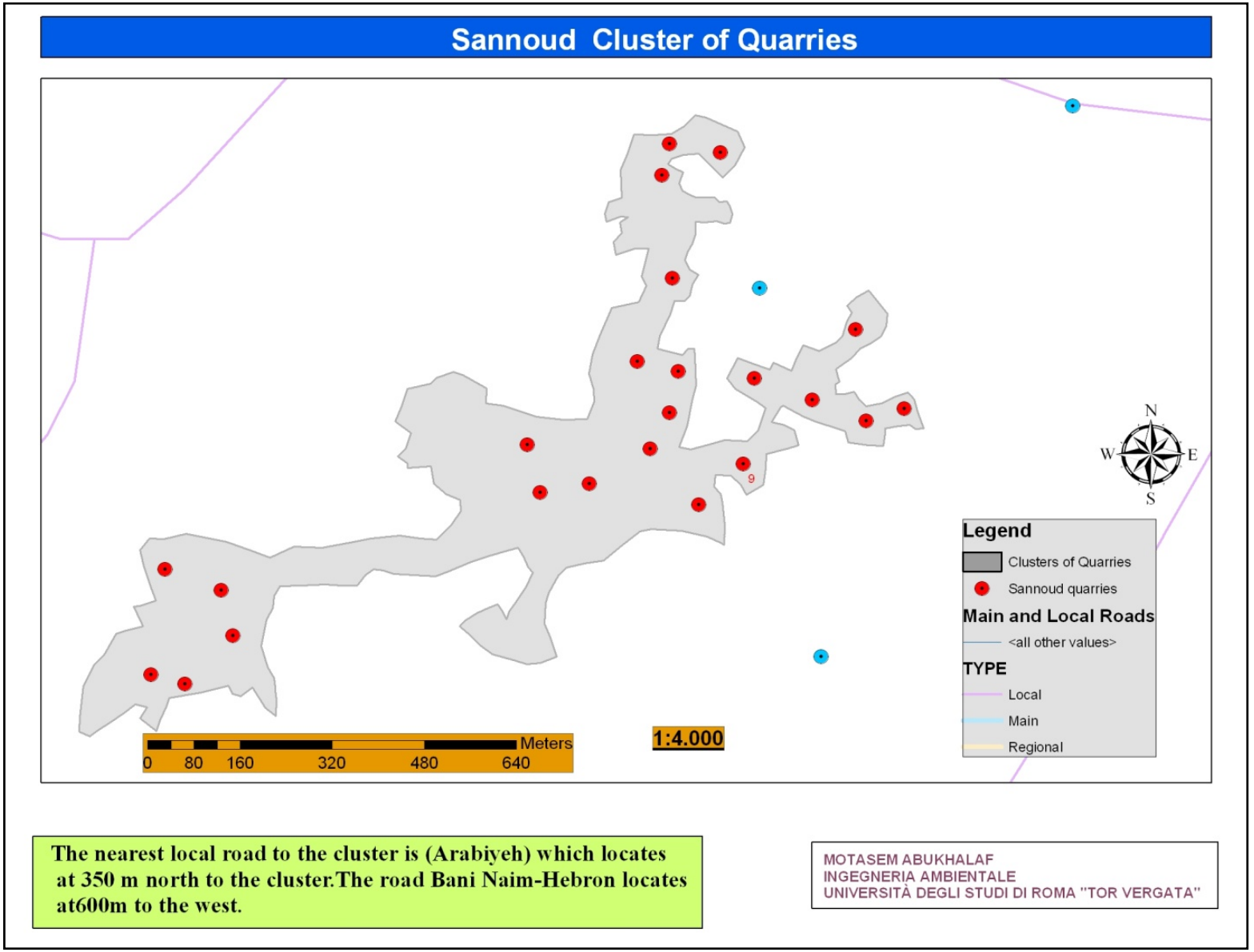


Figure 4.15.h: Sannoud cluster main and local roads map.

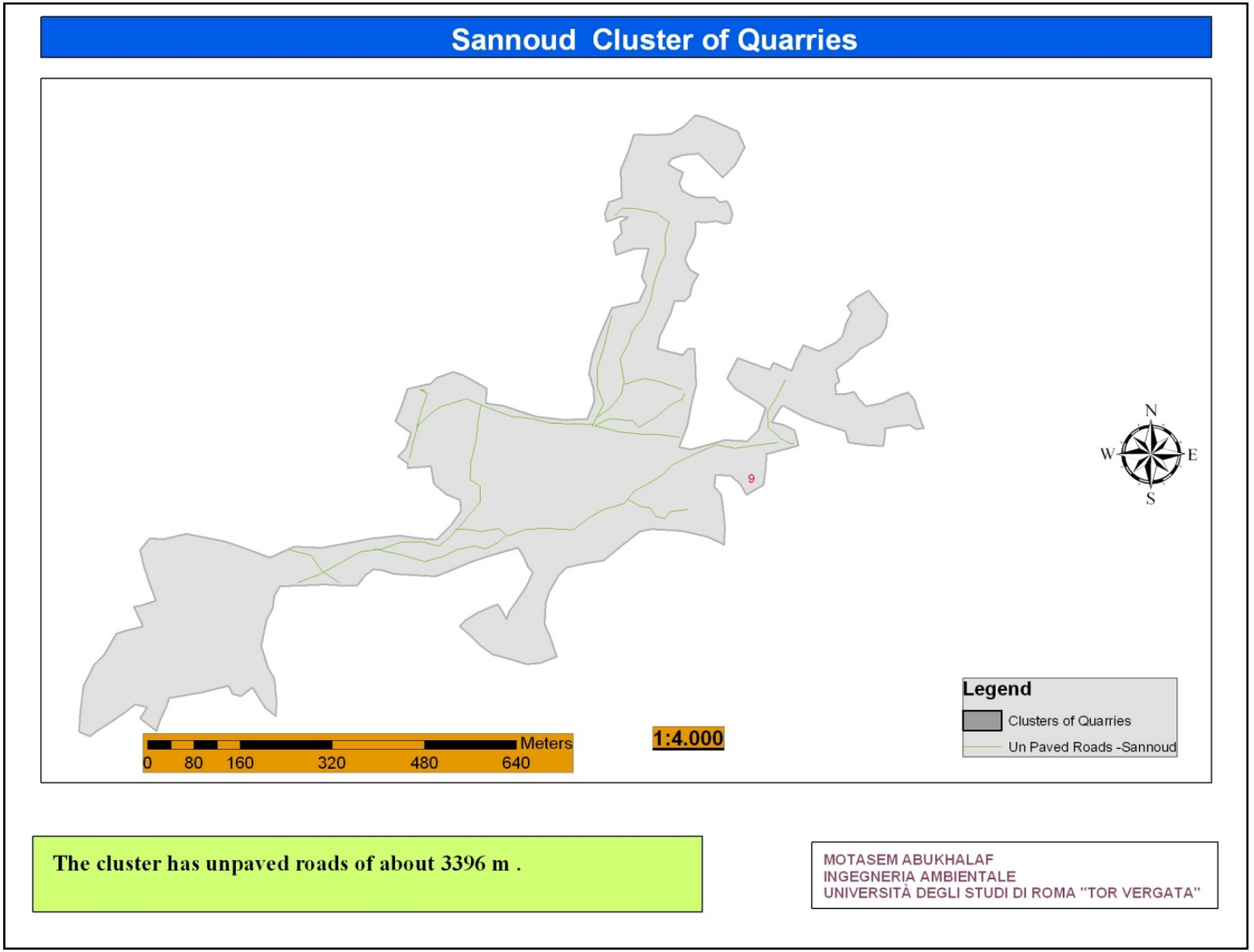


Figure 4.15.i: Sannoud cluster un-paved roads map.

4.5. Description of Mineral and Quarrying Method.

The description of the limestone mineral and the quarrying method will be applicable more or less to the stones of all clusters and quarries.

All the quarries produce stones of the sedimentary limestone covering most of the West Bank hills. These deposits have special physical, chemical and mechanical properties. Also, they have different local names like Irbia , Injas, Sur Mayen and Sannoud.

The quarrying or mining method used for building stone is the strip mining or open-pit method. The earth covering the stone deposit (called overburden) is removed with bulldozers. The deposit then is cut into cubes of size ranging from 3 to 8 m^3 by mechanical sawyer for stones. The cubes are then moved by bulldozers and then lifted to trucks.

The waste byproducts at the quarries like the rubbish stone of different size and the accompanied soil are moved to old abandoned quarries or nearby areas forming stockpiles and waste materials occupying vast areas. These areas were included in the clusters delineation because their occupied sites are part of the whole process(USM,2009).

5. Environmental Impacts Evaluation.

In general, the potential environmental impacts from the quarrying project may be categorized into the following stages of development:

- Exploration and prospecting stage,
- Initial site preparation and construction stage,
- Quarrying or production stage,
- Rehabilitation and abandonment stage.

The potential impacts likely arose from these activities are soil erosion and associated sediment pollution of the watercourses, possible loss of fauna, flora and habitats, noise and air pollution and generation of construction wastes, solid waste and liquid wastes.

Air pollution and noise pollutions are considered adverse impacts. Air pollution is due to burning of biomass (if undertaken), and dust generation and dispersion during earth-moving and quarrying operations. Noise pollution is generated by heavy machinery and vehicles and they may exceed the standard threshold.

Local impacts include the disturbance caused by the noise and vibrations produced by controlled explosions, airborne dust pollution and deposition, and heavy truck traffic. While these impacts have a local effect, the visual effects on the landscape are far-reaching and aesthetically intrusive eliminating any impression of landscape naturalness that may otherwise exist (George D. Mouflis.,et al, 2007).

The sites' survey and data analysis reviled several possible impacts. These impacts are listed as follow**:**

5.1. Environmental Pollution:

This include the following:

a)Air pollution (dust);

The main sign of air pollutant resulted from quarries is the emission of dust -suspended particulate matter created either from the quarries itself or from the movement of heavy trucks on the unpaved roads- . The concentration of dust in air is seasonal dependant as well as on working hours and conditions.

Internationally recognized standards (Davis M. and Morishita TY.,2004), the maximum permitted concentration of dust in air is 15 mg/m^3.The dust particles are heavy and diffused horizontally adjacent to the earth surface. As no available measuring instrument as used to assess the dust concentration, however, visual inspection over the survey period showed dens duct formation in vicinity of the quarrying activities. The adverse impact of the dust arose from the fact that dust is mainly composed of calcium carbonate in addition to considerable percentage of silicon oxides, which is carcinogenic material when inhaled. Dust accumulates on plants and on soil clogging the pores of the soil and leading to the death of plants. Dust also settled on tree leafage and plant reducing its capability of

metabolism. Plant inspected around the Wadi Sier area are showed covered with white dust. (as shown in Photo 5.1)

Photo 12: Plants covered by white dust.

Another source of air pollution is the gases emitted from burning fuel of the used equipment. The gas concentration will not be significant to be considered comparatively as serious pollution. Just workers at quarries should take precautions when machinery are not fit and gas resulted is well-noticed.
Truck vehicles is another contributor to air pollution. There is an intensive and continuous movement of trucks carrying stone blocks to cutting plants. Carbon monoxide, sulfur oxides, nitrogen oxides, volatile hydrocarbons and lead compounds are emitted as a result of this movement.

Large amounts of particulate materials and dust are produced from quarries and stone cutting facilities as many of them located close to residential areas in Hebron and Bethlehem districts. Particulate materials are harmful to human health especially the respiratory system.(ARIJ ,2006).

Primary sources of dust are from truck traffic within the quarry sites, processing plants, stockpiles of processed material, and from land areas stripped of vegetation. Methods for controlling dust in quarry sites include water suppression, application of environmentally safe chemical solutions, proper design and maintenance of processing equipment, and minimization of the amount of land void of vegetation at any point in time. Dust is not a serious issue in quarry sites, where washing operations are included in the processing plant.

b)Noise pollution;

The noise resulted from the quarries is affect mainly workers at quarries. Noise extend to residents who live in the vicinity of quarries. The impact of noise is reflected in human physiology, psychology, communication, performance and social behavior. When noise pollution exceeds 140 decibels (db), it may cause damage to the nervous system, the hearing , increasing blood pressure and ability to sleep. When exposed to noise exceeding 80 db for about three hours daily, the human will suffer from various health symptoms.

The noise at quarries resulted from the machinery (caterpillar, bulldozers, compressors, trucks, etc). The noise affects the wildlife and its habitats in the surroundings.
Primary sources of noise are truck traffic, stone crushers, processing plants, and dumping of aggregates on metal such as trucks and loading hoppers.
Communities set decibel levels for quarrying operations. Most noise levels standards can be met through a combination of proper equipment maintenance, using natural terrain to reduce the noise level or by creating earth berms in appropriate locations. Distance between the noise source and the recipient is an important factor in reducing noise impacts.

c)Water pollution (water borne sediments);

- Groundwater

The longer-term environmental degradation is evident in the pollution of groundwater resources, the lack of proper waste management, shortcomings in environmental administration and legislation. These two types of environmental degradation were found in all previous post-conflict environmental assessments carried out by UNEP **(**UNEP ,2003**).**
Groundwater quality has shown some deterioration over time, primarily due to surface contamination from wastewater and unsustainable agricultural practices (UNEP, 2003).
The aquifer system in the West Bank is highly permeable due to its geological nature. The limited soil cover over the water recharge zones makes the aquifer highly susceptible to pollution since there is no natural barrier to contaminants that travel down rapidly to the groundwater (Rofe and Raffety, 1965; UNEP,2003).

Groundwater in most areas of the West Bank is generally considered to be of good quality, though easily contaminated in some regions, depending on land use and local soil and geological conditions. In general, however, the region's geology is limestone, which has the property of allowing substances to penetrate easily. The attenuation or removal of nutrients and pollutants in wastewater is low, making aquifers vulnerable to contamination. In some areas, groundwater is unsuitable for drinking because of high salinity. This occurs partly as a result of natural factors, but is expected to worsen over the coming years since over-abstraction of freshwater leads to intrusion of salty water from deeper levels.
Removing the topmost soil layer and surface rock material multiplies the vulnerability of groundwater contamination due to karst features of hard limestone and the high infiltration rate of disturbed sands.
Currently, hazardous wastes are not separated from other wastes, nor stored or disposed of safely. At most of the solid waste disposal sites, there is a practice of open burning, which releases toxic substances, such as dioxins. Also liquid hazardous wastes enter the soil, thus polluting the groundwater. These existing practices may result in solid waste disposal sites being closed in the near future, with major clean-up operations of polluted soil then being needed. To minimize or avoid these very expensive risks, immediate action should be taken to separate the hazardous wastes and handle them properly.(UNEP 2003)
The hydrogeological effect of limestone extraction from open pits (quarries) depends on the location of the site in the landscape, the vertical and horizontal extent of the excavation, the methods used to excavate the stone, and the extent of karstification. Groundwater quality is commonly affected by quarrying through increased fine sediment concentrations and accidental spillages. Removal of any soil cover allows direct access for pollutants into the aquifer, a problem which may be exacerbated by licensed or illegal tipping of waste

following cessation of stone extraction. Quarrying also removes the entire subcutaneous (epikarstic) zone which is an important groundwater store, together with part or all of the unsaturated zone. Pumping of water from the excavation will change the groundwater balance and can alter the direction and amounts of conduit flow, particularly if the quarry extends beneath the water table. Prediction of such impacts is difficult, especially when the limestone is karstified, such that there will always be a degree of uncertainty associated with the impact of the workings. Hence, it is essential that for new quarries monitoring is undertaken prior to, throughout, and following mineral working, with options for mitigation if mineral working causes an unacceptable impact. When a quarry ceases to be worked, the direct impacts on groundwater quality may rapidly decrease but there are important implications for after-use of the site. Impacts on groundwater quantity are likely to be more long-term.(Hobbs S. L. ; Gunn J.1998).

Ministry of Health data published in 2001 (UNEP,2003**)** indicated that 600 of 2,721 samples – including water from both wells and tanks – failed to meet WHO bacteriological guideline values for drinking water (Ministry of Health, 2001). Scarpa *et al*, 1998 and Abdul-Jaber *et al*, 1999 showed microbiological pollution to be widespread in all the mountain aquifers. Rather few wells in the Bethlehem and Hebron district were found to be permanently contaminated, though all those tested were subject to at least periodic contamination.

There is relatively little information concerning the impacts of industrial pollution in the West Bank, though one recent study (SWEMP, 1999c) provided some insights and identified pollution 'hot spots', including industrial sites such as stone-cutting facilities, olive oil factories, slaughterhouses, and tanneries. While there are no hard data concerning the impact of industrial effluent on groundwater quality in the region, it is a fact that almost all industrial wastewater flows directly into municipal wastewater systems without pre-treatment.

The primary concern of quarrying activities on sub-surface hydrology is the potential impact on the ground water table. At issue is whether or not the water table will be contaminated by the quarrying operation or whether or not the water table will be lowered, thereby affecting the water table level on adjacent properties. This is a complex and many times controversial issue.

Previous studies have never encountered or was ever presented any significant evidence of ground water tables being negatively affected by Limestone quarrying operations when no effort was made to lower the water table.

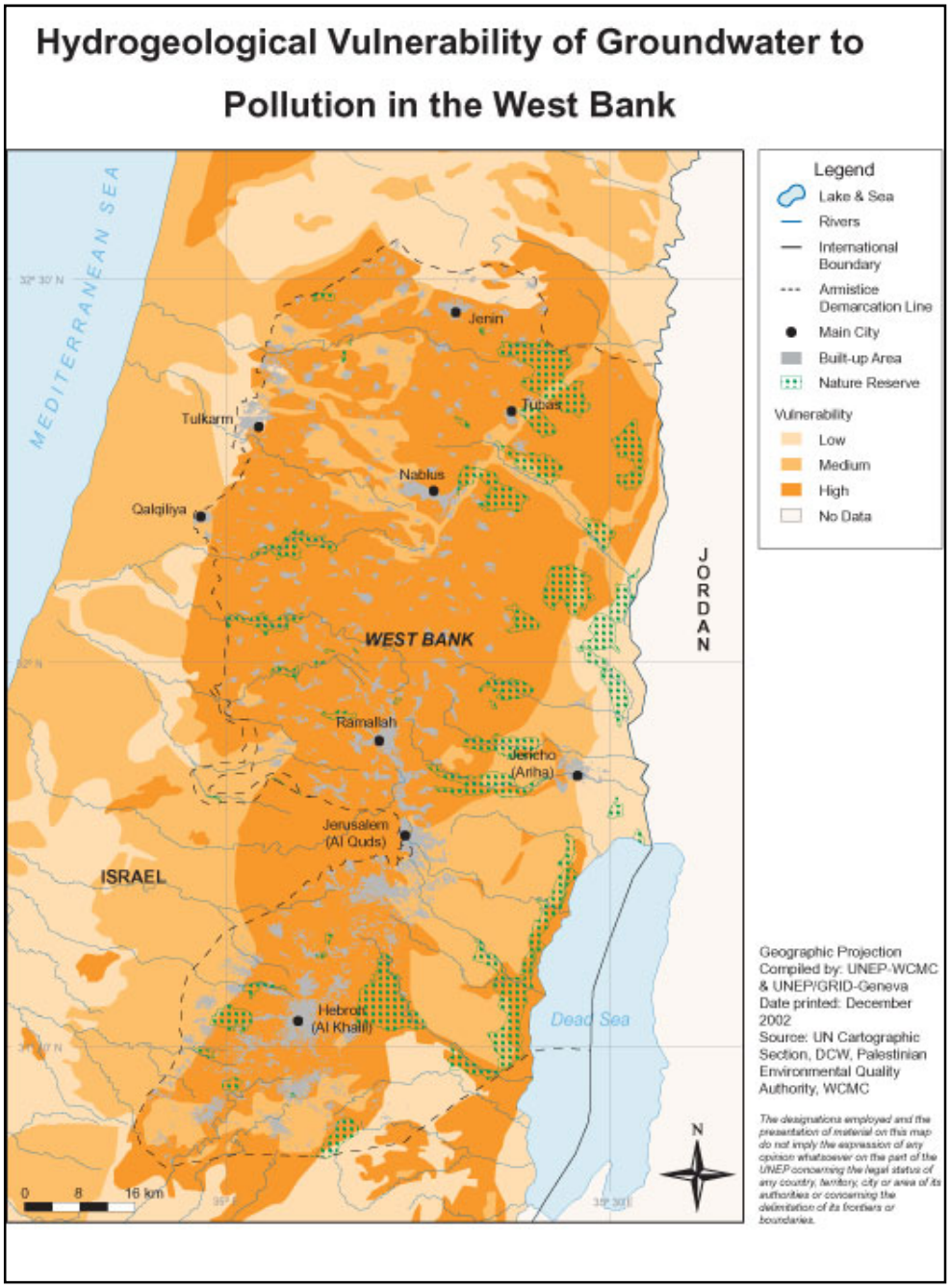


Figure 5.1 :-Hydrological vulnerability of ground water to pollution in the West Bank.(Source ,UNEP 2002).

There is no indication that there is water pollution resulted from the waste by products from the quarries in all clusters. However, this issue should be thoroughly investigated by conducting chemical and physical analysis of surface and groundwater of this area.
The groundwater elevation range under the quarries of the study is 300 to 450 m as shown in Figure 5.2.

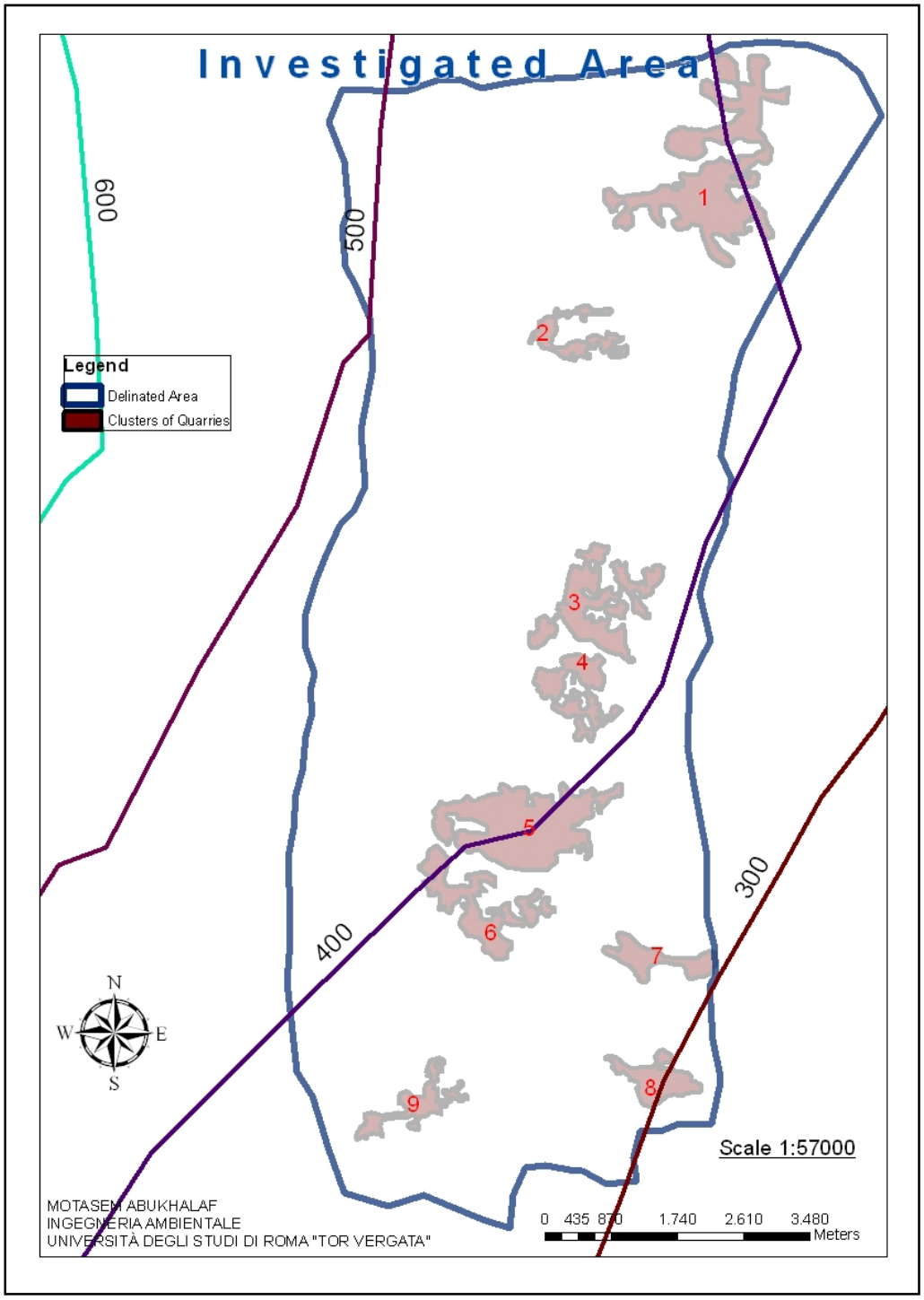


Figure 5. 2 : Groundwater Elevation Contours of the study area.

