ECOSYSTEMS AND HUMAN WELL-BEING

El Maghara, Northern Sinai, Egypt




UNEP

FORDFOUNDATION

ISBN: 978-92-807-3056-2

Produced by
Division of Early Warning and Assessment (DEWA) – United Nations Environment Programme
P.O. Box 30552, Nairobi 00100, Kenya
Tel: (+254) 20 762-1234
Fax: (+254) 20 762-3927
E-mail: uneppub@unep.org
Web: www.unep.org

Cover: Audrey Ringler, UNEP, Nairobi
Concept and layout: ©Ocean Graphics, Cairo, Egypt
Printing: Progress Press Ltd., Malta
Distribution Services: SMI Ltd., UK

This publication is available from Earthprint.com http://www.earthprint.com

Acknowledgments

UNEP acknowledges the contributions made by many individuals and institutions that have contributed to “Ecosystems and Human Well-Being: Al Maghara, Northern Sinai, Egypt”. A special word of thanks goes to H.E. Eng. Maged George Elias Ghattas, Minister of State for Environment Affairs in Egypt for his support. Also, our special thanks go to the encouragements and supports provided by Professor Mohamed El Zhogby, president of the Suez Canal University, Professor Farouk Abdelkader, president of Sinai University as well as Professor Ibrahim Nagi Aly, vice president of the Suez Canal University. A special word of thanks goes to Ms. Hanna Ayoub, Ms. Judy Barsalou, Ms. Marina Dawoud, Ms. Sharry Lapp, Ms. Amany Manqabadi and Ms. Emma Playfair from the Ford Foundation, Cairo office. Our thanks are also extended for the coordination and support provided by the directors of the Millennium Ecosystem Assessment Dr.Walter V. Reid (January 2002 - March 2005) and Mr. Marcus Lee (April - September 2005). The full list of names to acknowledge is given below:

Authors

Lead Coordinating Author

Mohamed Tawfic Ahmed

Introduction

Author: Mohamed Tawfic Ahmed

Chapter 1

Lead Author: Mohamed Tawfic Ahmed
Contributing Authors: Ahmed Abdelrehim, Ali Amasha, Mohamed O.Arnous, Khairy El Ashry, Hamdy El Sharabasy, Mohamed El Tabie, Mayar Sabet

Chapter 2

Lead Authors: Mohamed Tawfic Ahmed, Mohamed O.Arnous, Mohamed A. El Ghawaby, Kamal Ouda Ghodief
Contributing Authors: Raafat Abdelwahab, Mohamed El Shafie, Hamdy El Sharabasy, Mohamed A.A.Hassan, Naglaa Loutfy, Mahmoud Zahran

Chapter 3

Lead Author: Mohamed Tawfic Ahmed, Luohui Liang
Contributing Authors: Manal Hassan, Manal Hefny, Naglaa Loutfy, Kariman Mahomoud, Mayar Sabet

Chapter 4

Leading Authors: Mohamed Tawfic Ahmed, Mohamed Mostafa Saleh
Contributing Author: Adel Abdelkader, Ahmed Abdelrehim

Chapter 5

Lead Author: Ahmed El Kholy
Contributing Authors: Adel Abdelkader, Ahmed Abdelrehim, Mohamed Tawfic Ahmed

Funding: The Government of the Kingdom of Saudi Arabia, the Ford Foundation, Cairo Office, the Millennium Ecosystem Assessment and UNEP, World Fish Center, Penang, Malaysia together funded this assessment.

UNEP Coordination: Adel Abdelkader

Extended Team:

UNEP: Yasmina Adra, Marion Cheatle, Salif Diop, Habib El-Habr, Ahmed Ghosn, Peter Gilruth, Marcus Lee (2006-2008), Hiba Sadaka, Gemma Shepherd

Suez Canal University: Yassir Awad, Gamal El Kady, Samir El Shazli, Amira Gamal, Salah Goaied, Gamal Gomaa, Sara Griesh, Samia Henneidk, Samar Kishta, Nehal Loutfy, Samia Massoud, Moustafa Saleh, Eid Quraish, Rabie Saleh, Adel Salem, Tamer Shawki

Desert Research Centre: Yassir Hanafy, Badran Hassanain

Jawaharlal Nehru University: JK Saxena, New Delhi, India

Editors: Cathy Costain, Mona Hashish, Rosemarie Philips

Technical Editors: Adel Abdelkader, Mohamed Tawfic Ahmed

Concept and Layout : ©Ocean Graphics, Cairo, Egypt
Art Director : Sheridan Mohamed Hashish
Design: Mona Mahmoud Fouad