- Surface Water.

The main sources of surface water available to Palestinians include springs (West Bank only), accumulated rainwater, and seasonal wetlands and wadi flows.

The extreme rainfall events do occur during cyclonic conditions. It is during these periods of severe rainfall that water will run-off the benches of the quarry into cracks and fissures

carrying large quantities of dust and sediment into the underlying water table and/or caves. Such heavy rainfall events in limestone quarries have already been shown to have dramatic impacts on cave fauna in underlying cave systems (Eberhard 1990 and 1992).

For the most part off-site surface drainage is reduced because of the hole created by quarrying operations. However, erosion and sedimentation associated with disturbed land areas and with constructed earth berms may increase sediment load in runoff leaving the site.
Annual average rainfall varies around a mean of 500 mm per annum.There are no lakes or rivers in the study area .So there are no that significant effect on any nearby water bodies.

d) Soil pollution ;

The accumulated settled heavy particles of dust would probably change the soil chemical and physical structure of the agricultural land adjacent to the quarry. The dust would increase the calcium carbonate percentage that leads to more alkaline soils that are already alkaline in this region. Also, these particles would change the texture of the topsoil depending on the particle size of the settled dust. Also, the wastewater resulted from the quarries, which is probably drained into the soil with the help of rain, would pollute the surrounding soils. As a matter of fact, studies should be conducted in the area to figure out the impact of the quarries pollutants on soil and the consequent impact on its fertility.
Approximately 7500 tons of building stone slag is produced annually in the West Bank, representing thus a waste disposal problem . These fines, mainly composed of limestone and other minerals such as dolomite, may serve as a basic raw material for refractories or, at worst, chalk production(Dudeen B.,2001).

5.2. Effects on Land Use:

The number of abandoned quarries is large in most of the clusters; therefore, the new created landscape is distorted and considered dangerous.

The abandoned quarries create a dangerous area for the movement of people and animals. Also, the scenes of the quarrying site pose an aesthetic issue that should be taken in consideration, especially for those plants adjacent to the urbanized area.

The agricultural and grazing land reduction and the quality of land deterioration were investigated due to the random spread of quarries. The effect of quarries on the urbanization was also addressed.
The natural landform is permanently altered, original vegetation is destroyed and soil overlaying the limestone is removed as overburden. Therefore limestone extraction has ecological and landscape impacts associated with the destruction of vegetation cover and the adverse conditions for the natural revegetation of disused quarry pits.

If we consider the effects on land use from each cluster we will find the following:

- Beit Fajjar Cluster

Beit Fajjar cluster was clearly established on natural grazing land and some agricultural land on the northern part. The most important negative effect of this cluster is the reduction of grazing area which has negative consequences on the livestock raising, in addition to reducing the available agricultural lands at the northern edge. Also, the western edge of this cluster is blocking the urbanization expansion which is so vital to the town of Beit Fajjar to the east.

- Irbea Cluster.

Irbea cluster was clearly established on a blend of natural grazing and non-irrigated arable land. The most important negative effect of this cluster is the reduction of agricultural land in the surroundings.

- Shyoukh Clusters.

Shyoukh clusters were clearly established on natural grazing and small spots of non-irrigated arable land. The most important negative effect of these two clusters is the reduction of grazing area which has negative consequences on the livestock raising. Also, the western edge of these clusters is blocking the urbanization expansion which is so vital to the town of Shyoukh.

- Injas Clusters.

Injasa clusters were also clearly established on natural grazing and considerable area of non-irrigated arable land planted with some orchards. The most important negative effect of these three clusters is the reduction of grazing and agricultural area which has negative consequences on the livestock and agricultural production. Also, the western edge of these cluster association is creeping on the discontinuous urbanized and agricultural area.

- Sour Mayen Cluster.

Sour Mayen cluster at Bani Naim was also clearly established on natural grazing land. The most important negative effect of this cluster is the reduction of grazing area which has negative consequences on the livestock raising. Also, the western edge of this cluster is blocking the urbanization expansion which is so vital to the town of Bani Naim to the east.

- Sannoud Cluster.

Sannoud cluster at Bani Naim was established on discontinuous urban fabric area. Quarries are located between houses on originally agricultural land supposed to be built on. The most important negative effect of this cluster is the reduction of possible urbanization area with all utilities available. We should take in consideration that it is totally forbidden from environmental point of view to establish quarries in such an area.

- Quarries Outside Clusters.

There are about 40 quarries outside clusters and most of them (23 quarries) are located at the northern part and inside Bani Naim. These quarries were established at the expense of land inside the municipal borders supposed to be devoted as an urbanized area. They are established randomly without even the primitive precautions that should be taken at such an area.

5.3. Effects on Biodiversity:

Biological diversity (biodiversity) means the variability among living organization from all sources, including the ecological complexes of which they are part, and the diversity within and between species and of ecosystems (as defined in the Convention on Biological Diversity). The significance of biodiversity is estimated in respect to soil fertility, water purity, climate regulation and the provision of plants used for medical reasons.

Palestine is rich in agro-ecological zones representing complex topography, variable climate and rich biodiversity. However, the chaotic and uncontrolled expansion of quarry sites and limited rehabilitation of quarries is affecting vegetation cover, causing forest fragmentation and loss of arable lands.

Negative impacts of abandoned quarries in our study area include degraded scenery, landscape fragmentation, loss of biodiversity and decreased quantity and quality of water resources.

Land degradation resulting from mismanagement of quarried sites affects the ecosystem and water balance in the watersheds leading to soil erosion and landslides. Mediterranean ecosystems are frequently fragile and prone to drought, making vegetation recovery a difficult and long process. Quarries, particularly those on steep slopes with unstable rocks, increase landslides and other mass movements with consequent destruction of natural habitats and biodiversity.(T. M. DARWISH et al., 2007).

The majority of the quarries sites in the study area have been cleared of native vegetation and consists of introduced pasture for agricultural landuse (grazing). Scattered stands of native trees and isolated patches of remnant woodland remain among the grassland.

Mountains contain unique species of fauna and flora that must be preserved, plants are often a source of new medicines, and the diversity of animal life will counteract the pressure towards uniformity that modern societies places on domesticated animals.(ARIJ ,2006).

Wildlife is an important resource in the studied area especially its eastern part. Sier and surroundings have about 30 rare species of flora(Mahasnah M.,2002). It is evident that the area of the clusters 2,3,4,5,6 and 7 is mainly natural grazing with some agricultural non-irrigated arable land; therefore; both the agro and animal diversity were negatively touched in the context of the random spread of the quarries. As a result of the pressures imposed by these clusters, the flora and fauna have lost many of its species and many more are threatened.

The negative effects would be serious if we take in consideration that the quarries clusters are established at the edge of distinguished agroecological zone. To the east of this zone is the desert agroecological zone. It is vital to preserve the fauna and flora diversity in this region.

5.4. Effects on Landscape.

The number of abandoned quarries is large in most of the clusters; therefore, the new created landscape is distorted and dangerous one.
The abandoned quarries create a dangerous area for the movement of the people and the animals. Also, the scene of the quarrying site pose an aesthetic issue that should be taken in consideration, especially for those plants adjacent to the urbanized area.

5.5. Socio-economical effects.

Quarrying is an economical activity associated with social and environmental impacts, mainly on the local landscape and ecology, noise and traffic problems for local communities.

The life of a quarry depends upon the nature of its deposit and local conditions. Opening a quarry is a long-term process requiring time and depending on a rigorous process for permits.

On the other hand, Stone cutting and fabrication is an important industrial sector that support the Palestinian economy, by providing a source of financial income for many families and investors in addition to the fact that such activities create jobs.

5. 6. Other Effects such as visual impact, health, Traffic and ground vibration.

Several quarries in the study area can be viewed visually from surrounded urbanized areas and local roads. However the visual impact will be very high for local residence and other people commuting on the roads. This impact should be carefully considered as it will have a long term impact on the very important tourism industry (specially in Bani Naim area).

The visual impact of the quarries extends over larger areas as noticeable scars of high color contrast, reducing the aesthetic appeal of the landscape and deteriorating the scenic quality of areas.

Primary issues are undesirable views of industrial structures and equipment, waste material and processed aggregates stockpiles, and disturbed land areas. Most negative visual aspects of a mine site can be resolved by using the natural terrain and woodlands in siting the processing plant and by using the natural terrain and woodlands in directing the pattern of excavation. In addition, negative views associated with disturbed land areas can be minimized by a sequential mining and reclamation program to keep the amount of disturbed land, at any given point in time, to a minimum. Proper design and maintenance of the processing plant, areas surrounding the plant, and entrances to the plant will reduce negative visual aspects of the processing plant. Other techniques include installation of

earth berms and plant material screens, and placement of all operational areas and activities at the lowest point in a pit or quarry.
Several health problems such as Bronchial Asthma becomes the most common problem between population, especially those who work in stone & marble factories. The number highest number of the effected people was at Bani Naim area, then Beit Fajjar,Shyoukh and Sier respectively.

Both poor and non-poor residents of areas where stone quarries are located (as the case with Beit Fajjar town in Bethlehem District) demanded moving these quarries away from residential areas in order to reduce environmental pollution (UNDP,2003).

Trucking is the primary means of transporting construction aggregates to the market. Trucking is also one of the most contentious issues in the permitting of a mining operation. Typical concerns raised by local citizens and officials include excessive wear on local roads, increased traffic, safety, dust, and impact on property values. Trucking issues that need to be addressed in the permitting process include entrance points, intersection design, truck routing, and bonding of local roads.
Ground vibration in buildings and sensitive facilities in several distances from the quarrying site is a serious problem that effects the surrounding residences and their facilities as shown in photo.

Photo 13:- Cracks through the walls of a house in Bani Naim area as a result of neighboring quarrying land vibration.

5.7. Folchi Method for open-pit mining:

The Folchi method (2003) was first applied for a mining project in the Italian city of Sardina. It is the numerical expression of environmental effect of open pits. This method consists of the following seven stages:

(1) Characterizing the pre-existing environmental context in terms of geology, geotechnics, hydrology, weather, economy, etc., (2) Identifying the impacting factors, which could modify the pre-existing environmental conditions in the mine life, (3) Defining the possible ranges for the magnitude of the variation caused by each impacting factor, (4) Singling out the environmental components whose pre-existing condition could be modified as a result of mining, (5) Correlating each impacting factor and each environmental component, (6) Estimating the specific magnitude for each impacting factor, using the already defined ranges, (7) Calculating the weighted sum of the environmental impact on each environmental component.

In this method, some parameters such as general health and safety, social relationships, weather and climate conditions, vegetation and, animals are defined first, for an area affected by a mining operation. Then, consequences of effective (directly or indirectly) mining indexes on the each of the environmental parameters are determined, by applying a rating system for each parameter, based on various concerned scenarios. The sum of all the ratings of effective parameters determines overall effect on each of the environmental indexes. According to this method, impacting factors are as follows (Folchi 2003):

I. Alteration of area's potential resources; II. Exposition, visibility of the pit; III. Interference with surface water; IV. Interference with underground water; V. Increase in vehicular traffic; VI. Atmospheric release of gas and dust; VII. Fly rock; VIII. Noise; IX. Ground vibration; and X. Employment of local work force.

The possible scenarios for each impacting factor are then considered and a magnitude is given to each of them. Table 5.1 shows various scenarios and their related magnitudes for each impacting factor.

The Folchi method was first applied in nine cluster of quarries of the study area namely Beit Fajjar,Irbea,Shyoukh-north,Shyoukh-south, Injas 1,Injas 2,Injas 3,Sour Mayen and Sannoud (Fig.5. 3).

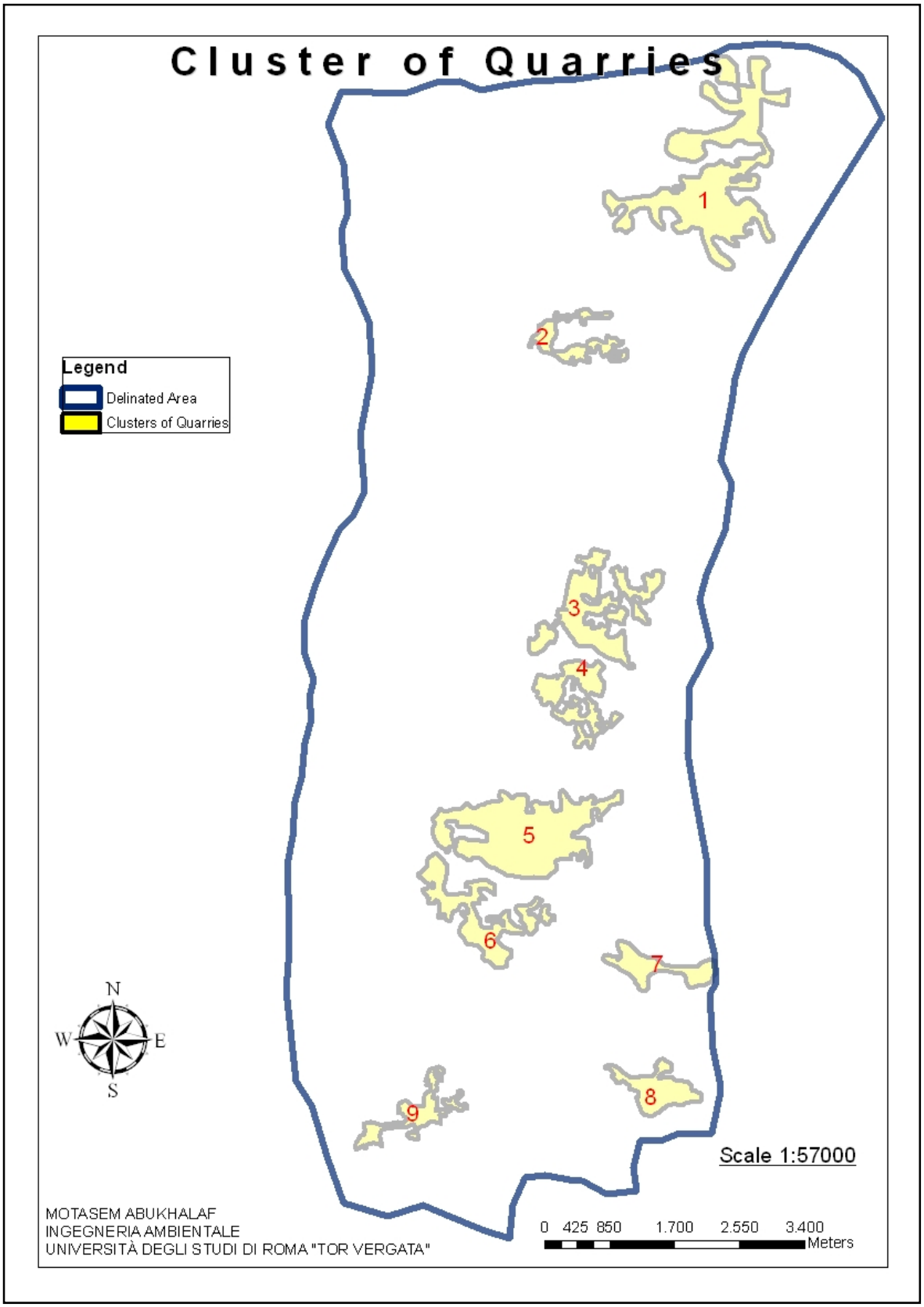


Figure 5.3: Cluster of quarries in the study area.

In the present research, the environmental data related to the above nine cases studies were collected and then using the Folchi method for each cluster of quarries which affect the environment was evaluated. Further, using the magnitude ranges defined in Table 5.1, each impacting factor of the proposed quarrying activity was assessed (Table 5.3). Final scoring for each environmental component can be acquired by multiplying Table 5.2 into Table 5.3. For each case study, the overall effect on each environmental component is calculated by summing the weighted magnitudes of all the impacting factors (Tables 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, 5.11,5.12).

The Folchi method indicates that specific aspects of environmental impact can be quantified. The most significant impacts in the cluster (Sannoud) are air quality, noise and economy with score values of 100, 80 and 77.6, respectively. In the cluster (Sour Mayen), environmental components of economy, noise and social relationship had score values of 80, 70 and 70, respectively. In the cluster (Injas 3), environmental components of air quality, noise and economy had score values of 60. In the cluster (Injas 2), environmental components of air quality, economy and use of territory had score values of 90, 80 and 75.72, respectively. In the cluster (Injas 1), environmental components of use of territory, economy and noise had score values of 74.87, 70 and 68, respectively. In the cluster (Shyoukh/south), environmental components of air quality, economy and use of territory had score values of 80, 80 and 78.57, respectively. In the cluster (Shyoukh/north), environmental components of use of territory ,economy and social relationship had score values of 80, 70 and 66.22, respectively. The most affected environmental components in the cluster (Irbea) are social relationship ,noise and economy with scores of 62.37, 62 and 60, respectively. Finally, the most affected environmental components for the cluster (Beit Fajjar) are use of territory, economy and noise with 74.28, 70 and 68 score values, respectively (Fig. 5.12).

To compare all the above cases, the sum of scores for all the environmental components can be calculated and then evaluated for each case. The sum of component scores for each cluster of quarries is summarized in Table 5.13. Using score calculations, it can be said that the cluster (Sannoud) posses the most potential environmental impact while the cluster (Irbea) is the least one. As a matter of fact, some remedial measures must be taken for the affected environmental components (e.g. air quality, water condition, etc.), which are essential for the living creatures.

The Folchi method has accounted many environmental parameters not recognized by other approaches; hence it can be considered as the best approach for evaluating quarrying sector in Palestine. This is the first such analysis performed in Palestine. With due attention to its usefulness and prevalent environment, the approach could be used for all quarries of the study area in particular and the West Bank in general. Accordingly, the Folchi method can potentially be used as an environmental regulation tool for Palestine. There are several benefits to apply this method, e.g. it can simplify complex analysis by splitting it in a number of easily quantified components, which can then be handled one by one at a time, being reconstituted in a standardized matrix to give a total magnitude value. This value can then be used to compare mining operations of different types in a consistent manner. This is a key requirement for use as a regulatory tool.

One area of improvement for the Folchi method relates to that fact that the method is a snap shot of conditions and thus is temporally limited. Several issues arise as the impacts are to be assessed in a predefined temporal window. Here, only those environmental problems are assessed that are evident at the time of the evaluation. Operators can potentially take action to skew assessment prior to a single evaluation. Incipient environmental issues or issues which have been improved but not fully rectified may be missed. Repeated evaluations over a period of time would make the approach more meaningful. Both scheduled and unannounced site assessments should ideally be made quarterly and annually.

The Folchi method allows for quantitative analysis of mining activities especially to highlight the environmental effects of the quarries. Going through the nine existing cluster of quarries in the study area, it thus indicates that Irbea is the least destructive for the environment while Sannoud is the most one(Figure 5.14). The method applied in the current research may be an important tool for future environmental regulation development in Palestine. The approach is also flexible and potentially useful in different settings. The Folchi method may also permit the possibility of fair, repeatable comparisons of environmental assessments of quarrying operations, globally.

Table 5.1: Ranges of magnitudes for impacting factor.

Impacting factors	Scenario	Magnitude
I. Alteration of area's potential resources	Parks, protected areas	8-10
	Urban area	6-8
	Agricultural area, wood	3-6
	Industrial area	1-3
II. Exposition, Visibility of the pit	Can be seen from inhabited areas	6-10
	Can be seen from main roads	2-6
	Not visible	1-2
III. Interference with above ground water	Interference with lakes and rivers	6-10
	Interferences with non relevant water system	3-6
	No interference	1-3
IV. Interference with underground water	Water table superficial and permeable ground	5-10
	Water table deep and permeable grounds	2-5
	Water table deep and un-permeable grounds	1-2
V. Increase in vehicular traffic	Increase of 200%	6-10
	Increase of 100%	3-6
	No interference	1-3

VI. Atmospheric release of gas and dust	Free emissions in the atmosphere Emission around the given reference value Emission well below the given reference values	7-10 2-7 1-2
VII. Fly rock	No blast design and no clearance procedures Blast design and no clearance procedure Blast design and clearance procedures Peak air overpressure at 1 km distance	9-10 4-9 1-4
VIII. Noise	\141 db \131 db \121 db	8-10 4-8 1-4
IX. Ground vibration	Cosmetic damage, above threshold Tolerability threshold Values under tolerability threshold	7-10 3-7 1-3
X. Employment of local work force	Job opportunities High Medium Low	7-10 3-6 1-2

Table 5.2 :- Correlation matrix with values of the weighted influence of each impacting factor on each environ component.

Impacting factors	Environmental Components										
	Human Health and Safety	**Social Relationship**	**Water quality**	**Air quality**	**Use of territory**	**Flora and Funa**	**Above ground**	**Under-ground**	**Landscape**	**Noise**	**Economy**
I. Alteration of area's potential resources lteration of area's	Med **0.8**	Min **0.77**	Nil 0	Nil 0	Max **5.71**	Min **0.63**	Nil 0	Nil 0	Max **2.86**	Nil 0	Nil 0
II. Exposition, Visibility of the pit	Nil 0	Min **0.77**	Nil 0	Nil 0	Med **2.86**	Nil 0	Nil 0	Nil 0	Max **2.86**	Min **2.00**	Nil 0
III. Interference with above ground water	Max **1.60**	Nil 0	Max **4.44**	Nil 0	Nil 0	Max **2.50**	Med **6.67**	Nil 0	Max **2.86**	Nil 0	Nil 0
IV. Interference with underground water	Min 0.4	Nil 0	Max **4.44**	Nil 0	Nil 0	Nil 0	Nil 0	Med **6.67**	Nil 0	Nil 0	Nil 0
V. Increase in vehicular traffic	Max **1.60**	Max **3.08**	Nil 0	Nil 0	Min 1.43	Max 2.50	Nil 0	Nil 0	Min **0.71**	Nil 0	Nil 0
VI. Atmospheric release of gas and dust	Max **1.60**	Min **0.77**	Min **1.11**	Max **10.00**	Nil 0	Max **2.50**	Min **3.33**	Nil 0	Min **0.71**	Nil 0	Nil 0
VII. Fly rock	Max **1.60**	Nil 0	Nil 0	Nil 0	Nil 0	Med **1.25**	Nil 0	Nil 0	Nil 0	Nil 0	Nil 0
VIII. Noise	Med **0.8**	Max **3.08**	Nil 0	Nil 0	Nil 0	Min **0.63**	Nil 0	Nil 0	Nil 0	Max **8.00**	Nil 0
IX. Ground vibration	Max **1.60**	Med **1.54**	Nil 0	Nil 0	Nil 0	Nil 0	Nil 0	Min **3.33**	Nil 0	Nil 0	Nil 0
X. Employment of local work force	Nil 0	Nil 0	Nil 0	Nil 0	Nil 0	Nil 0	Nil 0	Nil 0	Nil 0	Nil 0	Max **10.00**
TOTAL	**10,00**	**10,00**	**10,00**	**10,00**	**10,00**	**10,00**	**10,00**	**10,00**	**10,00**	**10,00**	**10,00**

Table 5.3: Rating of environmental parameters in each case study of Clusters of Quarries.

Impacting Factor	Beit Fajjar	Irbea	Shyoukh/ north	Shyoukh/ south	Injas 1	Injas 2	Injas 3	Sour Mayen	Sannoud
I. Alteration of area's potential resources	8	3	8	8	8	7	5	6	8
II. Exposition, Visibility of the pit	6	3	8	8	6	9	6	7	10
III. Interference with above ground water	3	2	3	4	4	5	3	3	6
IV. Interference with underground water	5	5	4	5	5	4	2	3	5
V. Increase in vehicular traffic	8	9	8	7	8	7	6	8	8
VI. Atmospheric release of gas and dust	5	5	6	8	6	9	6	7	10
VII. Fly rock	4	2	3	2	3	2	2	3	6
VIII. Noise	7	7	6	7	7	7	6	8	9
IX. Ground vibration	3	3	4	7	4	8	4	7	10
X. Employment of local work force	7	6	7	8	7	8	6	8	9

Table 5.4: Final scoring for each environmental component in (Beit Fajjar) Cluster.

Impacting Factors	Environmental Components										
	Human Health and Safety	Social Relationship	Water quality	Air quality	Use of territory	Flora and Funa	Above ground	Under ground	Landscape	Noise	Economy
I. Alteration of area's potential resources	6,40	6,16	0,00	0,00	45,68	5,04	0,00	0,00	22,88	0,00	0,00
II. Exposition, Visibility of the pit	0,00	4,62	0,00	0,00	17,16	0,00	0,00	0,00	17,16	12,00	0,00
III. Interference with above ground water	4,80	0,00	13,32	0,00	0,00	7,50	19,98	0,00	8,58	0,00	0,00
IV. Interference with underground water	2,00	0,00	22,20	0,00	0,00	0,00	0,00	33,35	0,00	0,00	0,00
V. Increase in vehicular traffic	12,80	24,64	0,00	0,00	11,44	20,00	0,00	0,00	5,68	0,00	0,00
VI. Atmospheric release of gas and dust	8,00	3,85	5,55	50,00	0,00	12,50	16,65	0,00	3,55	0,00	0,00
VII. Fly rock	6,40	0,00	0,00	0,00	0,00	5,00	0,00	0,00	0,00	0,00	0,00
VIII. Noise	5,60	21,56	0,00	0,00	0,00	4,41	0,00	0,00	0,00	56,00	0,00
IX. Ground vibration	4,80	4,62	0,00	0,00	0,00	0,00	0,00	9,99	0,00	0,00	0,00
X. Employment of local work force	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	70,00
Total	**50,80**	**65,45**	**41,07**	**50,00**	**74,28**	**54,45**	**36,63**	**43,34**	**57,85**	**68,00**	**70,00**

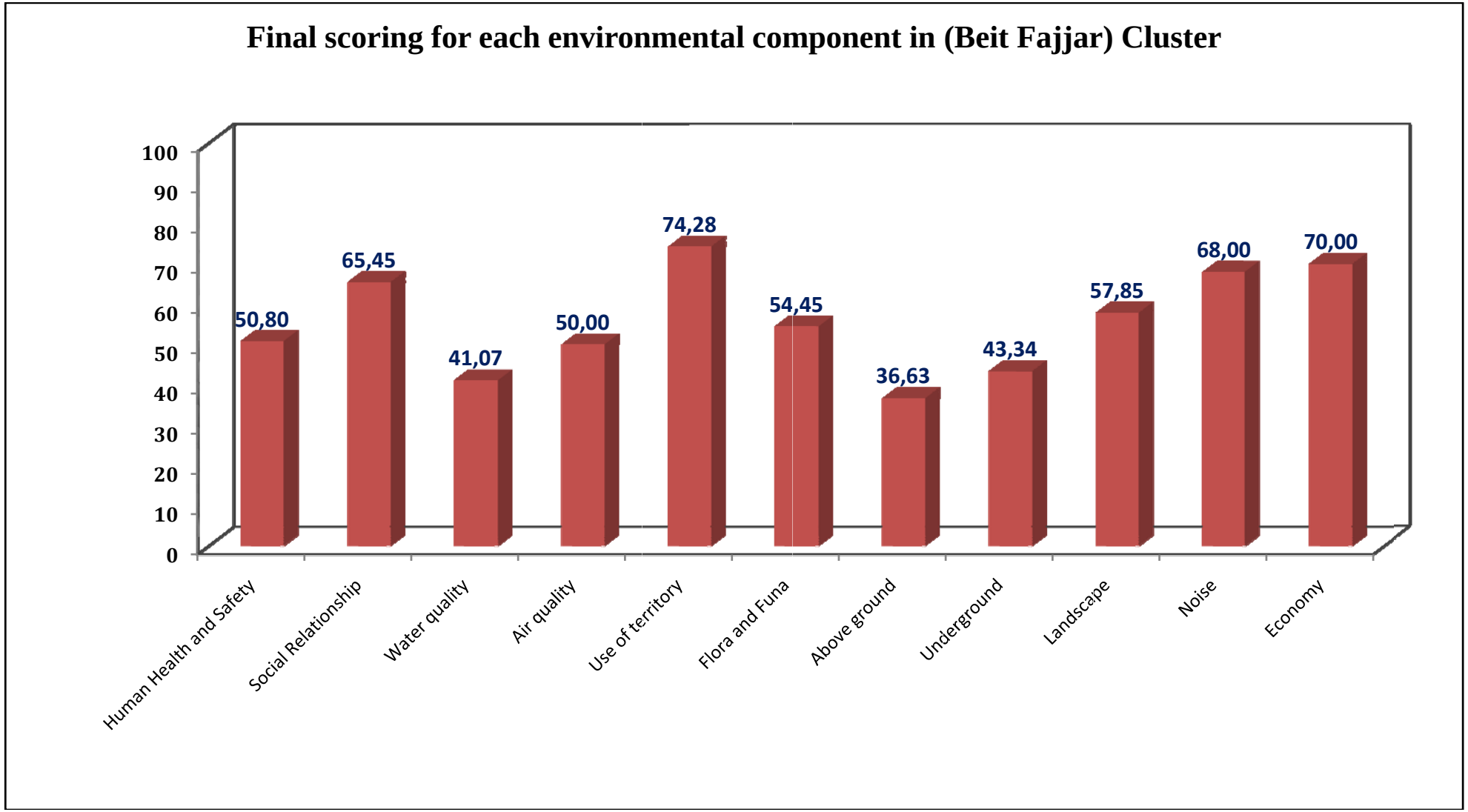


Figure 5.4: Final scoring for each environmental component in (Beit Fajjar)cluster.

Table 5.5: Final scoring for each environmental component in (Irbea) Cluster.

Impacting Factors	Environmental Components										
	Human Health and Safety	Social Relationship	Water quality	Air quality	Use of territory	Flora and Funa	Above ground	Under ground	Landscape	Noise	Economy
I. Alteration of area's potential resources	2,40	2,31	0,00	0,00	17,13	1,89	0,00	0,00	8,58	0,00	0,00
II. Exposition, Visibility of the pit	0,00	2,31	0,00	0,00	8,58	0,00	0,00	0,00	8,58	6,00	0,00
III. Interference with above ground water	3,20	0,00	8,88	0,00	0,00	5,00	13,32	0,00	5,72	0,00	0,00
IV. Interference with underground water	2,00	0,00	22,20	0,00	0,00	0,00	0,00	33,35	0,00	0,00	0,00
V. Increase in vehicular traffic	14,40	27,72	0,00	0,00	12,87	22,50	0,00	0,00	6,39	0,00	0,00
VI. Atmospheric release of gas and dust	8,00	3,85	5,55	50,00	0,00	12,50	16,65	0,00	3,55	0,00	0,00
VII. Fly rock	3,20	0,00	0,00	0,00	0,00	2,50	0,00	0,00	0,00	0,00	0,00
VIII. Noise	5,60	21,56	0,00	0,00	0,00	4,41	0,00	0,00	0,00	56,00	0,00
IX. Ground vibration	4,80	4,62	0,00	0,00	0,00	0,00	0,00	9,99	0,00	0,00	0,00
X. Employment of local work force	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	60,00
Total	**43,60**	**62,37**	**36,63**	**50,00**	**38,58**	**48,80**	**29,97**	**43,34**	**32,82**	**62,00**	**60,00**

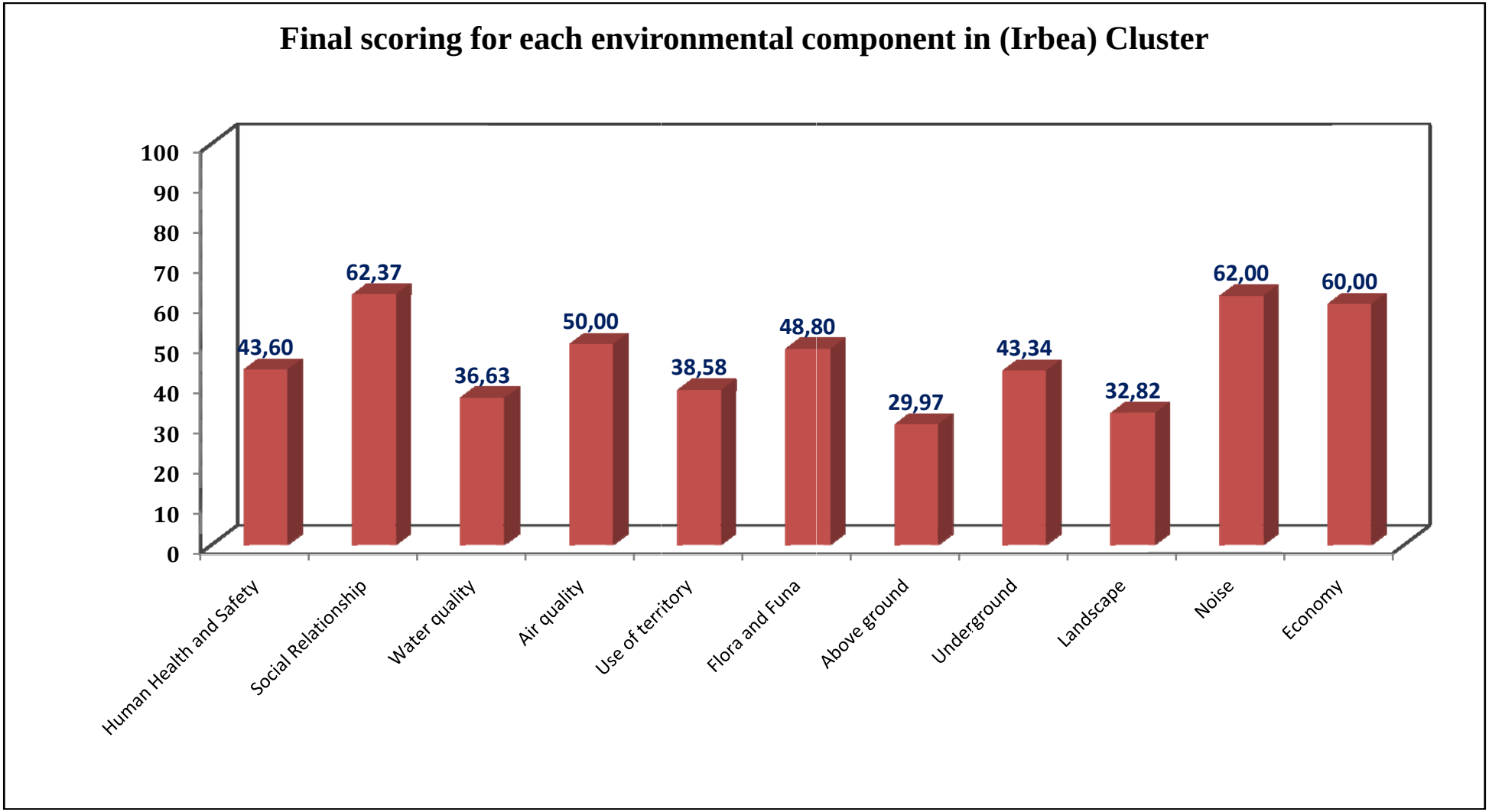


Figure 5.5: Final scoring for each environmental component in (Irbea)cluster.

Table 5.6: Final scoring for each environmental component in (Shyoukh/north) Cluster.

Impacting Factors	Environmental Components										
	Human Health and Safety	Social Relationship	Water quality	Air quality	Use of territory	Flora and Funa	Above ground	Under ground	Landscape	Noise	Economy
I. Alteration of area's potential resources	6,40	6,16	0,00	0,00	45,68	5,04	0,00	0,00	22,88	0,00	0,00
II. Exposition, Visibility of the pit	0,00	6,16	0,00	0,00	22,88	0,00	0,00	0,00	22,88	16,00	0,00
III. Interference with above ground water	4,80	0,00	13,32	0,00	0,00	7,50	19,98	0,00	8,58	0,00	0,00
IV. Interference with underground water	1,60	0,00	17,76	0,00	0,00	0,00	0,00	26,68	0,00	0,00	0,00
V. Increase in vehicular traffic	12,80	24,64	0,00	0,00	11,44	20,00	0,00	0,00	5,68	0,00	0,00
VI. Atmospheric release of gas and dust	9,60	4,62	6,66	60,00	0,00	15,00	19,98	0,00	4,26	0,00	0,00
VII. Fly rock	4,80	0,00	0,00	0,00	0,00	3,75	0,00	0,00	0,00	0,00	0,00
VIII. Noise	4,80	18,48	0,00	0,00	0,00	3,78	0,00	0,00	0,00	48,00	0,00
IX. Ground vibration	6,40	6,16	0,00	0,00	0,00	0,00	0,00	13,32	0,00	0,00	0,00
X. Employment of local work force	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	70,00
Total	**51,20**	**66,22**	**37,74**	**60,00**	**80,00**	**55,07**	**39,96**	**40,00**	**64,28**	**64,00**	**70,00**

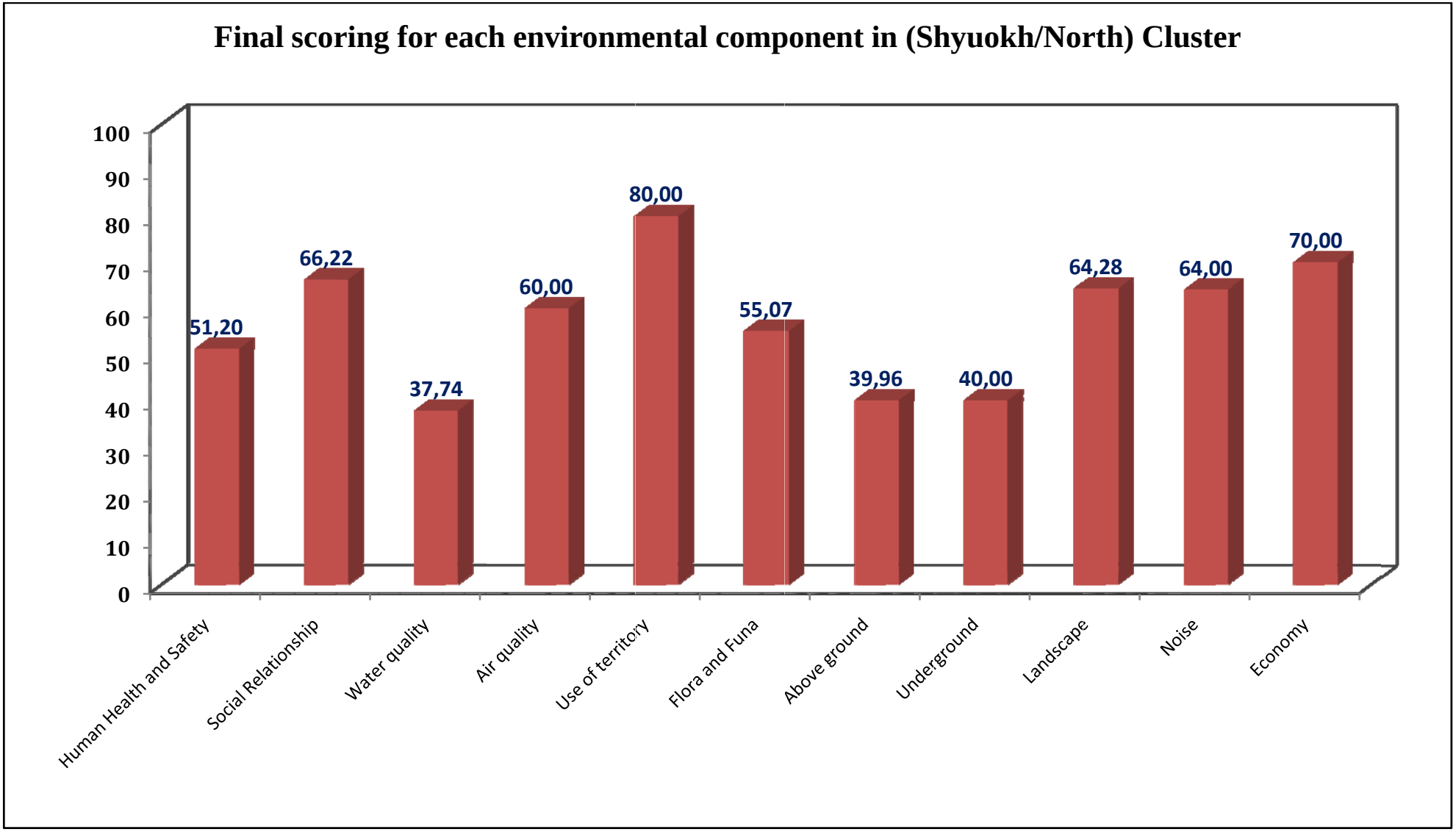


Figure 5.6: Final scoring for each environmental component in (Shyoukh/north)cluster.

Table 5.7: Final scoring for each environmental component in (Shyoukh/south) Cluster.

Impacting Factors	Environmental Components										
	Human Health and Safety	Social Relationship	Water quality	Air quality	Use of territory	Flora and Funa	Above ground	Under ground	Landscape	Noise	Economy
I. Alteration of area's potential resources	6,40	6,16	0,00	0,00	45,68	5,04	0,00	0,00	22,88	0,00	0,00
II. Exposition, Visibility of the pit	0,00	6,16	0,00	0,00	22,88	0,00	0,00	0,00	22,88	16,00	0,00
III. Interference with above ground water	6,40	0,00	17,76	0,00	0,00	10,00	26,64	0,00	11,44	0,00	0,00
IV. Interference with underground water	2,00	0,00	22,20	0,00	0,00	0,00	0,00	33,35	0,00	0,00	0,00
V. Increase in vehicular traffic	11,20	21,56	0,00	0,00	10,01	17,50	0,00	0,00	4,97	0,00	0,00
VI. Atmospheric release of gas and dust	12,80	6,16	8,88	80,00	0,00	20,00	26,64	0,00	5,68	0,00	0,00
VII. Fly rock	3,20	0,00	0,00	0,00	0,00	2,50	0,00	0,00	0,00	0,00	0,00
VIII. Noise	5,60	21,56	0,00	0,00	0,00	4,41	0,00	0,00	0,00	56,00	0,00
IX. Ground vibration	11,20	10,78	0,00	0,00	0,00	0,00	0,00	23,31	0,00	0,00	0,00
X. Employment of local work force	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	80,00
Total	**58,80**	**72,38**	**48,84**	**80,00**	**78,57**	**59,45**	**53,28**	**56,66**	**67,85**	**72,00**	**80,00**

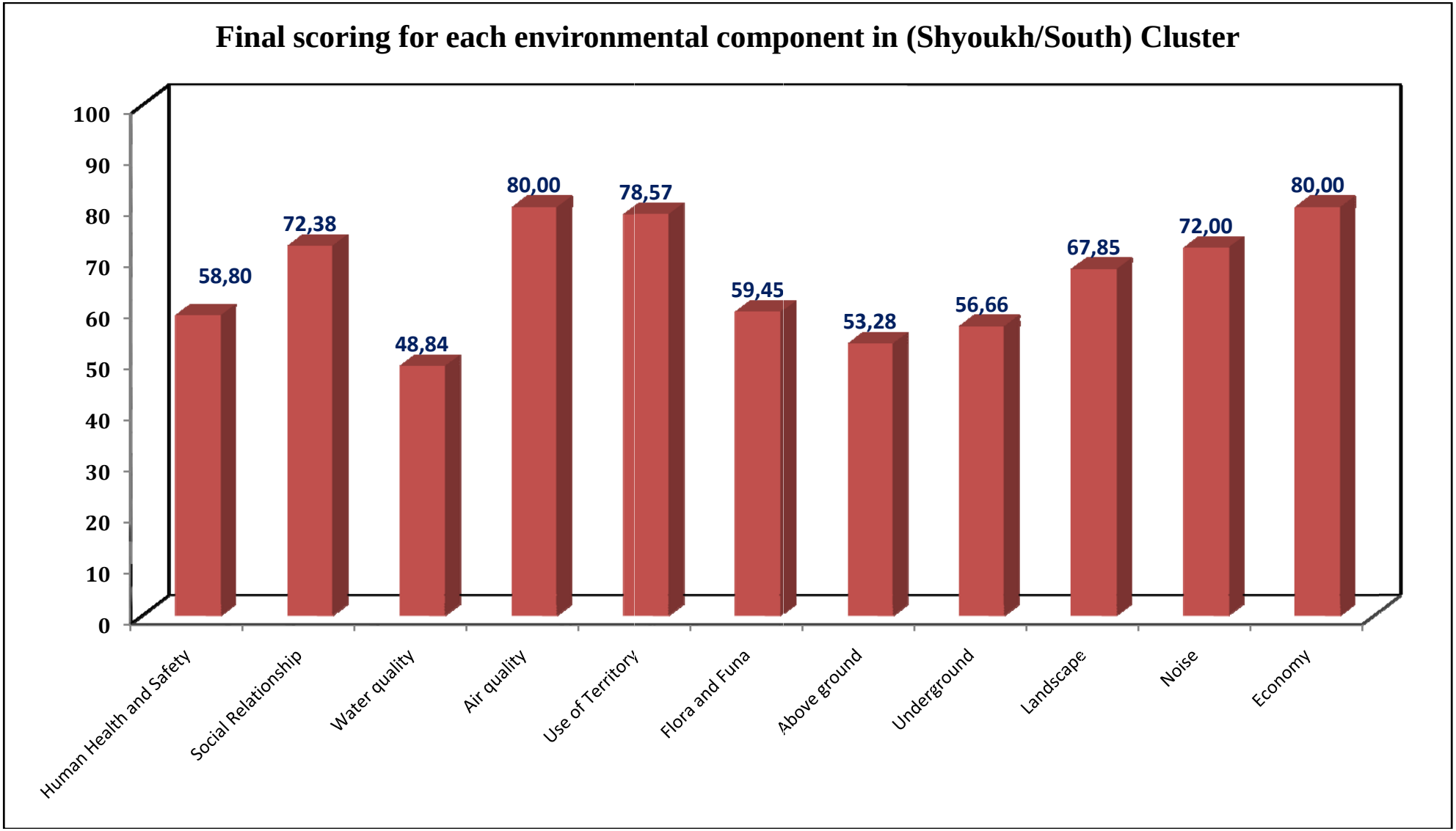


Figure 5.7: Final scoring for each environmental component in (Shyoukh/south)cluster.

Table 5.8: Final scoring for each environmental component in (Injas 1) Cluster.