Cover Design: Audrey Ringler

Capacity Building Component Team: Asma Abahussain, Mohammad Abido, Anwar Shaikh Al-Din A. Khalil, Waleed Zubari

Institutions

Centre for Environment and Development for Arab Region and Europe, CEDARE
Desert Research Centre, Egypt
Egypt Metrological Service
Governorate of North Sinai
Jawaharlal Nehru University, New Delhi, India
Ministry of Electricity, North Sinai
Ministry of Water Resources and Irrigation, North Sinai
Petroleum Research Centre, Cairo
Soul Water, Cairo
United Nations University, Tokyo, Japan
World Fish Centre, ICLARM, Penang, Malaysia

Reviewers:
Reda Bayoumi, Hernán Blanco, Colin Filer, Manal El Batran, Mohamed El Ghawaby, Mohamed El Kassas, Wafa Essahli, Edgar Göll, Marcus Lee, Luohui Liang, Belinda Reyers, Adel Zakri

Contents

Foreword x
Preface xi
Introduction 1

Chapter 1: Assessment Methods 9

Chapter 2: El Maghara Ecosystem, Trends, Conditions and Impacts 31

Chapter 3: Local Knowledge: A Valuable Resource 73

Chapter 4: El Maghara Scenarios: Alternative Images of the Future 87

Chapter 5: Policy Responses: Moving Toward Sustainability 127

Glossary 156
Index 160

List of illustrations

Introduction

Figure 1. Conceptual framework of the millennium ecosystem assessment 3
Figure 2. Consequences of ecosystem change on human well-being 4
Figure 3. Proportion of capital stocks in-country in different income groups 5
Figure 4. Map of sub-global assessments worldwide 6
Figure 5. Location map of Arab MA 7
Figure 6. Location map of El Maghara area with reference to Middle East region 8

Chapter 1 Assessment Methods

Figure 1.1. A regional map showing where the assessment was conducted 14
Figure 1.2. Satellite image of El Maghara area showing main geo-morphological units 15
Figure 1.3. Digital elevation model (DEM) of El Maghara area 16
Figure 1.4. Land use/land cover map of El Maghara area 17
Figure 1.5 Populated areas around El Maghara 22
Figure 1.6. Proportion of the El Maghara population at various income levels 24
Figure 1.7. School enrollment, El Maghara area 25
Figure 1.8. Men education status, El Maghara area 26
Figure 1.9. People's aspirations and needs in El Maghara area, as indicated by questionnaire 29

Chapter 2 El Maghara Ecosystem Trends, Conditions and Impacts

Figure 2.1. Land use / land cover map, El Maghara area, 2007 35
Figure 2.2. Land use pattern in El Maghara area, 1986 36
Figure 2.3. Land use pattern in El Maghara area, 2000 36
Figure 2.4. Enhanced classified landsat satellite image of El Maghara area, 1986 38
Figure 2.5. Enhanced classified landsat satellite image of El Maghara area, 2000 38
Figure 2.6. Soil erosion rate map, El Maghara area 39
Figure 2.7. Distribution of plant species around El Maghara, 2006 44
Figure 2.8. Percentage vegetative cover 44
Figure 2.9. Classified enhanced landsat (TM, 1986) image, El Maghara area 46
Figure 2.10. Classified enhanced landsat (ETM, 2000) image, El Maghara area 46
Figure 2.11. Average annual rainfall on Sinai peninsula 49
Figure 2.12. Flashfloods in main basins and sub - basins of El Maghara area 50
Figure 2.13. Drainage basins and surface water distribution map constructed from ETM image 52
Figure 2.14. The distribution of water points (wells) from different aquifers in El maghara area 52
Figure 2.15. Aquifer type distribution map, El Maghara area 54
Figure 2.16. Static flow water level map of El-Massajid aquifer 54
Figure 2.17. Salinity in aquifers map, El Maghara area 57
Figure 2.18. Sodium absorption ratio (SAR) map of all aquifers in the study area 57

Figure 2.19. Variations in current per capita water availability for each watershed in El Maghara area 59
Figure 2. 20. Soil sampling sites 61
Figure 2.21. Soil fertility map, El Maghara area 62
Figure 2.22. Silt content map, El Maghara area 63
Figure 2.23. Organic matter map, El Maghara area 63
Figure 2.24. Integrated land capability classes map, El Maghara area 64
Figure 2.25. Integrated fertility classes map, El Maghara area 64
Figure 2.26. Biodiversity and population density of some soil inhabiting organisms around El Maghara coal mine 66
Figure 2.27. The morphological distortion in an isolate of Aspergillus Niger from thestudy area compared with the normal isolate of the same Fungus 66
Figure 2.28. Soil salinity map, El Maghara area. 67
Figure 2.29. Lithological map of El Maghara area 69
Figure 2.30. Rock use map, El Maghara area 69