Impacting Factors	Environmental Components										
	Human Health and Safety	Social Relationship	Water quality	Air quality	Use of territory	Flora and Funa	Above ground	Under ground	Landscape	Noise	Economy
I. Alteration of area's potential resources	6,40	6,16	0,00	0,00	45,68	5,04	0,00	0,00	22,88	0,00	0,00
II. Exposition, Visibility of the pit	0,00	4,62	0,00	0,00	17,16	0,00	0,00	0,00	17,16	12,00	0,00
III. Interference with above ground water	6,40	0,00	17,76	0,00	0,00	10,00	26,64	0,00	11,44	0,00	0,00
IV. Interference with underground water	2,00	0,00	22,20	0,00	0,00	0,00	0,00	33,35	0,00	0,00	0,00
V. Increase in vehicular traffic	12,80	24,64	0,00	0,00	11,44	20,00	0,00	0,00	5,68	0,00	0,00
VI. Atmospheric release of gas and dust	9,60	4,62	6,66	60,00	0,00	15,00	19,98	0,00	4,26	0,00	0,00
VII. Fly rock	4,80	0,00	0,00	0,00	0,00	3,75	0,00	0,00	0,00	0,00	0,00
VIII. Noise	5,60	21,56	0,00	0,00	0,00	4,41	0,00	0,00	0,00	56,00	0,00
IX. Ground vibration	6,40	6,16	0,00	0,00	0,00	0,00	0,00	13,32	0,00	0,00	0,00
X. Employment of local work force	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	70,00
Total	**54,00**	**67,76**	**46,62**	**60,00**	**74,28**	**58,20**	**46,62**	**46,67**	**61,42**	**68,00**	**70,00**

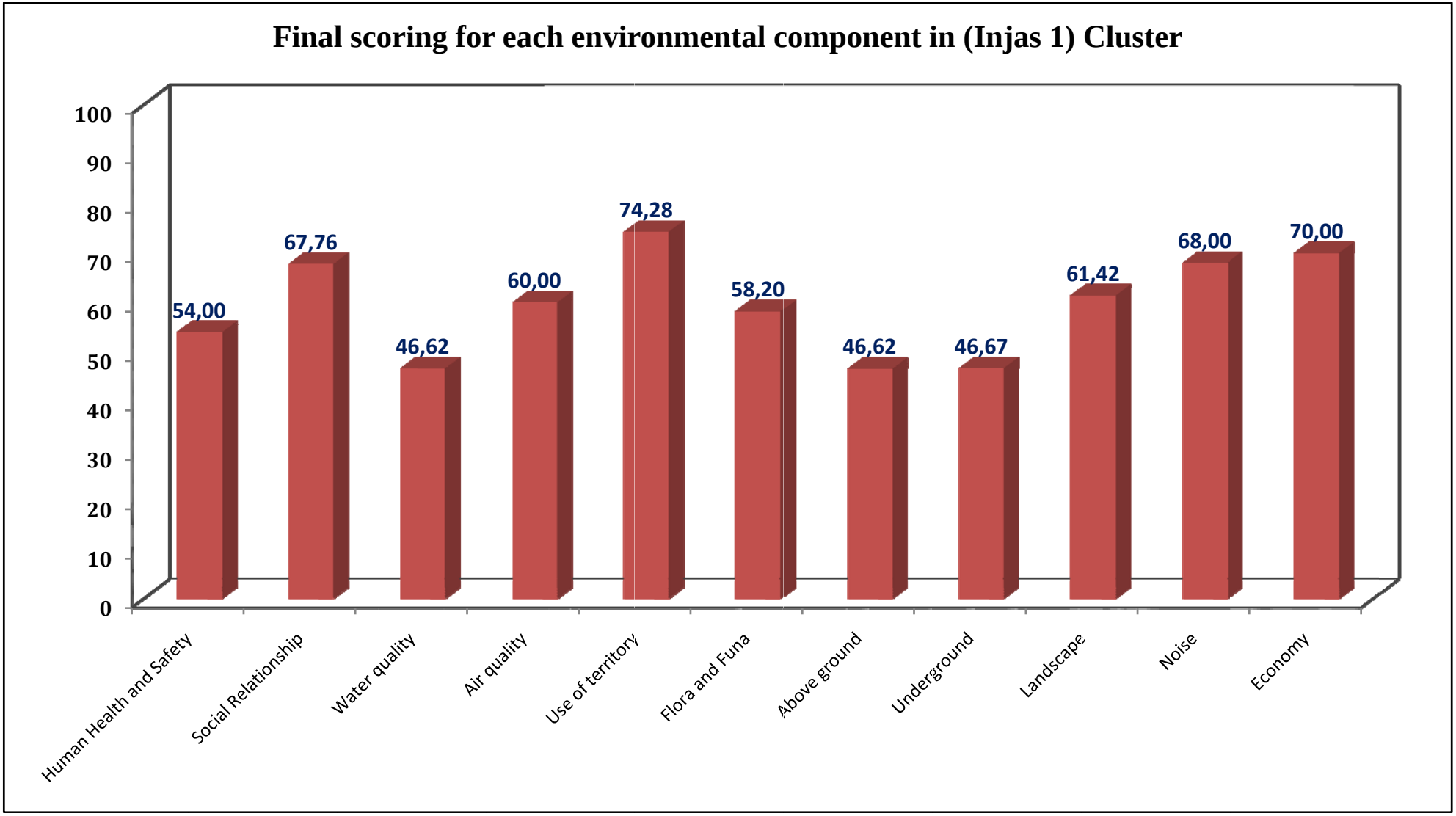


Figure 5.8: Final scoring for each environmental component in (Injas 1)cluster.

Table 5.9: Final scoring for each environmental component in (Injas 2) Cluster.

Impacting Factors	Environmental Components										
	Human Health and Safety	**Social Relationship**	**Water quality**	**Air quality**	**Use of territory**	**Flora and Funa**	**Above ground**	**Under ground**	**Landscape**	**Noise**	**Economy**
I. Alteration of area's potential resources	5,60	5,39	0,00	0,00	39,97	4,41	0,00	0,00	20,02	0,00	0,00
II. Exposition, Visibility of the pit	0,00	6,93	0,00	0,00	25,74	0,00	0,00	0,00	25,74	18,00	0,00
III. Interference with above ground water	8,00	0,00	22,20	0,00	0,00	12,50	33,30	0,00	14,30	0,00	0,00
IV. Interference with underground water	1,60	0,00	17,76	0,00	0,00	0,00	0,00	26,68	0,00	0,00	0,00
V. Increase in vehicular traffic	11,20	21,56	0,00	0,00	10,01	17,50	0,00	0,00	4,97	0,00	0,00
VI. Atmospheric release of gas and dust	14,40	6,93	9,99	90,00	0,00	22,50	29,97	0,00	6,39	0,00	0,00
VII. Fly rock	3,20	0,00	0,00	0,00	0,00	2,50	0,00	0,00	0,00	0,00	0,00
VIII. Noise	5,60	21,56	0,00	0,00	0,00	4,41	0,00	0,00	0,00	56,00	0,00
IX. Ground vibration	12,80	12,32	0,00	0,00	0,00	0,00	0,00	26,64	0,00	0,00	0,00
X. Employment of local work force	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	80,00
Total	**62,40**	**74,69**	**49,95**	**90,00**	**75,72**	**63,82**	**63,27**	**53,32**	**71,42**	**74,00**	**80,00**

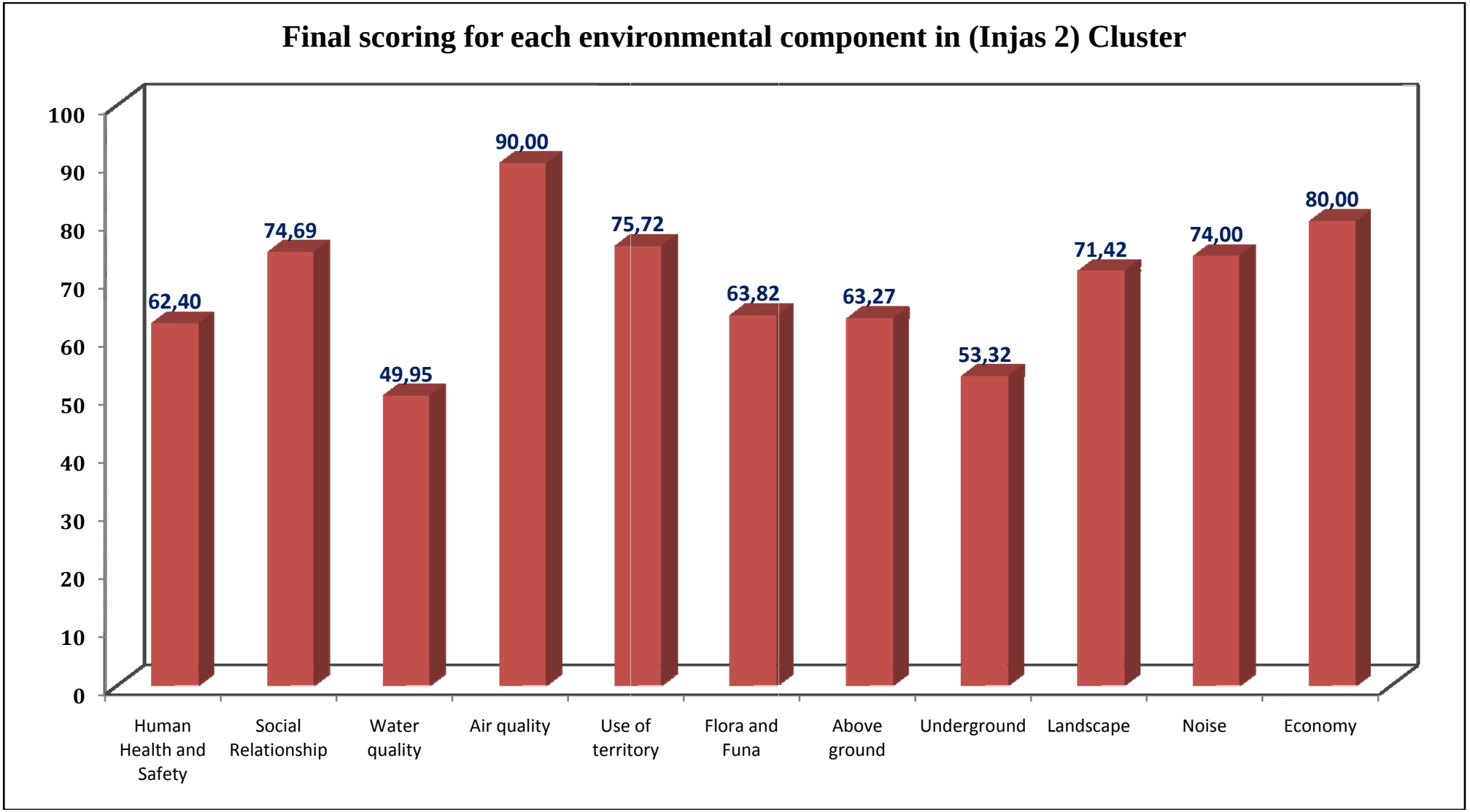


Figure 5.9: Final scoring for each environmental component in (Injas 2)cluster.

Table 5.10: Final scoring for each environmental component in (Injas 3) Cluster.

Impacting Factors	Environmental Components										
	Human Health and Safety	Social Relationship	Water quality	Air quality	Use of territory	Flora and Funa	Above ground	Under ground	Landscape	Noise	Economy
I. Alteration of area's potential resources	4,00	3,85	0,00	0,00	28,55	3,15	0,00	0,00	14,30	0,00	0,00
II. Exposition, Visibility of the pit	0,00	4,62	0,00	0,00	17,16	0,00	0,00	0,00	17,16	12,00	0,00
III. Interference with above ground water	4,80	0,00	13,32	0,00	0,00	7,50	19,98	0,00	8,58	0,00	0,00
IV. Interference with underground water	0,80	0,00	8,88	0,00	0,00	0,00	0,00	13,34	0,00	0,00	0,00
V. Increase in vehicular traffic	9,60	18,48	0,00	0,00	8,58	15,00	0,00	0,00	4,26	0,00	0,00
VI. Atmospheric release of gas and dust	9,60	4,62	6,66	60,00	0,00	15,00	19,98	0,00	4,26	0,00	0,00
VII. Fly rock	3,20	0,00	0,00	0,00	0,00	2,50	0,00	0,00	0,00	0,00	0,00
VIII. Noise	4,80	18,48	0,00	0,00	0,00	3,78	0,00	0,00	0,00	48,00	0,00
IX. Ground vibration	6,40	6,16	0,00	0,00	0,00	0,00	0,00	13,32	0,00	0,00	0,00
X. Employment of local work force	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	60,00
Total	**43,20**	**56,21**	**28,86**	**60,00**	**54,29**	**46,93**	**39,96**	**26,66**	**48,56**	**60,00**	**60,00**

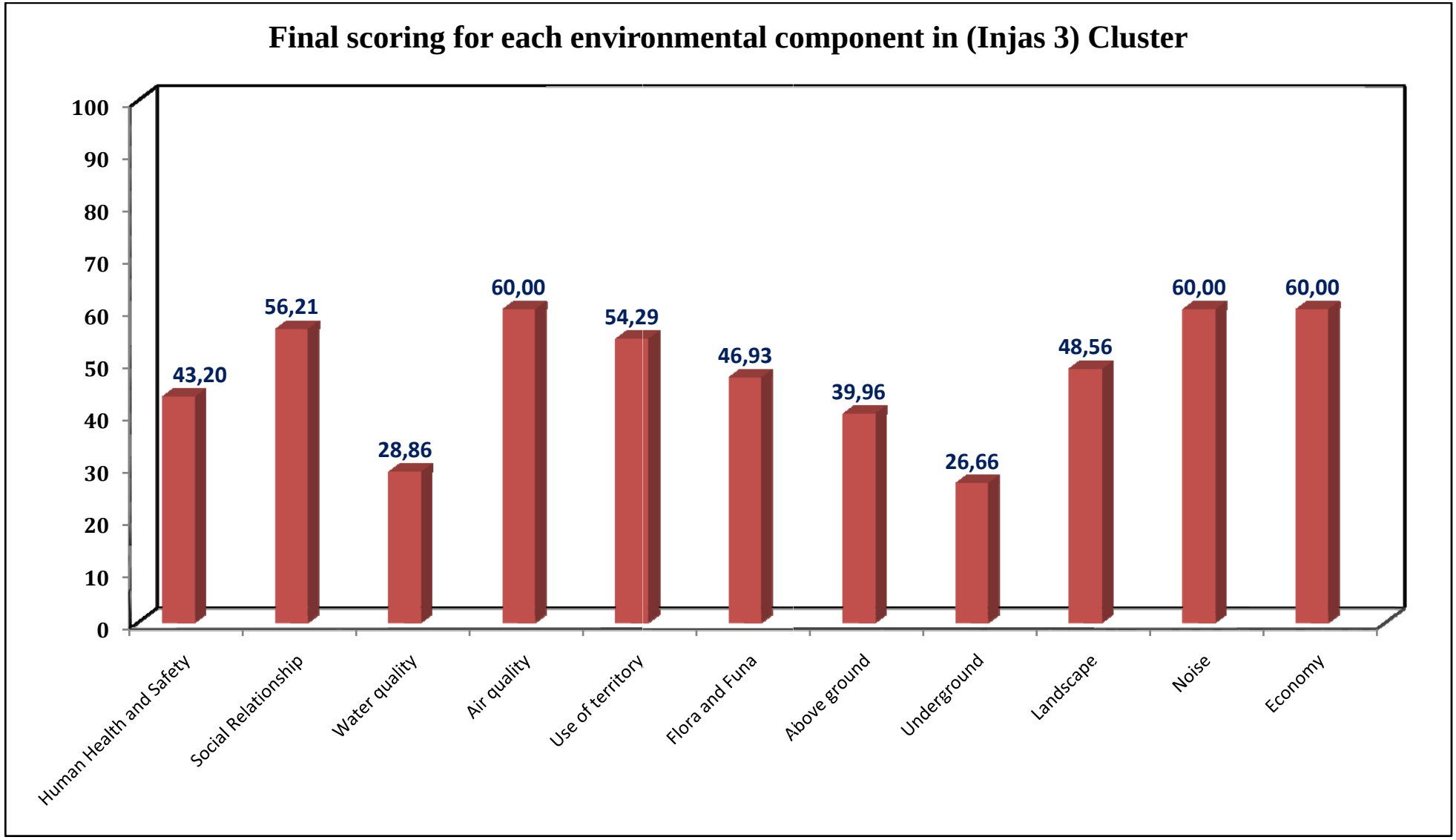


Figure 5.10: Final scoring for each environmental component in (Injas 3)cluster.

Table 5.11: Final scoring for each environmental component in (Sour Mayen) Cluster.

Impacting Factors	Environmental Components										
	Human Health and Safety	Social Relationship	Water quality	Air quality	Use of territory	Flora and Funa	Above ground	Under ground	Landscape	Noise	Economy
I. Alteration of area's potential resources	4,80	4,62	0,00	0,00	34,26	3,78	0,00	0,00	17,16	0,00	0,00
II. Exposition, Visibility of the pit	0,00	5,39	0,00	0,00	20,02	0,00	0,00	0,00	20,02	14,00	0,00
III. Interference with above ground water	4,80	0,00	13,32	0,00	0,00	7,50	19,98	0,00	8,58	0,00	0,00
IV. Interference with underground water	1,20	0,00	13,32	0,00	0,00	0,00	0,00	20,01	0,00	0,00	0,00
V. Increase in vehicular traffic	12,80	24,64	0,00	0,00	11,44	20,00	0,00	0,00	5,68	0,00	0,00
VI. Atmospheric release of gas and dust	11,20	5,39	7,77	70,00	0,00	17,50	23,31	0,00	4,97	0,00	0,00
VII. Fly rock	4,80	0,00	0,00	0,00	0,00	3,75	0,00	0,00	0,00	0,00	0,00
VIII. Noise	7,20	27,72	0,00	0,00	0,00	5,67	0,00	0,00	0,00	72,00	0,00
IX. Ground vibration	11,20	10,78	0,00	0,00	0,00	0,00	0,00	23,31	0,00	0,00	0,00
X. Employment of local work force	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	90,00
Total	**58,00**	**78,54**	**34,41**	**70,00**	**65,72**	**58,20**	**43,29**	**43,32**	**56,41**	**86,00**	**90,00**

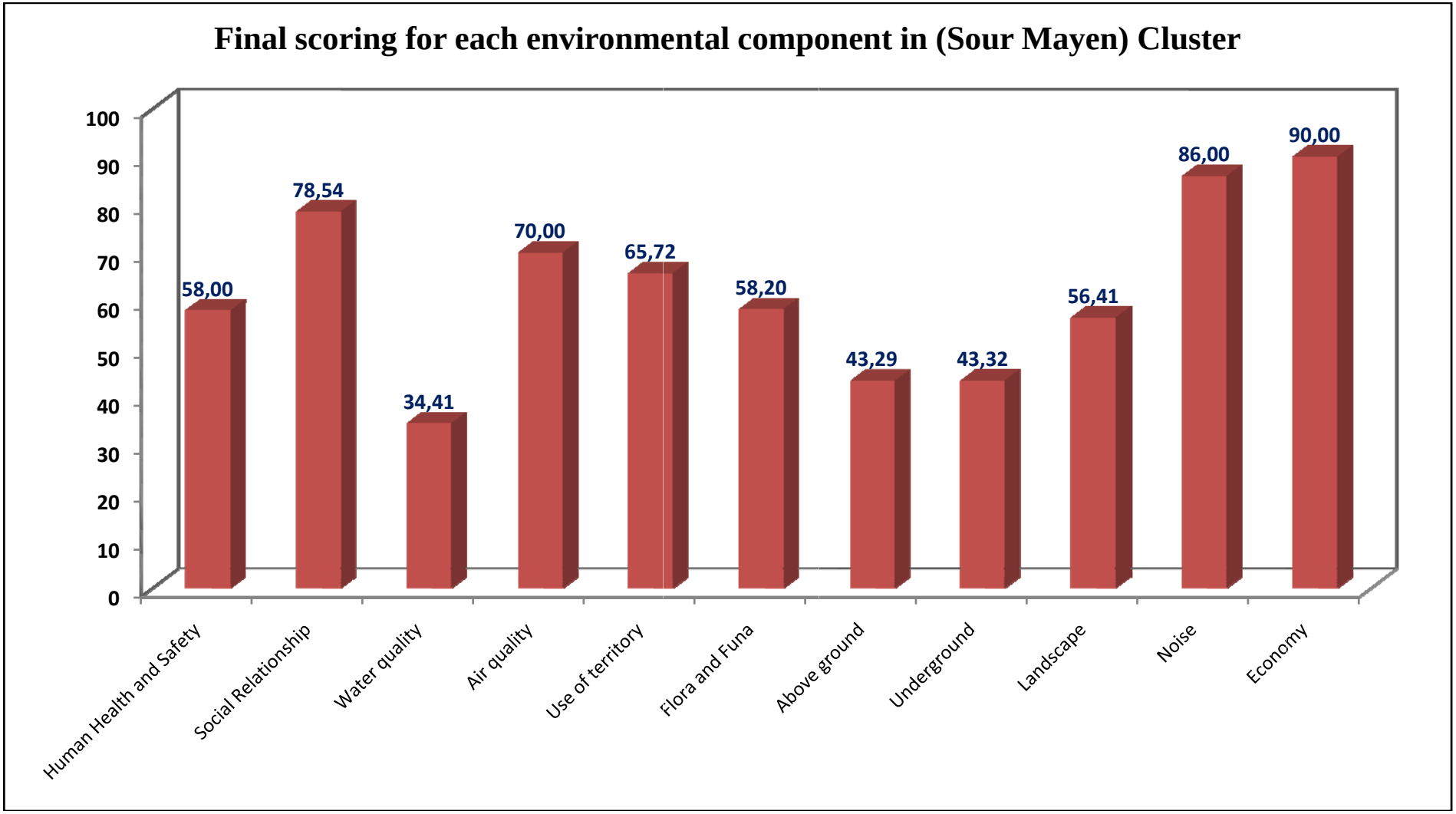


Figure 5.11: Final scoring for each environmental component in (Sour Mayen)cluster.

Table 5.12 Final scoring for each environmental component in (Sannoud) Cluster.

Impacting Factors	Environmental Components										
	Human Health and Safety	**Social Relationship**	**Water quality**	**Air quality**	**Use of territory**	**Flora and Funa**	**Above ground**	**Under ground**	**Landscape**	**Noise**	**Economy**
I. Alteration of area's potential resources	6,40	6,16	0,00	0,00	45,68	5,04	0,00	0,00	22,88	0,00	0,00
II. Exposition, Visibility of the pit	0,00	7,70	0,00	0,00	28,60	0,00	0,00	0,00	28,60	20,00	0,00
III. Interference with above ground water	9,60	0,00	26,64	0,00	0,00	15,00	39,96	0,00	17,16	0,00	0,00
IV. Interference with underground water	2,00	0,00	22,20	0,00	0,00	0,00	0,00	33,35	0,00	0,00	0,00
V. Increase in vehicular traffic	12,80	24,64	0,00	0,00	11,44	20,00	0,00	0,00	5,68	0,00	0,00
VI. Atmospheric release of gas and dust	16,00	7,70	11,10	100,00	0,00	25,00	33,30	0,00	7,10	0,00	0,00
VII. Fly rock	9,60	0,00	0,00	0,00	0,00	7,50	0,00	0,00	0,00	0,00	0,00
VIII. Noise	7,20	27,72	0,00	0,00	0,00	5,67	0,00	0,00	0,00	72,00	0,00
IX. Ground vibration	16,00	15,40	0,00	0,00	0,00	0,00	0,00	33,30	0,00	0,00	0,00
X. Employment of local work force	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	90,00
Total	**79,60**	**89,32**	**59,94**	**100,00**	**85,72**	**78,21**	**73,26**	**66,65**	**81,42**	**92,00**	**90,00**

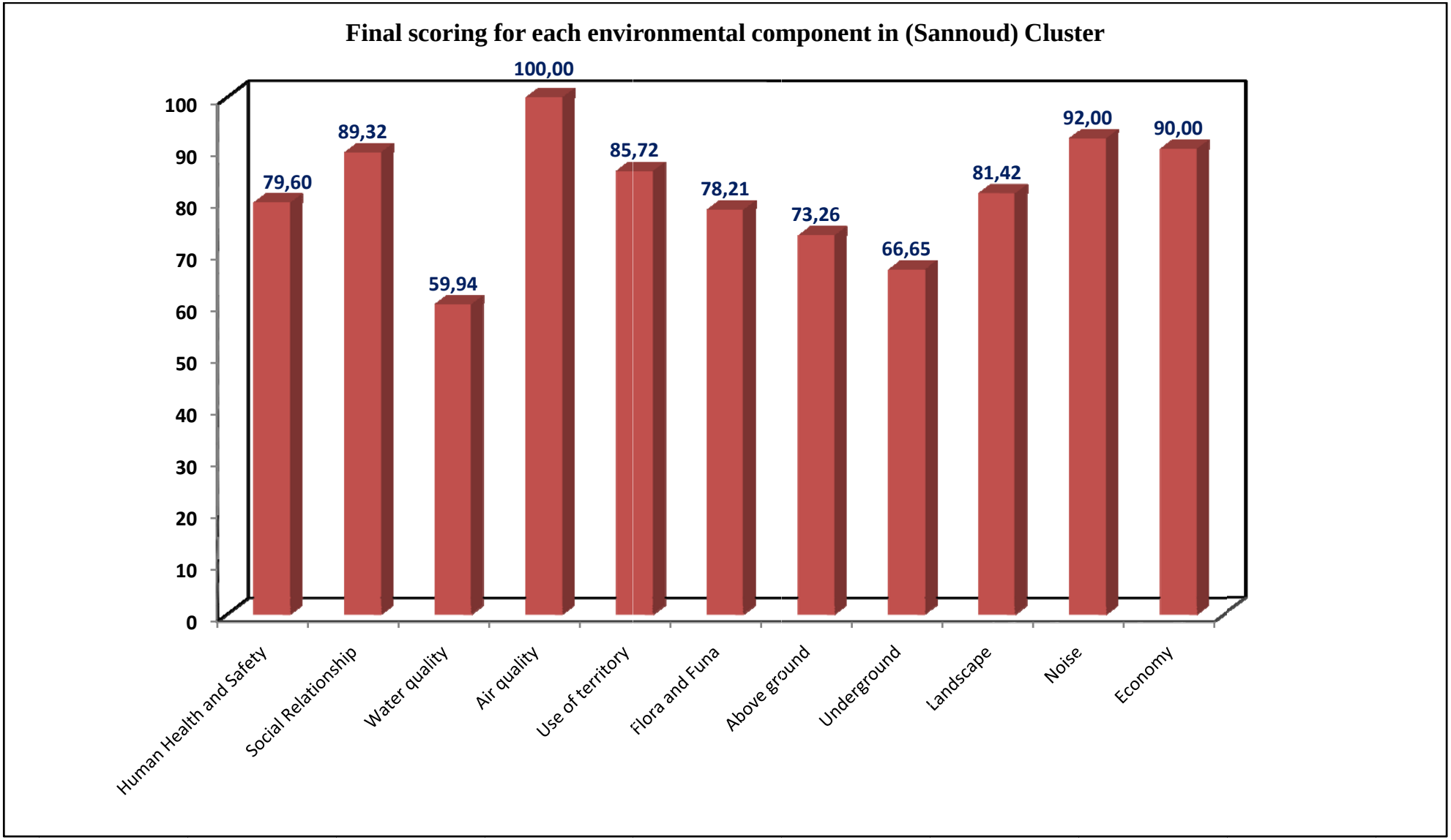


Figure 5.12 :Final scoring for each environmental component in (Sannoud)cluster.

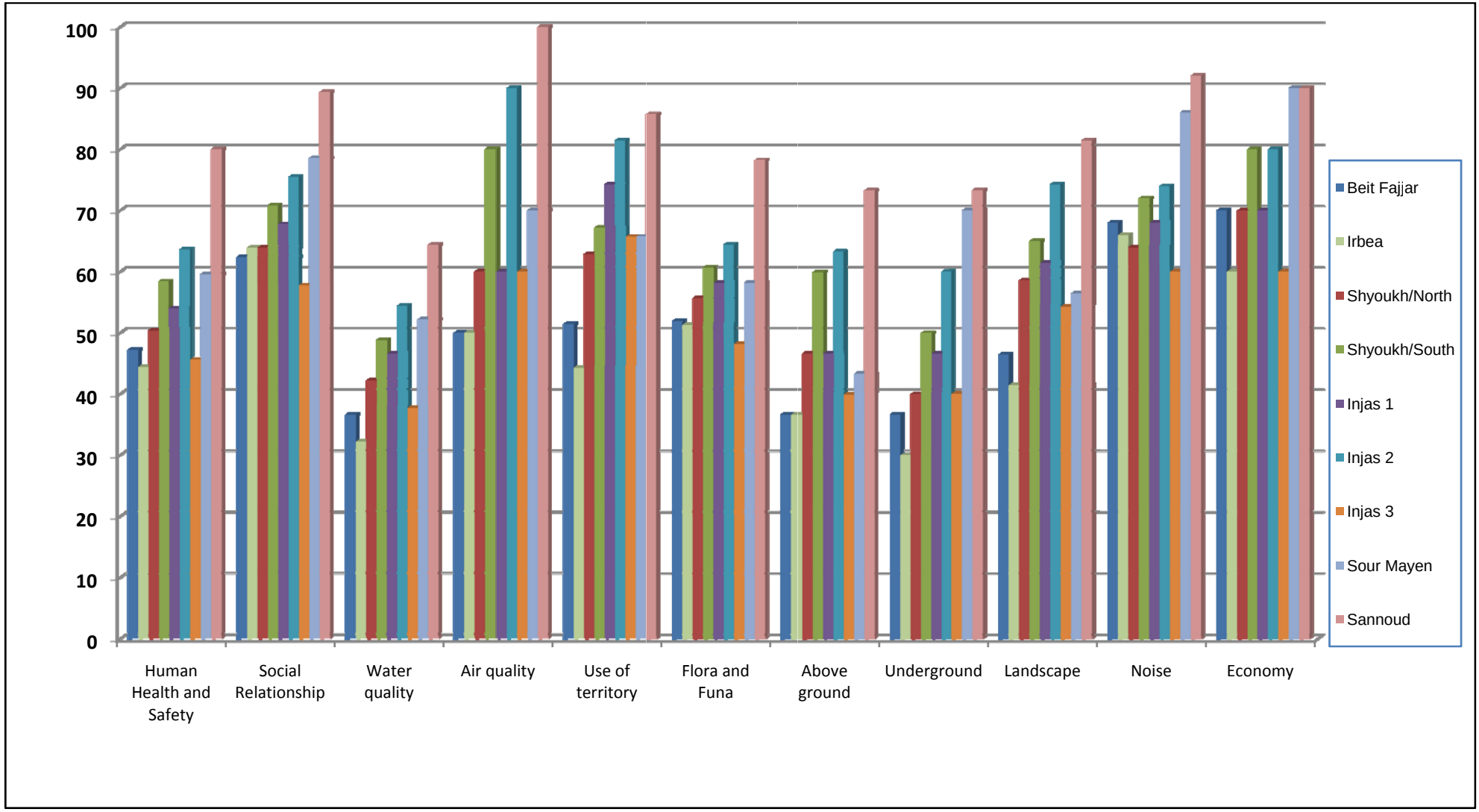


Figure 5.13: Comparison between the overall effects on each environmental component related to each Cluster of Quarries.

Table 5.13: Comparison between the overall effects on each environmental component related to each Cluster.

Cluster	Environmental Components											
	Human Health and Safety	Social Relationship	Water quality	Air quality	Use of territory	Flora and Funa	Above ground	Under ground	Landscape	Noise	Economy	
Beit Fajjar	47,20	62,37	36,63	50,00	51,44	51,93	36,63	36,67	46,41	68,00	70,00	**557,28**
Irbea	44,40	63,91	32,19	50,00	44,30	51,30	36,63	30,00	41,40	66,00	60,00	**520,13**
Shyoukh/North	50,40	63,91	42,18	60,00	62,87	55,68	46,62	40,00	58,56	64,00	70,00	**614,22**
Shyoukh/South	58,40	70,84	48,84	80,00	67,15	60,69	59,94	49,99	64,99	72,00	80,00	**712,84**
Injas 1	54,00	67,76	46,62	60,00	74,28	58,20	46,62	46,67	61,42	68,00	70,00	**653,57**
Injas 2	63,60	75,46	54,39	90,00	81,43	64,45	63,27	59,99	74,28	74,00	80,00	**780,87**
Injas 3	45,60	57,75	37,74	60,00	65,71	48,19	39,96	40,00	54,28	60,00	60,00	**569,23**
Sour Mayen	59,60	78,54	52,17	70,00	65,72	58,20	43,29	70,00	56,41	86,00	90,00	**729,93**
Sannoud	80,00	89,32	64,38	100,00	85,72	78,21	73,26	73,32	81,42	92,00	90,00	**907,63**
Total	**503,20**	**629,86**	**415,14**	**620,00**	**598,62**	**526,85**	**446,22**	**446,64**	**539,17**	**650,00**	**670,00**	

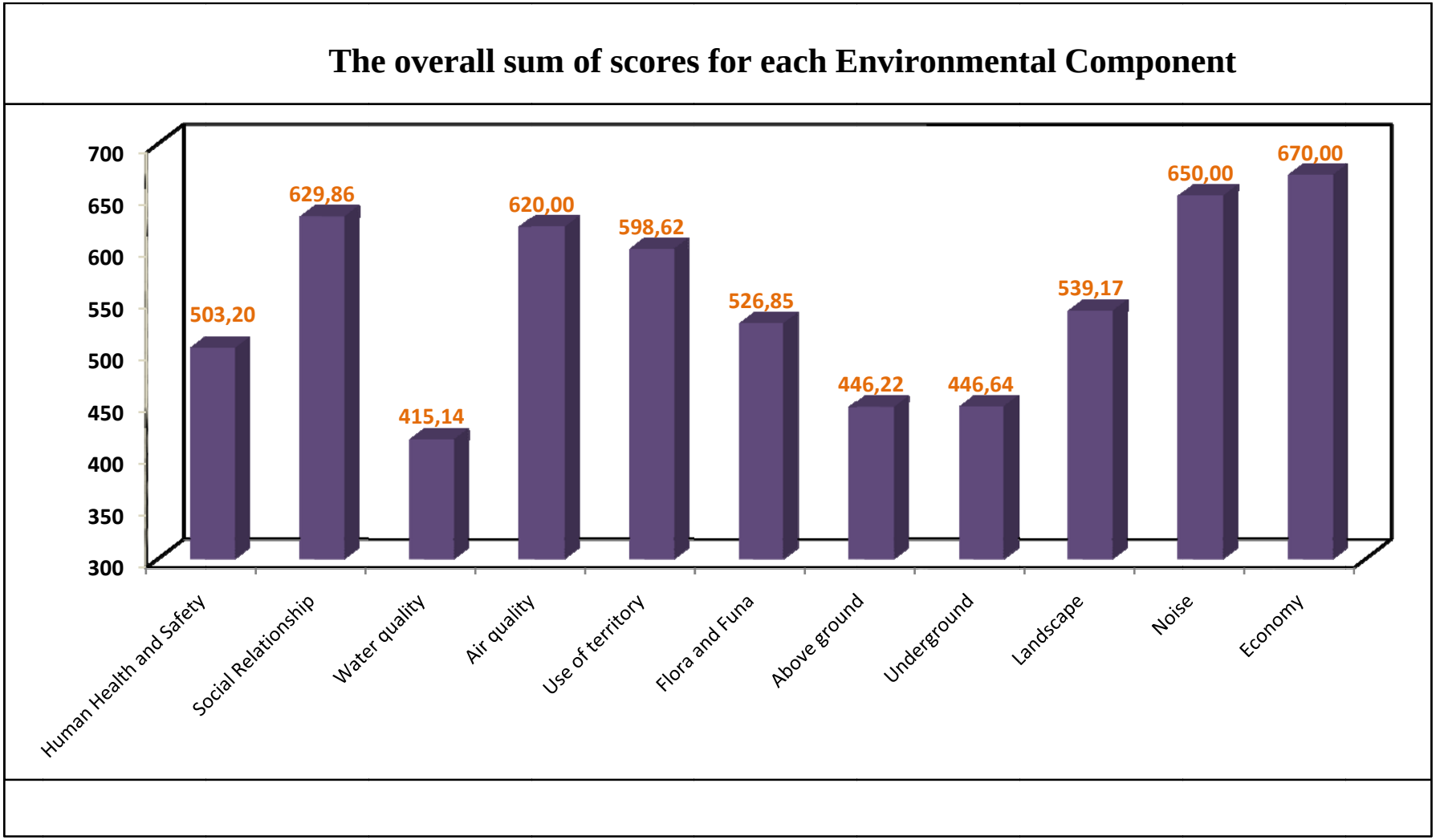


Figure 5.14: The overall sum of scores for each each environmental component .

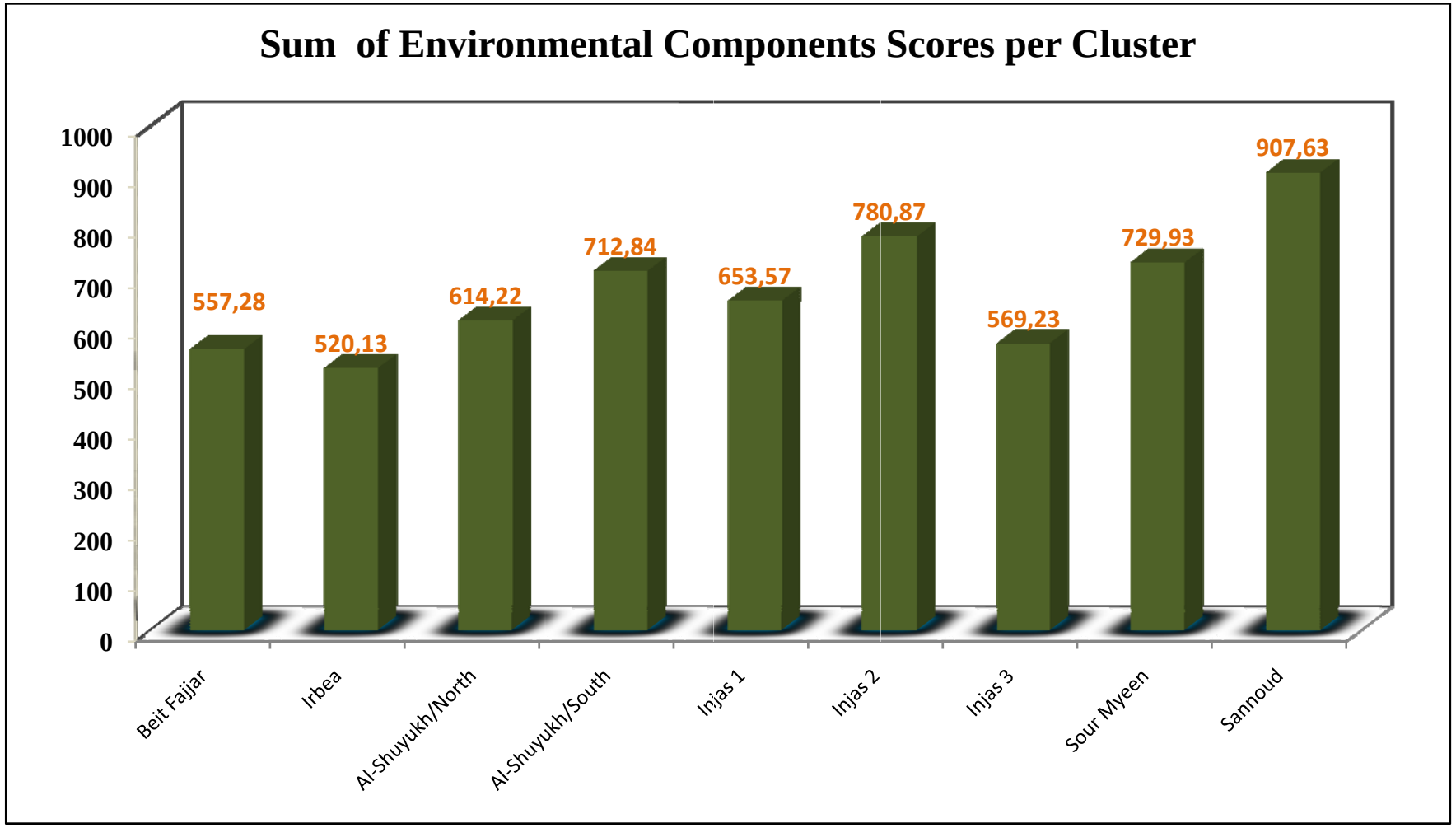


Figure 5.15: Sum of Environmental Components scores for each cluster of quarries.

6. Rehabilitation

Limestone is an important raw material that is widely used for cement production, metallurgy, agriculture, glass, and steel production (Pamukcu and Simsir, 2006).
Rapid economic development and the growth of urban areas in many countries have fueled an ever increasing need for limestone. Accordingly, many “mined-out” or low-productionquarries have been created and deserted, presenting a challenge for environmental managers and engineers to adequately restore these degraded habitats (Yuan et al., 2006).
Quarries that are left untreated after closure cause extensive land disturbances and have negative safety and environmental impacts. The original ecosystems have been removed, the original topography has been significantly changed, the fundamental ecological relations are irreversibly disrupted, and the biodiversity is greatly reduced. Abandoned quarries represent a problem for the environmental and the landscape too, including the the natural park and in protected areas.

The ecological effects of limestone extraction are reaching and extreme, resulting in the complete removal of the overlying ecosystem (Dershpiere UK, 2005).
There is often substantial pressure from governments and citizen groups to restore old quarries, as they can not only impose a significant negative visual impact, but may also pose serious soil erosion and degradation (Clemente et al., 2004). However, the restoration of limestone quarries has generally been considered difficult because of the residual coarse substrate, bad soil structure, and nutrient deficiencies (Wheater and Cullen, 1997; Clemente et al., 2004; Price et al., 2005).

When a quarried-out area are simply abandoned without any restoration such as changing the habitat of the area concerned, loss of fauna and flora and degradation of aesthetics and visual value. Thus, it is emphasized that rehabilitation programme is very essential for the quarry Project.
The rehabilitation of abandoned quarries may be defined as human involvement for removing the damage caused by quarries, in order to enable new land uses (Enis, 1974). Rehabilitation may also prevent the subtraction of large areas from the national land inventory; may alleviate the effects of environmental degradation and satisfy the social demand for improved quality of life. Rehabilitation of abandoned quarry sites could alleviate the effects of environmental dereliction and could meet the social demand for improvement of the quality of life in urban centers. Nevertheless, reclamation benefits are often overlooked in assessment procedures, since they are hard to estimate, at least in monetary terms. Reclamation projects of abandoned quarry sites located in urban districts offer certain advantages in terms of provision of green spaces and recreation areas. (Damigos and Kaliampakos, 2003). In recent years, there is an increasing demand for green areas and amenity spaces in urban centers due to recreation needs and growing environmental awareness. Green spaces provide aesthetic, ecological and economic benefits. They also include functions that have a physical and psychological effect on human health, such as air pollution control, noise reduction, improvement of microclimatological conditions and provision of recreational opportunities (Urbanco,1999; Tyrväinen and Miettinen, 2000). Today there are about 300 quarries in the study area, most of them are abandoned , that occupy an area of more than 700 ha within the boundaries of the study area. Rehabilitation of these sites could be proved of great significance, since the installation of recreation facilities could eventually enhance the standards of living conditions of neighboring inhabitants. However, most of the rehabilitation attempts, so far, are characterized by inadequate aesthetic design of the landscape and insufficient utilization of the quarrying sites.

The public objective of the rehabilitation program should be to ensure that depleted pits and quarries are rehabilitated to a condition which is "safe, environmentally stable, and compatible with

adjoining lands." While each site is somewhat unique, achievement of this general standard involves sloping embankments and spreading the available overburden and topsoil stripping stockpiles back over the surface.

Nevertheless, there is an intense conflict between marble companies and the public. The main reason for the conflict is that there are about 300 abandoned limestone quarries, which are related to many environmental problems.
In the majority of cases the limestone quarries are abandoned after closure, usually without any attempt to rehabilitate the site.

Due to institutional weakness and the absence of national policy, most Palestinian quarries have not been developed using environmental concepts and in preparation for post operation reclamation or restoration. Limited national resources available for reclamation must be targeted toward those quarries where the likelihood of successful reclamation, and thus the likelihood for mitigation of negative environmental impacts, is the greatest.

According to FAO, Rehabilitation should occur progressively as quarry areas are no longer used, while the Removed overburden should be replaced followed by topsoil and organic matter and The site should be replanted/resown with trees, shrubs or a cereal crop.

Environmentally, restoration and rehabilitation are perhaps the most important activities of a quarrying project. The main activities involved at this stage are as follows:

- Back-filling of the quarried out pits if any in the future.
- Compaction, leveling, grading and top soiling.
- Revegetation with suitable grasses or leguminous cover crops and fast-growing trees.

The rehabilitation programme of any quarrying operation is designed to restore the disturbed site. However, some adverse impacts may arise during the process of rehabilitation, or if the quarried-out area are simply abandoned without any restoration such as changing the habitat of the area concerned, loss of fauna and flora and degradation of aesthetics and visual value. Thus, it is emphasized that rehabilitation programme is very essential for the quarry Project.

One of the two main purposes of this study was to outline priorities for the rehabilitation of quarries as open spaces or developed landscapes, or as land available for multiple uses, and their integration in surrounding areas. The optimal land use of abandoned quarries can be determined according to the characteristics of their nearby environment. In the present study, an environmental database was created by using Geographic Information Systems (GIS), and by cross-checking data of abandoned quarries and their location according to different designated planning areas.

This research focuses on the environmental aspects of rehabilitating abandoned quarries and their future designation land use, emphasizing the theme of abandoned quarries in the study area. The research findings show that more abandoned quarries are located in areas designated for conservation than in areas intended for development projects. Therefore, abandoned quarries that are located in conservation areas should be rehabilitated as open spaces. Those in urban and rural areas should be rehabilitated as development projects, or as open spaces and agricultural land uses, or as combined land uses.

This study was developed to address the rehabilitation of all sites, including those which will be depleted in the future as well as those quarried out decades ago.

6.1. Environmental impacts caused by abandoned quarries

As previously mentioned ,quarries and areas of surface mining that remain untreated after closure, produce extensive damages to land and create negative safety and environmental impacts ([Ziev, 1985], [Vartzburger, 2004], [Willis and Garrod, 1999], [Lin et al., 2005] and [Sullivan et al., 2006]). Excavation activities entail the removal of top soil for exposing bare rock surfaces, thereby causing aesthetic as well as biological disorders (Goudie, 2000). Varieties of ecosystems develop as a result of reciprocal relations between organisms and their reactions to geological, topographical, hydrological, and climate conditions. Disruption of these conditions due to quarrying activities may cause severe damage to such habitats (Nieman and Merkin, 1995). Creating new habitats in post-mining areas is problematic because mining activities isolate populations, disrupt gene flow, exacerbate the loss of biodiversity, and increase inbreeding in remaining species. Not only the areas directly involved in open-pit mining, but also surrounding areas, may be affected and will require remedies (Sklenicka and Charvatova, 2003).

Removal of the natural flora and fauna and failure to rehabilitate the area can lead to soil erosion, damage downstream ecosystems, and pollute ground water and soil. Furthermore, the exposure of mineral rocks, without considering the surrounding environment, will inevitably create “eye sores” and aesthetic depreciation of the landscape (Kaliampakos and Mavrikos, 2006). Photo 6.1 illustrates such land disturbance. Modern excavation techniques are capable of changing the configuration of land forms by creating terraces with vertical faces of high rock. Terraces of redeemed quarries are steep, which replace the natural slope, with dangerous unstable angles, thus presenting a constant hazard of landslides and rock-fall (Zuquette et al., 2002). Ideally, quarry rehabilitation emphasizes the creation of naturalized landscapes that are designed for biodiversity and are compatible with surrounding lands(Milgrom T.,2008).
Effective quarry rehabilitation projects can create critical green space for rapidly expanding communities. The vast majority of abandoned pits and quarries in the study area are found in agricultural areas.

Abandoned quarries also trigger the creation of uncontrolled and unsupervised garbage disposal sites (Kaliampakos, 1998). While open spaces and accessible land usually have a high economic, environmental and social value, abandoned and non-rehabilitated quarries abound with environmental hazards, lose value and become inferior land-use assets. By removing the natural surface deposits, quarries disturb the ecological balance of the excavated site and of nearby land, limit consecutive land uses, reduce the economic value of adjoining land, and result in the subtraction of important tracts of land from the land inventory (Shwartz, 1988). Quarries left untreated after closure and not restored to a condition capable of supporting other land uses, remain as useless and non-sustainable resources (Jay and Handley, 2001).

The quarry rehabilitation projects should provide employment opportunities the local community.

Photo 14: An abandoned quarry in the middle of Bani Naim town.

6.2. Rehabilitation of abandoned quarries: open spaces or development projects?

Uneven population distribution, increasing population density, urbanization, industrialization and rising standards of living, bring about increasingly stringent demands on development projects, while at the same time producing growing demands for open space. These multiple needs produce intensive pressure on the land, which can be relieved to a degree by the reclamation of derelict lands. The rehabilitation of abandoned quarries discarded from the land inventory may reinstate new areas according to demands and needs (Shwartz, 1988). Occasionally, land reclamation projects are site-specific and aimed at improving the area on and around the site itself. In other cases, reclamation is expected to bring about broader improvements to the environment or to fulfill comprehensive end-uses demands (Handley, 1996). Restoration, in the wake of mining and quarrying, requires construction and topography design for the renewal of a functional ecosystem capable of maintaining itself. Guaranteeing long-term topographic reconstruction stability is a priority objective from both ecological and mining engineering points of view. Giving form to relief design is without doubt the most expensive part of any mining reclamation project (Nicolau, 2003). Reclaimed lands can be reserved for future favored uses as development residential and infrastructure projects, as open spaces, or as land available for diverse uses . Identifying lands which are most suitable for social and economy welfare, within a regional context and in terms of physical suitability, are important tasks during the comprehensive planning process.

The rehabilitation of abandoned quarries for development projects can be designated as industrial , commercial, residential, infrastructural zones or for purposes such as high-rise cemeteries or the like. Advanced engineering techniques for coping with the landslide hazards are available for adapting abandoned sites for particular developmental uses.
The main considerations in rehabilitation of abandoned quarries as open spaces refer to quarries located in landscapes which carry special values or areas with historical, geological, or botanical importance. Reclamation is based on the site's natural conditions and, perhaps more importantly, on the variations of those factors within the site (Jay and Handley, 2001). Ensuring establishment of a

properly functioning ecosystem requires strategies that include the selection of appropriate native plant species, compatible with prevailing soil and local climate conditions (Muzzi et al., 1997). Rehabilitation can also take place naturally without human interference, or by using intensive intervention methods for wilderness reclamation. Rehabilitated quarries can also be targeted as open spaces, such as outdoor recreational opportunities , hiking, bird watching, public or national parks, nature reserves, forests, lakes, etc. Another interim post-mining land-use designation can be for garbage disposal sites (Black and Conway, 1996), disposal of construction debris and municipal solid waste (Kaliampakos, 1998), all of which may be converted to open spaces after site utilization.