Chapter 4 El Maghara Scenarios: Alternative Images of The Future

Figure 4.1. The hybrid scenario process used in the El Maghara assessment 91
Figure 4.2. Indirect influence / dependence map 96
Figure 4.3. Potential indirect influence graph 97
Figure 4.4. Map of influence and dependence between actors 100
Figure 4.5. Sustainable development competitive scale 100
Figure 4.6. Quadrate of key drivers shaping the scenarios 102
Figure 4.7. Average monthly family income in each scenario 123
Figure 4.8. Literacy rate in each scenario 123
Figure 4.9. Employment rate in each scenario 124
Figure 4.10. Population levels in each scenario 124
Figure 4.11. Water share per capita in each scenario 124

Chapter 5 Policy Responses: Moving Toward Sustainability

Figure 5.1. Problem tree: implications of poor governance 130
Figure 5.2. Objectives tree: implications of good governance 132

List of boxes

Chapter 1 Assessment Methods

Box 1.1 Ecosystem, natural resources, and social fabric development in Sinai 20
Box 1.2 Crisis and people: A Sinai perspective 24

Chapter 2 El Maghara Ecosystem Trends, Conditions and Impacts

Box 2.1 Drivers and indirect drivers: A case study illustrating a domino reaction 46
Box 2.2 Juniperus phoenicea, values and uses 48
Box 2.3 Desert and natural resources 68

Chapter 3 Local Knowledge: a Valuable Resource

Box 3.1 El Karma dam 81
Box 3.2 Information validation 85

Chapter 4 El Maghara Scenarios: Alternative Images of The Future

Box 4.1 The power of a well-told story 103
Box 4.2 Bedouin protest against government 118

List of tables

Chapter 1 Assessment Methods

Table 1.1. Health Conditions, El Maghara Area 27

Chapter 2 El Maghara Ecosystem Trends, Conditions and Impacts

Table 2.1. Changes in land use and land use pattern in the study area, 1986–2000 37
Table 2.2. Monthly rainfall at Bir El-Hassana station, 1939–47 49
Table 2.3. The expected maximum and average flood volume for El Maghara basins 51
Table 2.4. Precipitation rate in selected parts of Sinai 51
Table 2.5. Well yield and exploitation from active wells, July 2005 55
Table 2.6. Results of physical and chemical analyses of the water samples 56
Table 2.7. Water availability and actual water allocation by watershed 58
Table 2.8. Residues of some heavy metals in water samples collected from El Maghara 60
Table 2.9. Levels of bacterial contamination of water samples taken from some haraba in central Sinai 60
Table 2.10. Suitability rating and classes for agricultural use in El Maghara area 62
Table 2.11. Residues of total petroleum hydrocarbons and some heavy metals in soil samples collected from around El Maghara coal mine 65

Chapter 4 El Maghara Scenarios: Alternative Images of The Future

Table 4.1. Matrix of direct influences (drivers) 95
Table 4.2. Matrix of direct influences (actors) 98
Table 4.3. Valued position matrix 99

Foreword

The planet's natural and nature-based assets, from freshwater and forests to soils, coral reefs, the air and the atmosphere, are coming under increasing pressure from over-exploitation; over-harvesting; pollution and unsustainable patterns of consumption.

Human well being and quality of life are being affected including human health and international action to overcome poverty and meet the Millennium Development Goals.

The Millennium Ecosystem Assessment, MA, initiative is a landmark in endeavour to understand and to formulate a decisive response among decision-makers; business and the general public in order to more intelligently manage ecosystems and the multi-trillion dollar services they deliver.

The Subglobal Assessments are fundamental elements that underpin the global findings of MA. The El Maghara, Subglobal assessment, conducted in Sinai, Egypt forms part of the Arab MA.

It provides and confirms the growing body of evidence that links poverty and human well being to the health of ecosystems and their continued ability to provide goods and services.

The El Maghara assessment is a powerful example of the drylands - one of the most vulnerable and fragile ecosystems on Earth - are often over-exploited to the point of acute decline and degradation.

Bedouin, the main stakeholders of the El Maghara assessment are a vivid example of the close connection between culture, the physical environment, and human well being.