6.3. Methods

The aim of this part of the search was to locate and map abandoned quarries according to their different designated planning areas within the study area, in order to determine their future land use as developmental areas or as open spaces. The assumption was that the optimal land use of such abandoned quarries could be determined by their proper characteristic and by their position within the surrounding environment. A secondary aim, derivative from this research, was to raise public and decision makers' attention to this issue, in order to determine rehabilitation priorities and to promote rehabilitation plans. The delays in rehabilitating abandoned quarries in Palestine is the result of excessively prolonged planning processes, absence of rehabilitation initiatives, and lack of awareness of the importance of rehabilitation or partial rehabilitation of quarries. In this sense the findings of the present study are significant, both academically and in practice.

This research attempted to encompasses all the abandoned quarry or the working quarries after their abandoned sites within the Study area. A total of 292 such sites were examined.

As presented in this study, the use of GIS for linking diverse land uses is essential for world-wide sustainable planning. This methodology enables cross-checking between different land-use plans and comparing of data, and may also be practicable for other reclamation forms of derelict lands, such as garbage disposal sites.

The optimal land use of abandoned quarries – as open spaces or as development projects – was determined by means of Geographic Information Systems (GIS). The derived data was processed and analyzed, in order to examine alternative sustainable planning solutions. GIS data layers of abandoned quarries were compiled and cross-checked for creating an updated environmental data.

One of the two main purposes of this study was to outline priorities for the rehabilitation of quarries as open spaces or developed landscapes, or as land available for multiple uses, and their integration in surrounding areas. The optimal land use of abandoned quarries can be determined according to the characteristics of their nearby environment. In the present study, an environmental database was created by using Geographic Information Systems (GIS), and by cross-checking data of abandoned quarries and their location according to different designated planning areas and the locality development priorities and needs set by the local authorities of the surrounding areas.

The location of quarries was identified according to their designation, separating the study area into areas designated either for conservation or for development. The computerized data layers were divided into these two categories:

- *Quarries designated for conservation.*
- *Quarries designated for development projects.*

6.4. Results and discussion

Figure 6.1 shows the distribution of quarries located in areas designated for conserving open spaces(green and dark green spots). These abandoned quarries are located in areas characterized as 'Integrated Reserved' or 'National Reserved' . The existence of abandoned quarries in these areas restrains their availability and threatens their future as open spaces .

This Figure also shows the distribution of abandoned quarries in areas designated for development projects (blue and pink spots). These abandoned quarries are located in urban and rural textures, thus affecting the population's quality of life, due to eventual landslide, or other environmental hazards. Their existence also reduces the economic value of nearby residential real estate. These abandoned sites must be abstracted from the land inventory of the region in which they are located, thus exacerbating the increased demand for housing and infrastructure projects .

The research findings showed that 243 abandoned quarries are included in the open spaces areas (83%), mainly in the northern and eastern parts of the study area. The areas of open spaces are larger than those of development projects, thus more quarries were found in this texture. According to the suggestions, plans for abandoned quarries are to be accompanied by Environmental Impact Statements and their rehabilitation objectives be designated as open spaces.

The findings showed that 49 quarries are located in development areas (17%), mainly in the southern part of the study area. The existence of abandoned quarries in development areas shows that regional and local authorities do not sufficiently initiate plans for rehabilitating quarried lands. The prescribed land use of rehabilitated abandoned quarries located in urban areas should be for developmental projects. These sites could be used for expanding industrial zones, residential or commercial areas, new infrastructure and other necessary projects. Due to the recent increasing demand of open spaces. Some quarries located in areas designated for development projects could be rehabilitated as open spaces or for integrated land uses.

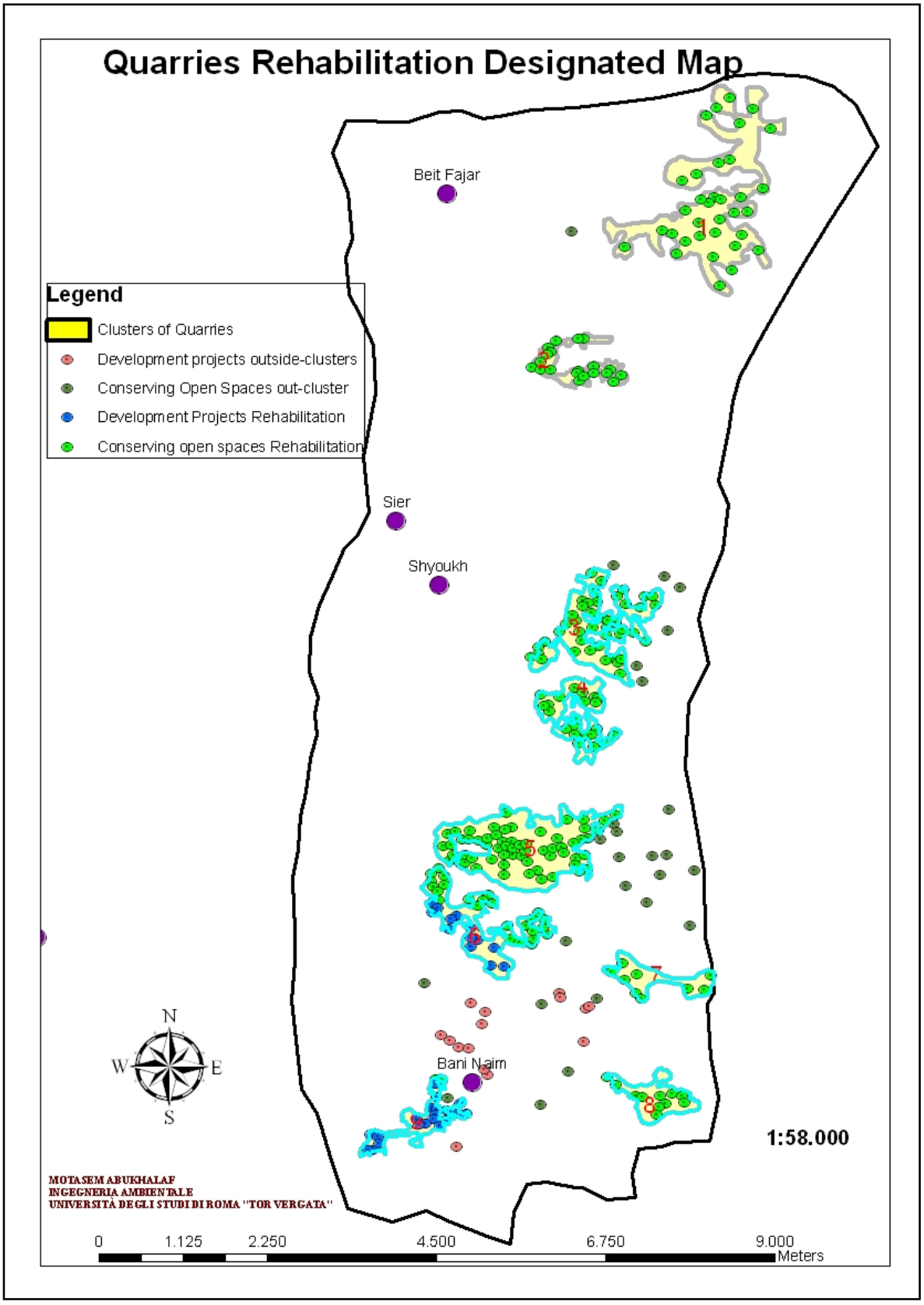


Figure 6.1: Distribution of abandoned quarries located in areas designated for conserving open spaces and development projects.

Table 6.1: Total abandoned quarries located in areas designated for conserving open spaces and development projects.

Town	Total Quarries			Rehabilitation designated for Open spaces	Rehabilitation designated for Development Projects
Bani Naim	55	Clusters	34	13	21
		Outside-Clusters	21	6	15
Sair	130	Clusters	117	104	13
		Outside-Clusters	13	13	0
Al-Shuyikh	73	Clusters	67	67	0
		Outside-Clusters	6	6	0
Beit-Fajjar	34	Clusters	34	34	0
		Outside-Clusters	0	0	0
Total			**292**	**243**	**49**
				83%	17%

6.5. Summary and conclusions:

One of the indicators chosen for assessing progress towards sustainable development is the percentage of rehabilitated abandoned quarries for beneficial after-use (Jay and Handley, 2001).

As presented in this study, the use of GIS for linking diverse land uses is essential for sustainable planning. This methodology enables cross-checking between different land-use plans and comparing of data, and may also be practicable for other reclamation forms of derelict lands, such as garbage disposal sites.

Abandoned quarries located in areas designated for the conservation of open spaces, should be rehabilitated as such. Abandoned quarries located in areas designated for development projects ('Urban' and 'Rural' textures), can be rehabilitated for developmental projects. In recent years there is an increasing demand for open spaces also in urban areas, due to the growing need for recreation environmental awareness. Therefore, abandoned quarries located in areas designated for development projects could be rehabilitated as open spaces or for integrated land uses. The study shows that the characterization of the location of abandoned quarries can help decision makers to turn surface-mined lands into productive and useful lands for the region. Local and regional authorities should promote rehabilitation plans of abandoned quarries within their jurisdiction. The location of abandoned quarries according to the findings and other experiences will help decision-makers to grant rehabilitation priority to quarries that have conservational or developmental characteristics, especially to those in proximity to residential areas, in order to reduce exposure of the population to environmental hazards.

Land is a limited resource everywhere, and particularly in a small country like Palestine. The rehabilitation of abandoned quarries, as well as the reclamation of derelict lands, may contribute to repairing damages imposed on the landscape in the past, enhance the environmental quality of existing areas, and reinstate additional lands either for development projects or for the conservation of nature and open spaces, and improve socio-economic welfare and quality of life for the benefit of present and future generations.

Given the large number of quarries and limited availability of resources for rehabilitation, a national priority for Palestine is to direct those resources to those sites with the greatest likelihood of successful rehabilitation.

Prioritization of quarries for reclamation should also consider the present environmental impact of the quarry and the potential for mitigation of that impact by reclamation. Assessing the environmental and health risk impact from current and future quarrying activities within a national policy for quarry exploitation and reclamation is essential to meet the needs of the growing population, while maintaining the sustainable use of natural resources for future generations. Legislation must consider not only licensing quarry exploitation but also their rehabilitation during the process of work. Monitoring of the potential effect on vegetation cover and water resources is a continuous task serving the ecosystem and public health.

7. Recommendations

Based on the evaluation of the situation of the whole studied area and that of quarries; either inside or outside clusters, it is possible to state general long term recommendations regarding the environment and land use and practical short term recommendations regarding the rehabilitation for abandoned quarries. General long term recommendations are addressed to planners and decision makers at governmental and regional concerned bodies as Ministry of Environment, Industry, Local Governorate, Agriculture and housing in addition to municipalities. Practical short term recommendations are addressed for NGOs or international organizations sponsors to start implementing rehabilitation for some of the recommended sites in cooperation with the local authorities.

7.1. General Long Term Recommendations:

Considering the environmental, land use and demographic situation for the whole area, the following recommendations would be stated:

1. The establishing of quarries should be prohibited to the west of the marked line on the attached map (GIS-Red line) in any case. This area should be devoted either to urbanization purposes or as an agricultural land if applicable.
2. Sannoud quarries cluster should be closed immediately because it is located inside an urbanized area. Also, Injas 2 (cluster #6) -which is so closed to the houses and agricultural fields of North Bani Naim should be closed directly. There should be a governmental legislation prohibiting establishing quarries within the borders of cities, towns and villages.
3. It is preferable to confine Irbea cluster to its current borders, because its expansion to the west would affect agricultural land.
4. It is of vital importance to establish a nature reserve or park to the east of the marked line. The most biologically sound way to preserve genetic resources is to keep them in the environment in which they develop. The most appropriate sites would be the northeastern part of the studied area (east of Seir) and to the east of Bani Naim. This would be considered as in situ conservation that may lead to recovery or maintenance of viable population of species at the original location.
5. A bio-diversity strategy should be defined to promote restoration of the ecological value of quarries, Establishment of bio-diversity indicators in order to define best practices for the ecological rehabilitation of a quarry.
6. An environmental law was issued by Palestinian National Authority, but there is a lack of preventive legislation codes for air pollution. This is a serious practical problem facing any environmental restriction that necessitates establishing monitoring stations to obtain precise indications on air pollution in prospected polluted areas.

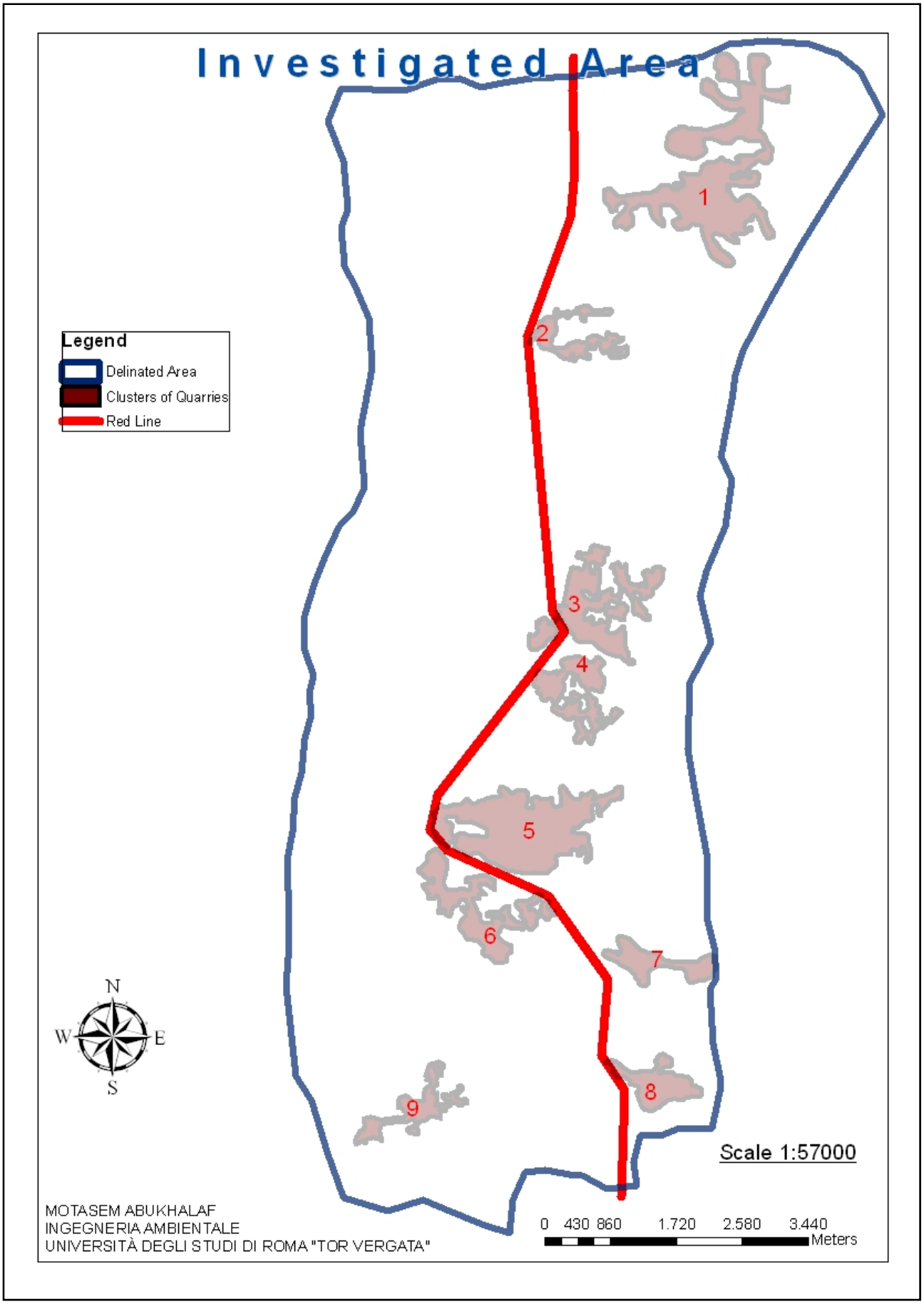


Figure 7.1: Map showing the marked line to the east of which no quarries should be established.

7. Utilization of waste slag's discarded after cutting building stones is extremely important to avoid pollution hazards and to improve the feasibility on new projects.
8. Providing the infrastructure utilities like electricity, water networks and paving the main roads leading to the quarries would reduce significantly the negative environmental impacts. Also, this would lead to the transformation of cutting stone plants from the urbanized areas at Hebron, Beit Fajjar and other towns closer to the quarry clusters. This transfer will have a positive economic impact by the reduction of building stones production cost.
9. Enahnce the awareness among those owning the quarries industries and workers by providing special training programs.
10. Assessment and prevention of community health impacts.
11. Prevention and minimization of impacts on cultural heritage.
12. Minimizing air pollution due to dust generation and dispersion during quarrying operation and transportation of materials, road shall be sprayed with water during dry/ windy weather and proper maintenance of the machinery and vehicles.
13. Public awareness campaigns must be immediately designed and implemented in areas where use of untreated wastewater for irrigation of freshly eatable crops is ongoing; these campaigns should be oriented to raising the farmer's awareness to the danger of using untreated wastewater for irrigating similar crops. Reports on this kind of irrigation to the Ministry of Health, Ministry of Agriculture and of course to the Palestinian Water Authority must be immediately made.
14. Urgent studies and evaluation of the environmental impact assessment should be carried out soon to evaluate the impact of the new discharge of untreated wastewater from Hebron.
15. Quarry expansions or new quarries should not be permitted in areas identified as Areas of Natural and Scientific Interest
16. Quarry expansion and rehabilitation must involve careful planning to ensure the protection of the natural environment in the watershed.
17. "Abandoned Quarry Reclamation," should be a clear and direct significant portion of the environmental law endorsed by PNA. It should incorporate the philosophy of the polluter paying for remediation of past abuses even though society as a whole behaved in a pattern that condoned the earlier practices. Priority there is for the restoration of land resources and the environment.
18. Better coordination and cooperation between the Palestinian and Israeli authorities is inevitable in improving in improving licensing and zoning mechanism of share quarries in the region.
19. Establishing of Quarries Rehabilitation Fund in Palestine (as in Israel).
20. Prioritization of quarries for reclamation should also consider the present environmental impact of the quarry and the potential for mitigation of that impact by reclamation.
21. Assessing the environmental and health risk impact from current and future quarrying activities within a national policy for quarry exploitation and reclamation is essential to meet the needs of the growing population, while maintaining the sustainable use of natural resources for future generations. Legislation must consider not only licensing quarry exploitation but also their rehabilitation during the process of work. Monitoring of the potential effect on vegetation cover and water resources is a continuous task serving the ecosystem and public health.

22. Innovative approaches between industry and government at all levels are necessary to produce high quality rehabilitation of quarries. It can take years to research and evaluate approaches to cliff or quarry face rehabilitation.
23. If they have a quarry face to rehabilitate, it is essential to plan carefully and try different techniques to get the rehabilitation objectives and design correct or appropriate to the area. Safety and stability are a challenge that must be dealt with when rehabilitating a quarry face. The measures taken in regard to safety and stability are very dependent on the final land uses near the quarry face and these final land uses are likely to include recreation in scenic areas.
24. Critical evaluation and monitoring are needed for both aesthetics and ecological values to assess the success of the rehabilitation.
25. Some of the mitigation measures undertaken to minimize soil erosion .

7.2. General Short Term Recommendations:

To have deep understanding of the practical short term recommendations which means the rehabilitation of the abandoned quarries and those which will be depleted in the future, justification and the basis for each recommendation will be displayed.

7.2.1. Quarries Land Reclamation for Agricultural Purposes.

This choice for the rehabilitation of some of the abandoned quarries should aim, in addition to producing a continuous supply of food for the residents in the area, at restoring the original landscape. This can be done by restoration with tree species that can withstand the existing conditions. It is possible to diversify the planted species considering the valuable uses for honey production, edible fruits, eco landscaping, habitat for animal life, medicinal and traditional values, and conservation purposes.
In light of the huge implied expenses and destruction of agricultural lands, if it was opted to bring in sufficient topsoil to cover and replant the quarries, it is possible to work on a prolonged rehabilitation plan without altering the prevailing edaphic conditions. Reforestation with tree species that can withstand the existing harsh growing conditions would transform the landscape.

7.2.2. Other Rehabilitation Actions.

The result of the research showed that Bani Naim Quarries have the most harmful effect on the environment, specially the quarries that are located outside the cluster and mainly inside the city and between the houses.

So, the first rehabilitation stage should be carried out for the quarries outside cluster in Bani Naim town then the clusters of quarries (Sannoud and Sour Mayen) and Injas2 cluster as a second stage.

Bani Naim Town:-

Quarries Cluster Designated Rehabilitation Plan:-

The following restoration plans are applicable to marked quarries area outside clusters as shown in the attached maps. Figures 6.2.a and 6.2.b show the recommended quarries for rehabilitation with respect to aerial photograph and their location related to main city roads.

There are 19 quarries in the delineated area, 13 of them are designated to be rehabilitated as open Spaces ,and 6 as development projects as shown in Table 6.2. The optimal land use of each quarry can be determined according to the characteristics of their nearby environment(Using the GIS database) and the locality development priorities and needs set by the local authorities of the surrounding areas(Table 6.3).

Figure 7.2.a: Rehabilitation plan for quarries outside cluster at Bani Naim area.

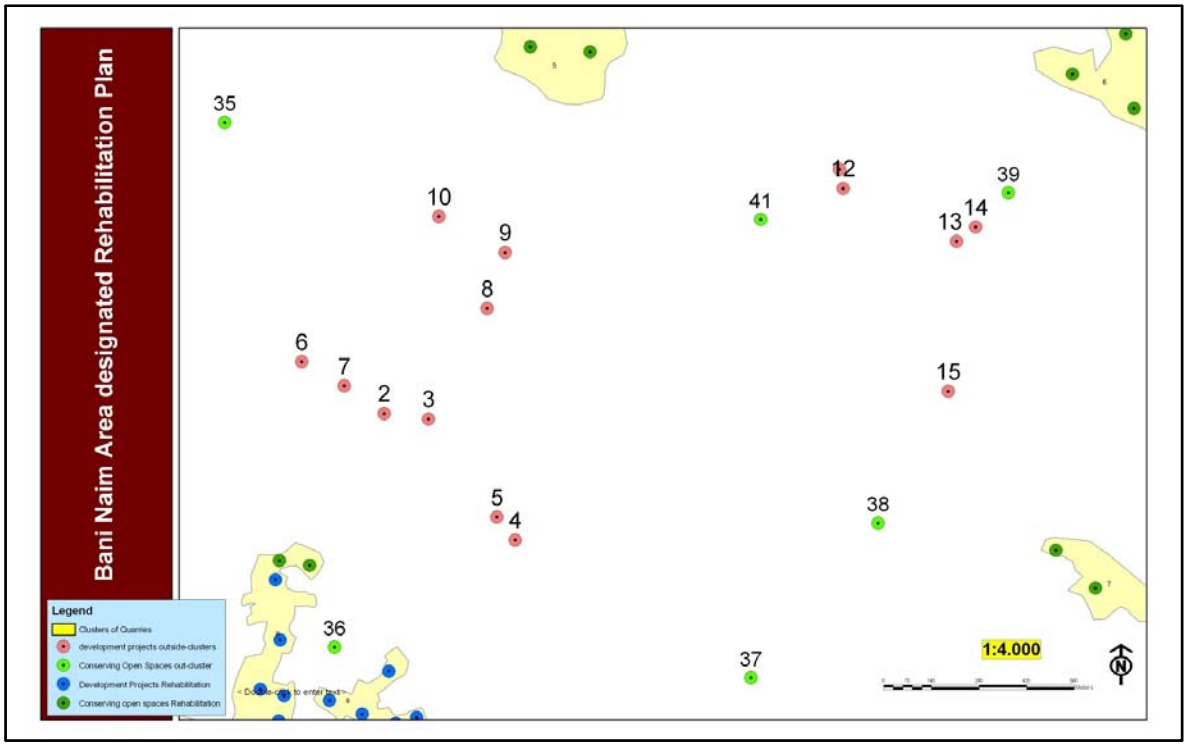


Figure 7.2.b: Detailed Rehabilitation plan for quarries outside cluster at Bani Naim area.

Table 7.1:Bani Naim designated rehabilitation plan.

Bani Naim Area designated rehabilitation Plan			
Development Projects		Open Spaces	
3,8	Elementary School	35	Agricultural revegetation
15	Water Reservoir	37,41	Public Park
6	Oil Station	38	Reforestration
4,5,11	Housing Units	36,39	Garden
2	Hospital-Health Center		
13,14	Sport Center		
9,10	Commercial center		
7	Cultural center		

Table 7.2:-Locality Development Priorities and Needs in Bani Naim Town(ARIJ 2009).

Table 14: Locality Development Priorities and Needs in Bani Na'im Town						
No.	**Sector**	**Strongly Needed**	**Needed**	**Moderately Needed**	**Not Needed**	**Notes**
	Infrastructural Needs					
1	Opening and Pavement of Roads		*			130 km^
2	Construction of New Water Networks		*			10 km
3	Rehabilitation of Old Water Networks		*			5 km
4	Construction of Water Reservoirs		*			500 m^3
5	Extending the Water Network to cover New Built up Areas		*			5 km
6	Construction of Sewage Disposal Network		*			
	Health Needs					
1	Building of New Clinics or Health Care Centre	*				
2	Rehabilitation of Old Clinics or Health Care Centres				*	
3	Purchasing of Medical Equipments and Tools	*				
	Educational Needs					
1	Building of New Schools		*			Elementary
2	Rehabilitation of Old Schools	*				Elementary secondary
3	Purchasing of New Equipments for Schools		*			
	Agricultural Needs					
1	Rehabilitation of Agricultural lands	*				10,000 dunums
2	Building Cisterns	*				100 cisterns
3	Construction of Barracks for Livestock		*			100
4	Veterinary Services	*				
5	Seeds and Hay for Animals	*				
6	Rehabilitation of Greenhouses				*	
7	Field Crops Seeds	*				
8	Plants and Agricultural Supplies	*				

^ 10 km main roads, 15 km internal roads, and 105 km agricultural roads

The designated proposed rehabilitation plan of each quarry is based its location representing the prospected quarries for rehabilitation. The restoration of the abandoned quarries will have both environmental and economic impacts because they are very close to urbanized and agricultural area. It is worth noticing that it should be prohibited to establish new quarries in this area. After consultation with some of the owners of these quarries, it is found that land reclamation is their preferable choice. However, if the public interest is to be taken in consideration and be the driving philosophy behind the process of rehabilitation, the following are the suggested options to rehabilitate these quarries. In this case, the implementation process would include the quarries site purchase by the Municipality or other NGOs, charitable or cooperative bodies.

- Water Reservoir:

The area where these quarries are located is facing a shortage in water supply. One of the quarries could be transformed into a water storage reservoir to serve as a makeup when water supply to community is very low, especially in summer.

- Composting Facility:

The urbanized area surrounding the selected marked area for quarries is lacking efficient solid waste disposal or utilization facilities. Composting could be a good choice for the utilization of part of the solid wastes for practical purposes.

- Health Center:
The area in general is lacking the convenient health services like other towns in Hebron District. Health center ranging from emergency unit to a small hospital would be very useful choice for one of the abandoned quarries.

- Housing Units:
The recently married couples in the studied area are facing real housing problem because of the lack of cooperative housing societies or the privately owned apartments for rent. Constructing housing units as part of many floor building could be a good possibility at one or two sites of the abandoned quarries.

The same procedure was applied to the other cases

Sannoud Cluster Designated Rehabilitation Plan:-

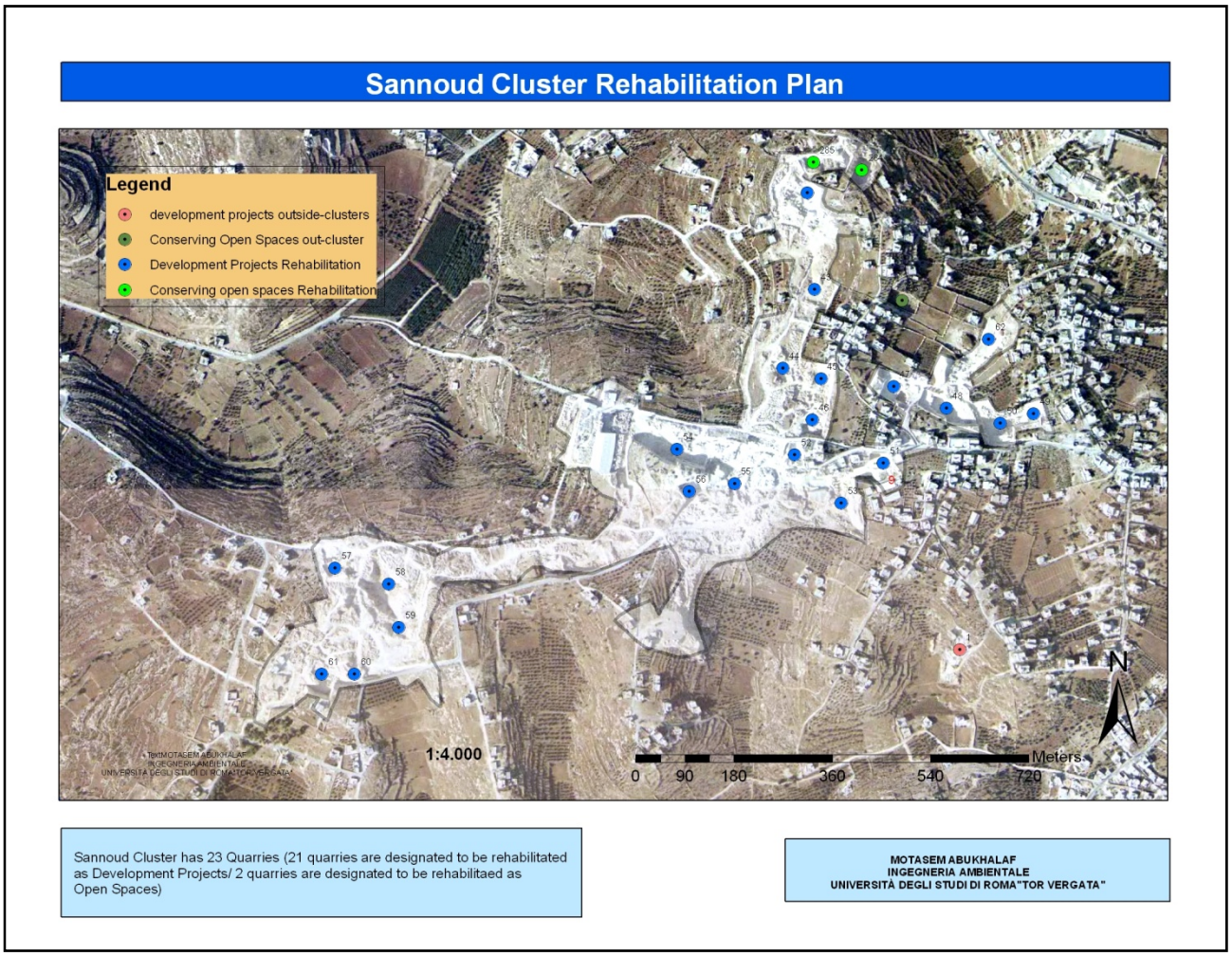


Figure 7.3.a: Rehabilitation plan for quarries in Sannoud cluster.

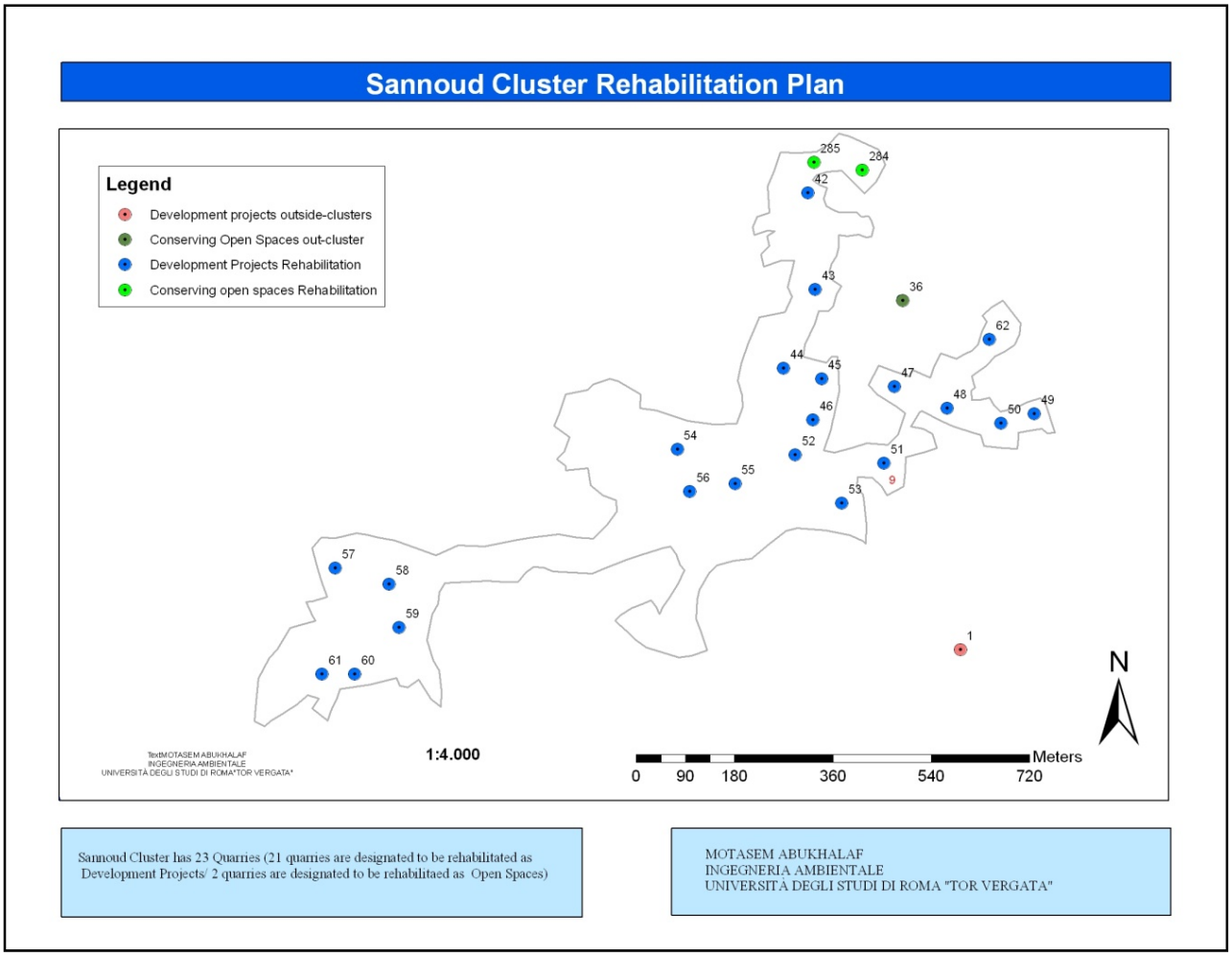


Figure 7.3.b: Detailed Rehabilitation plan for quarries in Sannoud cluster.

Table 7.3: Sannoud cluster designated rehabilitation plan.

Sannoud Cluster Rehabilitation Plan			
Development Projects		Open Spaces	
42,62	Elementary School	284,285	Public Park
57	Oil Station		
48,49,50,51	Housing Units		
44,45,46,52	Hospital-Health Center		
58,59,60,61	Sport Center		
54,55,56	Commercial center		
47,43	Cultural center		

Sour Mayen Cluster Designated Rehabilitation Plan :-

All the 11 quarries of Sour Mayen cluster are designated to be rehabilitated as open spaces and agricultural purposes.

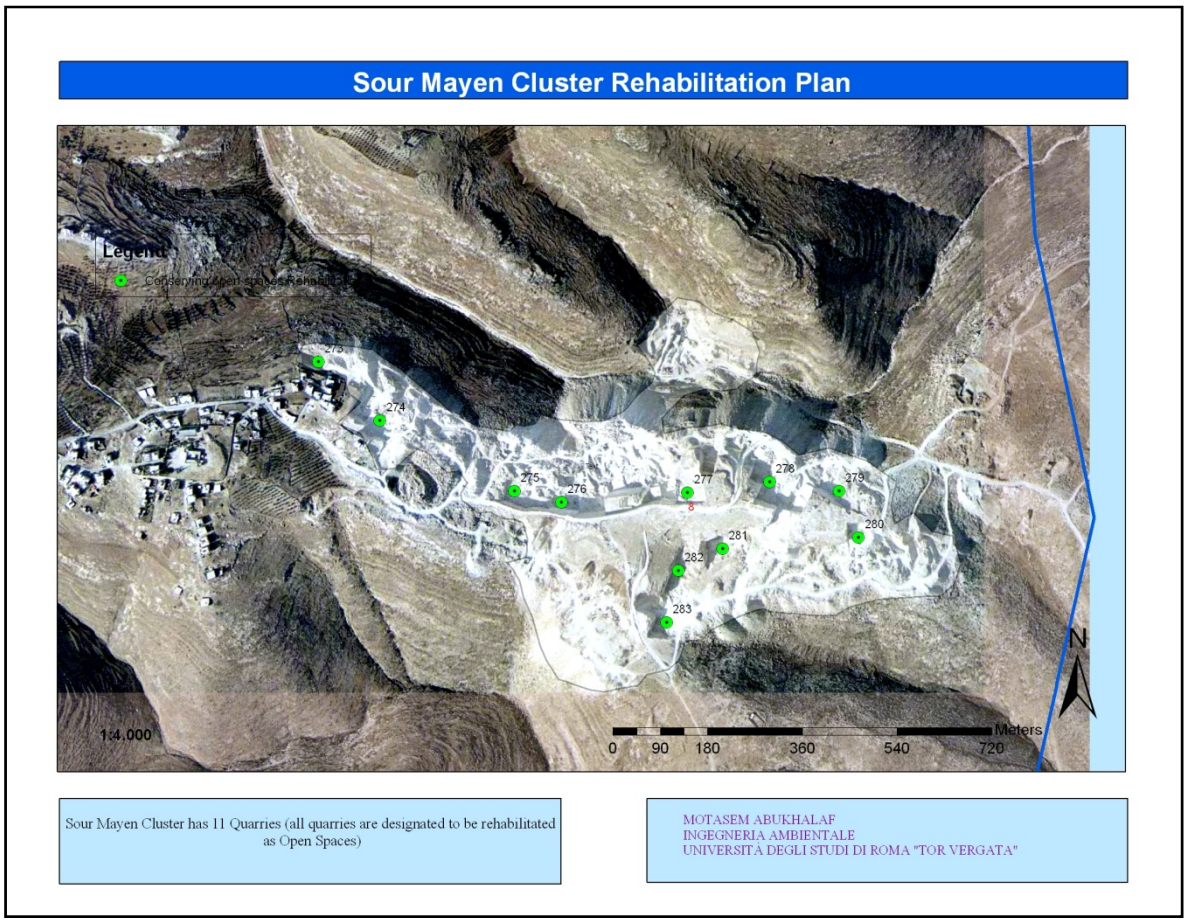


Figure 7.4.a: Rehabilitation plan for quarries in Sour Mayen cluster.

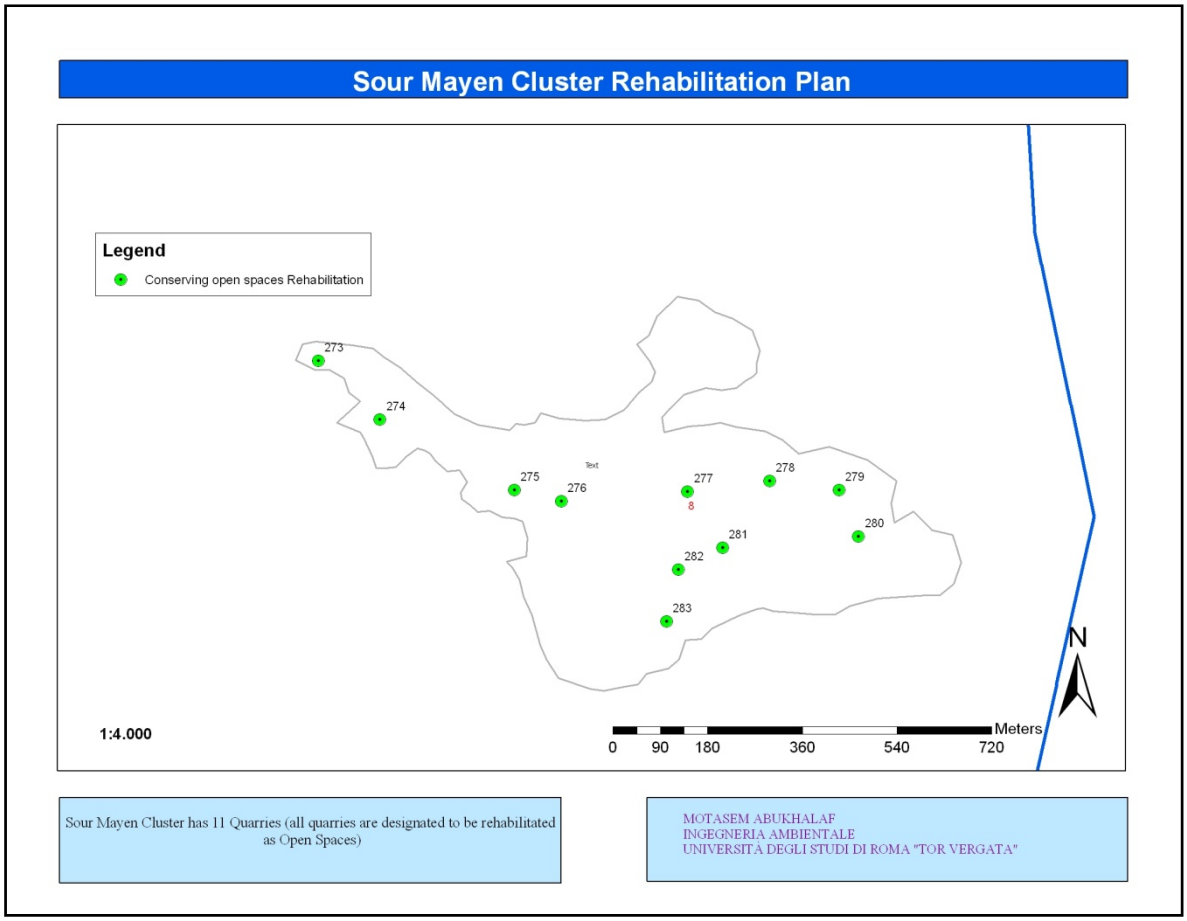


Figure 7.4.b: Detailed Rehabilitation plan for quarries in Sour Mayen.

Sier Town:-

Injas Cluster s Designated rehabilitation Plan:-

As shown in (Figure 6.5.b.),all the quarries in Injas clusters and the quarries outside the cluster are siposed to be rehabilitated as Open spaces except the quarries (63,64,65,66,67,68,69,70,71,72,73,74 and 75) which are supposed to be rehabilitated as development projects.
As shown in Table 6.4.,there is a high need for building new schools and health centers of the area.

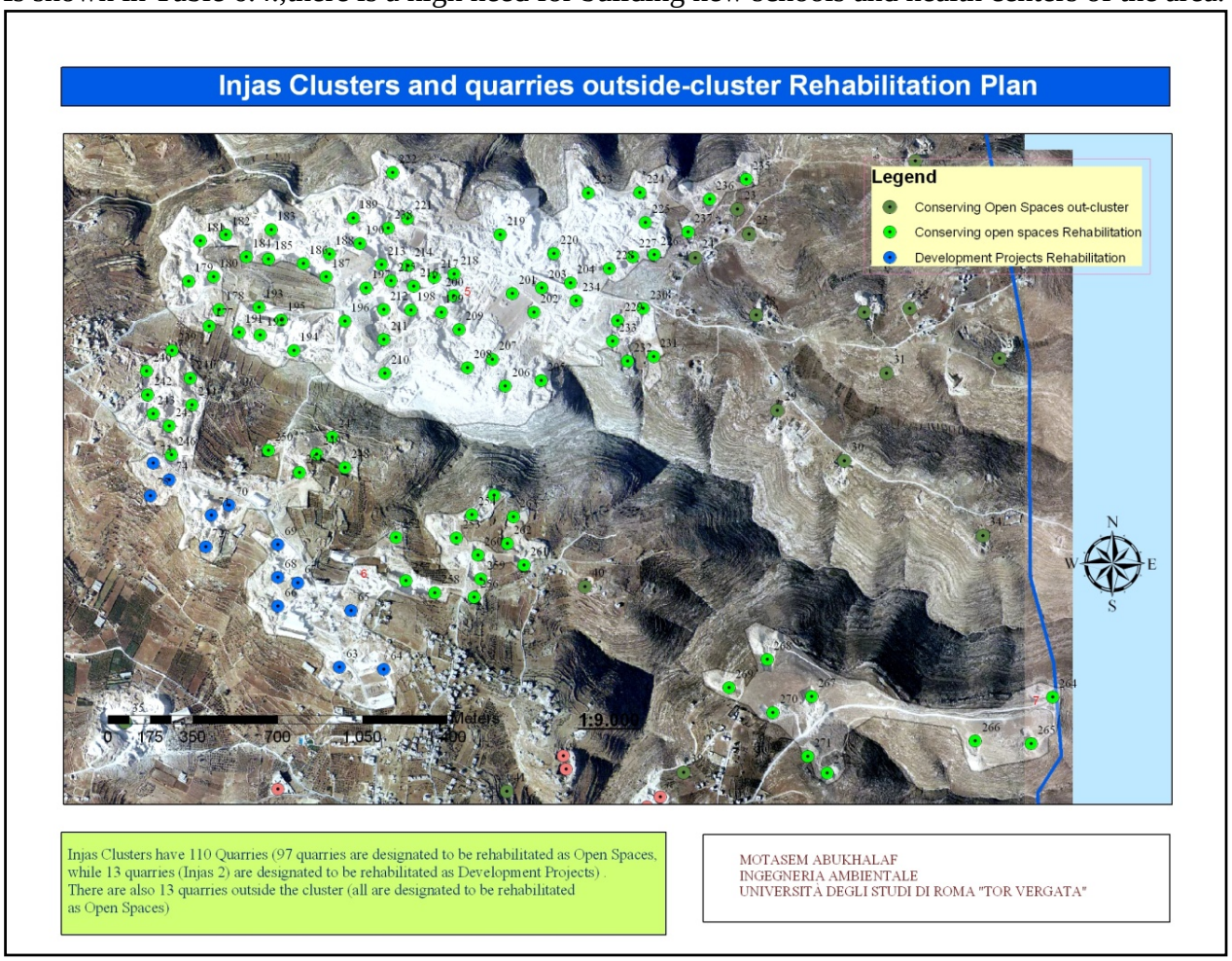


Figure 7.5.a: Rehabilitation plan for quarries in Injas area.

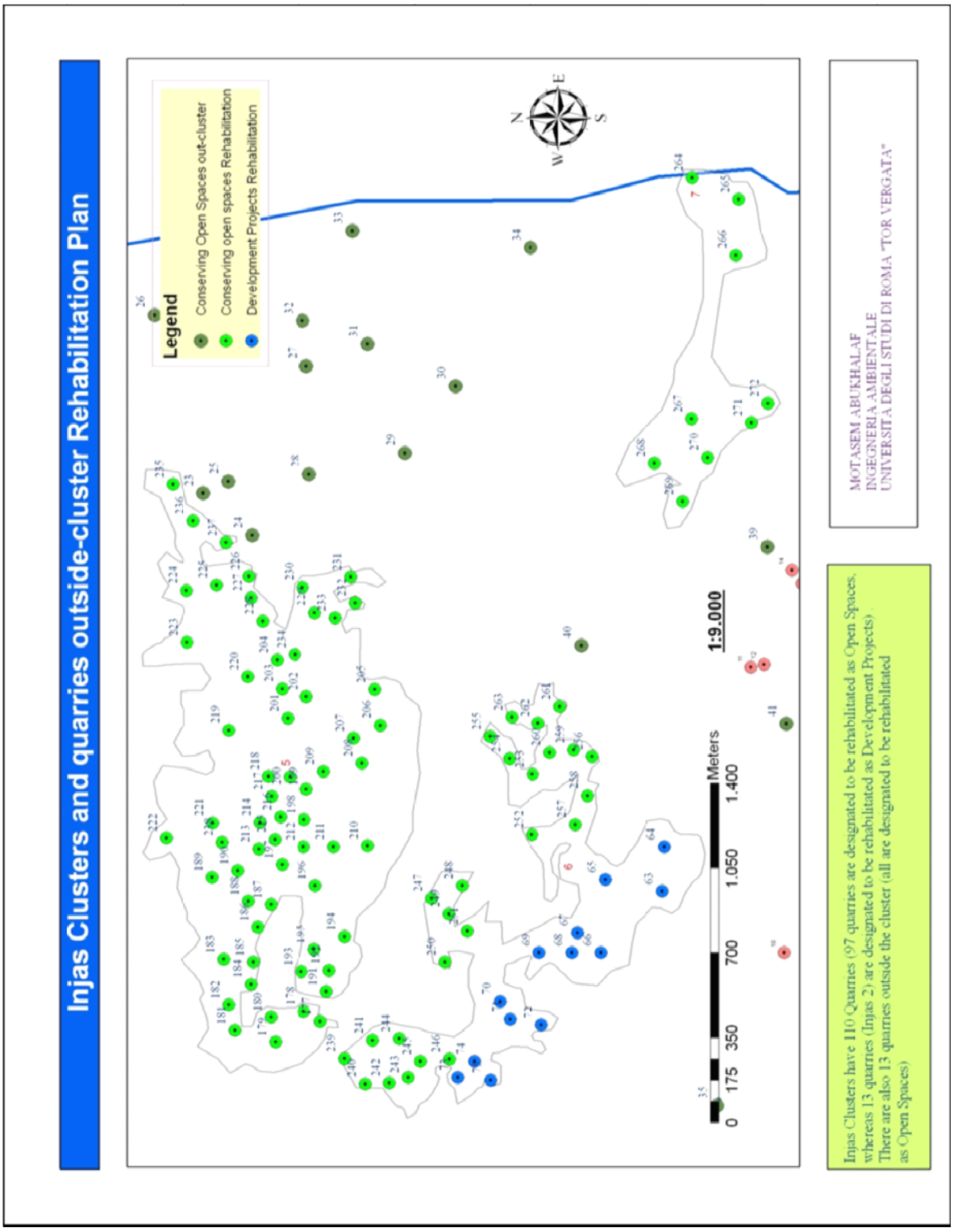


Figure 7.5.b: Detailed Rehabilitation plan for quarries in Injas area.

Irbea Cluster Designated Rehabilitation Plan:-

All the 20 quarries of Irbea cluster are designated to be rehabilitated as open spaces and agricultural purposes.

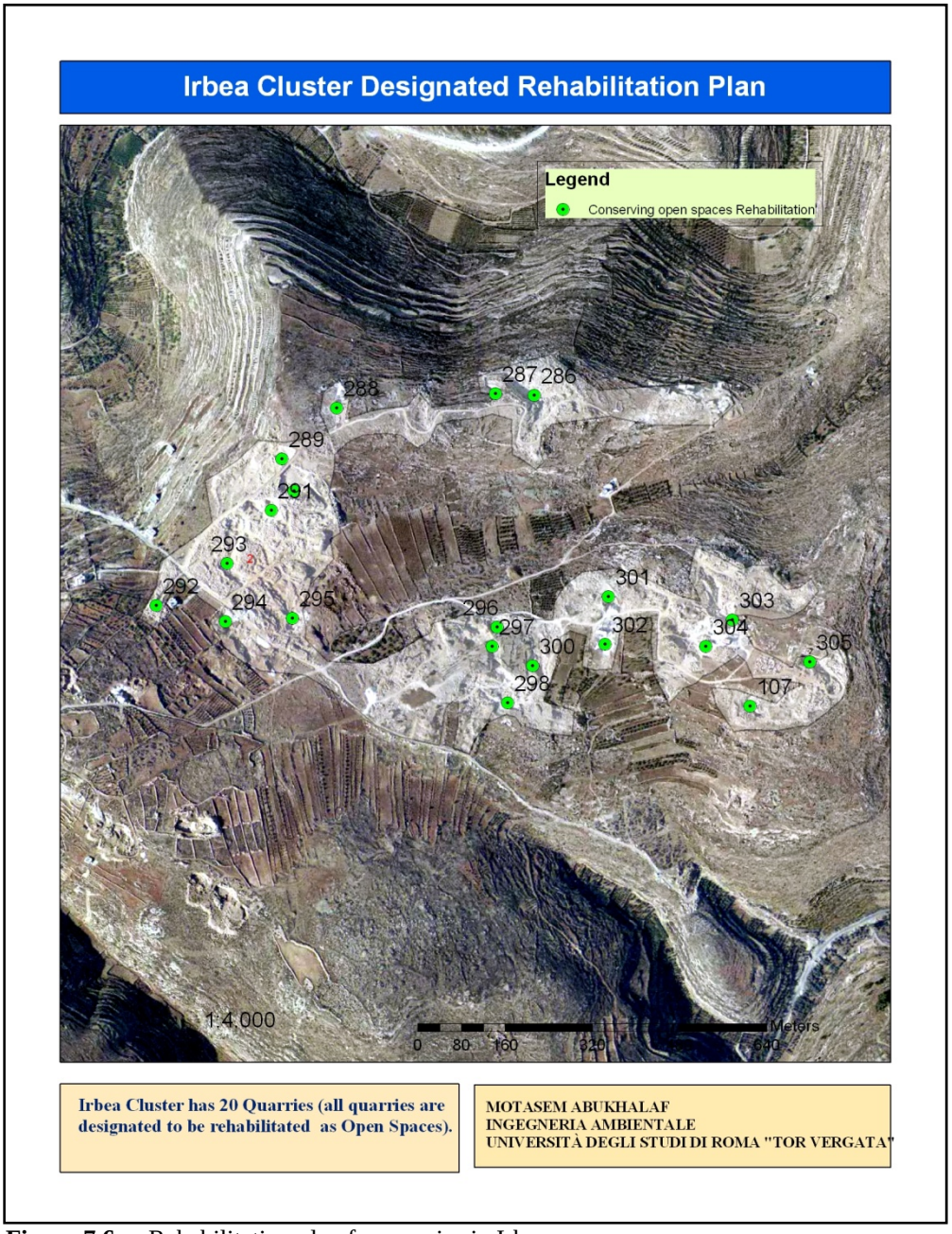


Figure 7.6.a: Rehabilitation plan for quarries in Irbea area.

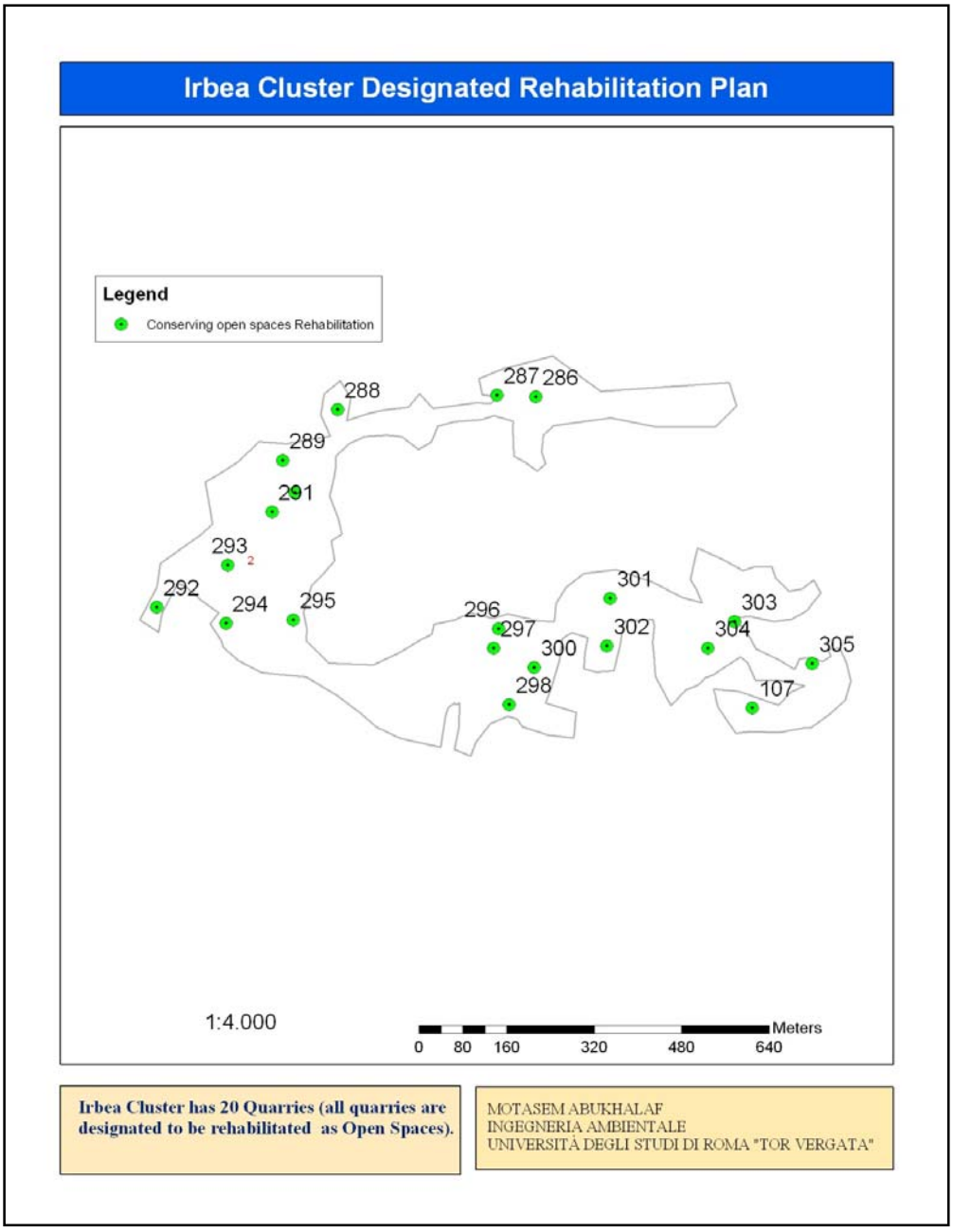


Figure 7.6.b: Detailed Rehabilitation plan for quarries in Irbea cluster.

Table 7.5:-Locality Development Priorities and Needs in Sier Town(ARIJ 2009).

Table 14: Development Priorities and Needs in Sa'ir Town						
No.	**Sector**	**Strongly Needed**	**Needed**	**Moderately Needed**	**Not Needed**	**Notes**
Infrastructural Needs						
1	Opening and Pavement of Roads	*				70 km^
2	Construction of New Water Networks	*				20 km
3	Rehabilitation of Old Water Networks	*				13km
4	Construction of Water Reservoirs	*				2000 m^3
5	Extending the Water Network to cover New Built up Areas	*				8 km
6	Construction of Sewage Disposal Network		*			
Health Needs						
1	Building of New Clinics or Health Care Centre	*				
2	Rehabilitation of Old Clinics or Health Care Centres		*			
3	Purchasing of Medical Equipments and Tools				*	
Educational Needs						
1	Building of New Schools	*				Secondary
2	Rehabilitation of Old Schools	*				Elementary
3	Purchasing of New Equipments for Schools		*			
Agricultural Needs						
1	Rehabilitation of Agricultural lands	*				3,000 dunums
2	Building Cisterns	*				150 cisterns
3	Construction of Barracks for Livestock	*				25 barracks
4	Veterinary Services	*				
5	Seeds and Hay for Animals	*				
6	Rehabilitation of Greenhouses		*			15 greenhouses
7	Field Crops Seeds	*				
8	Plants and Agricultural Supplies	*				

^ 25 km main roads, 20 km link roads and 25 km agriculture roads

Shyoukh Town:-

Shyoukh Clusters Designated Rehabilitation Plan:-

All the 67 quarries of Shyoukh clusters are designated to be rehabilitated as open spaces and agricultural purposes.

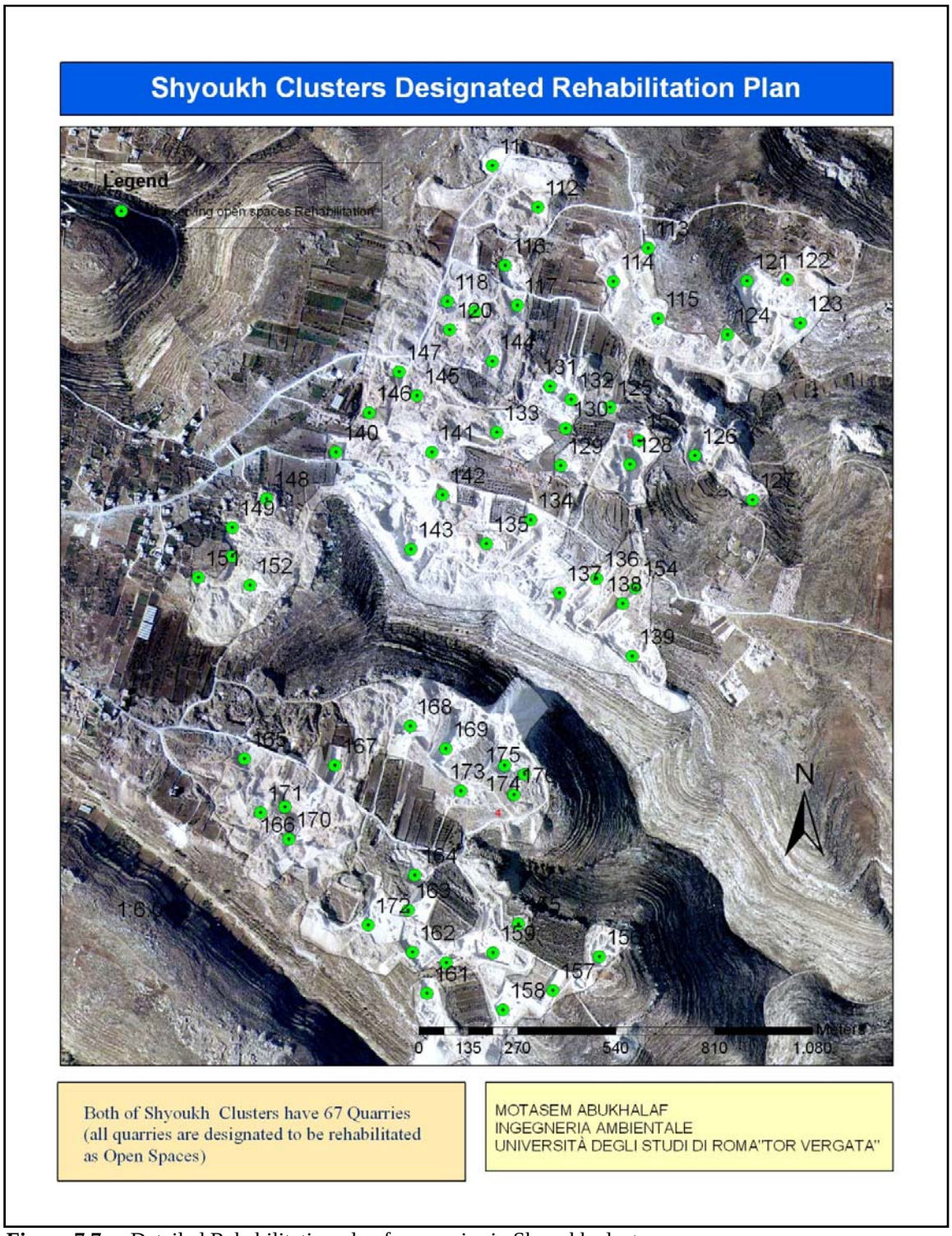


Figure 7.7.a: Detailed Rehabilitation plan for quarries in Shyoukh clusters.

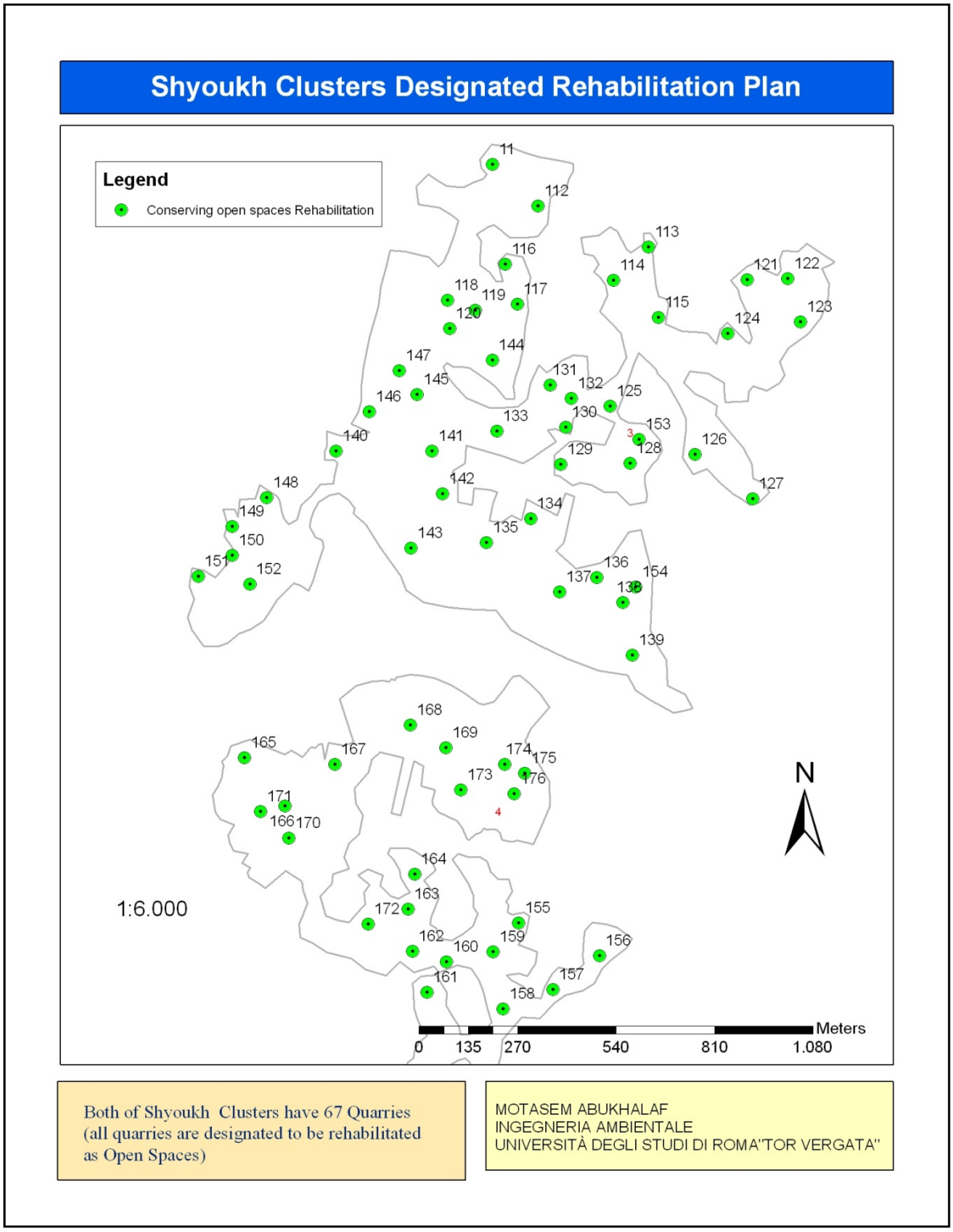


Figure 7.7.b: Detailed Rehabilitation plan for quarries in Shyoukh clusters.

Table 7.6: Locality Development Priorities and Needs in Shyoukh Town(ARIJ 2009).

Table 14: Development Priorities and Needs in Ash Shuyukh Town						
No.	**Sector**	**Strongly Needed**	**Needed**	**Moderately Needed**	**Not Needed**	**Notes**
	Infrastructural Needs					
1	Opening and Pavement of Roads	*				47 Km
2	Construction of New Water Networks	*				17 Km
3	Rehabilitation of Old Water Networks		*			
4	Construction of Water Reservoirs		*			2000 m'
5	Extending the Water Network to cover New Built up Areas	*				
6	Construction of Sewage Disposal Network	*				
	Health Needs					
1	Building of New Clinics or Health Care Centre	*				
2	Rehabilitation of Old Clinics or Health Care Centres	*				
3	Purchasing of Medical Equipments and Tools			*		
	Educational Needs					
1	Building of New Schools	*				
2	Rehabilitation of Old Schools	*				
3	Purchasing of New Equipments for Schools			*		
	Agricultural Needs					
1	Rehabilitation of Agricultural lands	*				500 dunum
2	Building Cisterns	*				100
3	Construction of Barracks for Livestock		*			
4	Veterinary Services		*			
5	Seeds and Hay for Animals		*			
6	Rehabilitation of Greenhouses		*			
7	Field Crops Seeds		*			
8	Plants and Agricultural Supplies		*			
	Other Needs					
1	Renovation of the Old City	*				
2	Finishing and opening of already constructed schools	*				
3	Establishing of an agricultural products market	*				

Beit Fajjar Town:-

Beit fajjar Cluster Designated Rehabilitation Plan:-

All the 34 quarries of Beit Fajjar cluster are designated to be rehabilitated as open spaces and agricultural purposes.

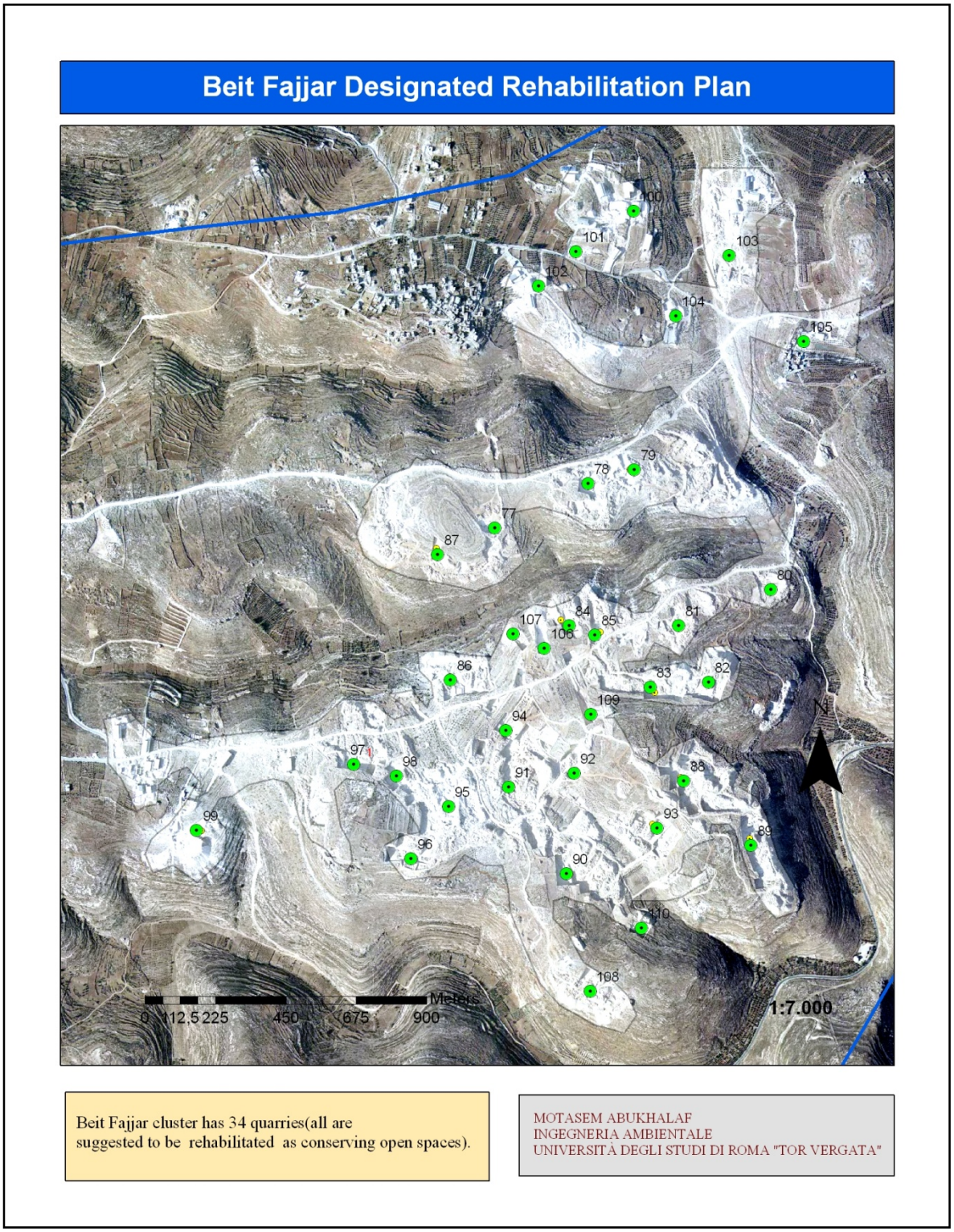


Figure 7.8: Detailed Rehabilitation plan for quarries in Beit Fajjar cluster.

Figure 7.9: Current view **a**nd a future possible view (not to scale) for Quarry number 3 (Bani Naim Area designated rehabilitation Plan) which is supposed to be rehabilitated as a school .

Figure 7.10: Current view and a future possible view (not to scale) for Quarry number 73 (Injas Area designated rehabilitation Plan) which is supposed to be rehabilitated as a commercial center .

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ANNEXES

LIST OF FIGURES

LIST OF TABLES

LIST OF PHOTOS