One central lynchpin in this relationship is the role of local knowledge in the sustainable management of drylands which has assisted the Bedouin to survive and to thrive over millennia.

The El Maghara assessment has also catalyzed action to conserve the area's natural environment. For example local authorities have now taken a decision to make the Sheikh Hemid Wood a protected area as a result of its unique importance.

Studies of the El Maghara area has also assisted in updating the flora of the area, which in turn is an important part of Egypt's overall flora. Last but not least, the El Maghara assessment has contributed towards catalyzing a response to water scarcity: a water desalination unit has been installed to serve the main Bedouin community concerned.

In addition, the El Maghara assessment report can serve as a blue-print for similar reports in areas of the world that share similar social, economic and environmental conditions.

I would also like to thank the Government of Egypt for supporting this assessment and the Ford Foundation for providing financial support.

In addition congratulations to the Suez Canal University and especially El Maghara assessment team for their professionalism, determination and painstaking work in realizing this important report.

Achim Steiner
United Nations Under-Secretary General and Executive
Director, United Nations Environment Programme

Preface

There is no doubt that The Millennium Ecosystem Assessment, MA, initiative has provided some substantial evidence of the state and conditions of the global environment, and the impacts of this state on ecosystem services and their contribution for human welfare. The MA has also provided some ample venues on how to improve the quality of life and restore ailing environmental assets, trying to cope with the growing demand of future generations.

The Sub Global Assessments SGA are integral component in the MA initiative, with significant bearing on the locations where they were conducted, the inhabitants of these locations, and the globe at large. The contribution of the SGA in disclosing the state of environment degradation, environment – based poverty and the factors contributing to that state is a central issue in the growing interest to alleviate poverty, improve environmental conditions, and to empower environmental sustainability.

It was an honour that the Suez Canal University was one of the global contributors to the findings of the global MA and also one of the main institutes with direct involvement in Sinai subglobal assessment. This role would go very well with the special mandate of Suez Canal University, as a leading institute in the Suez Canal and Sinai area, with special interest on community service and environmental issues.

It is indeed my pleasure to introduce the present work that illustrates among other things the endeavours of colleagues at our university to highlight and to depict facts in such a way that would enable future improvements, progress and sound management.

It is also my pleasure to thank our research team, for their dedication, patience, and also for their sincere efforts to help the inhabitants of El Maghara, where the assessment was performed.

Meanwhile, I would certainly hope, that the findings produced in this report would be of good use to decision makers and other stakeholders whom El Maghara area would present a real value.

I would like to thank the United Nations Environmental Programme UNEP for their continuous support and supervision that made it possible to produce this final report. Their sincere guidance, has led the way for this assessment to reach a creditable standard, that we all are very proud of.

I would also like to thank H.E. Mr Maged George, Egypt state minister of environmental affairs for the valuable and continuous support throughout.

Finally, I would also like to extend my thanks to the government of Saudi Arabia and for Ford Foundation, World Fish Centre, Penang, Malaysia, for the their financial support, and for the United Nations University, Tokyo for their technical support.

M. El. Zoghby

Professor Mohamed El Sayed El Zoghby
President, Suez Canal University - Ismailia, Egypt

Introduction

Author

Mohamed Tawfic Ahmed

The Millennium Ecosystem Assessment (MA) is an international initiative launched in 2001 to "assess the consequences of ecosystem change for human well-being." It also establishes, the scientific basis for actions to enhance the conservation and sustainable use of ecosystems and their contributions to human well-being.

The MA responds to government requests for information received through a number of international conventions and the business community, the health sector, non-governmental organisations, and indigenous peoples.

Egypt's sub-global assessment is part of the Arab millennium assessment which also includes Morocco and Saudi Arabia. Time has proven that Rachel Carson's memorable book *Silent Spring* (Carson 1962) fell significantly short of predicting the grim path the Earth is currently experiencing. The environmental worries and facts we are preoccupied with these appalling days reflect her view that our desire for total control of nature was mere arrogance. At the beginning of the twenty-first century, the Earth's troubles have been exacerbated and have probably become irreparable. Over the past 50 years, humans have been living beyond the planet's ecological limits and changing ecosystems more rapidly and extensively than in any comparable period of time in human history, largely to meet rapidly growing demands for food, freshwater, timber, fibre and fuel. This has resulted in a substantial and largely irreversible loss in the diversity of life on Earth. Global warming and climate change are becoming potential threats to millions of people in different countries, including some of the poorest places, with expected losses in land and resources and the possible forcible migration of millions from their homelands. Land degradation has affected some 1,900 million hectares of land

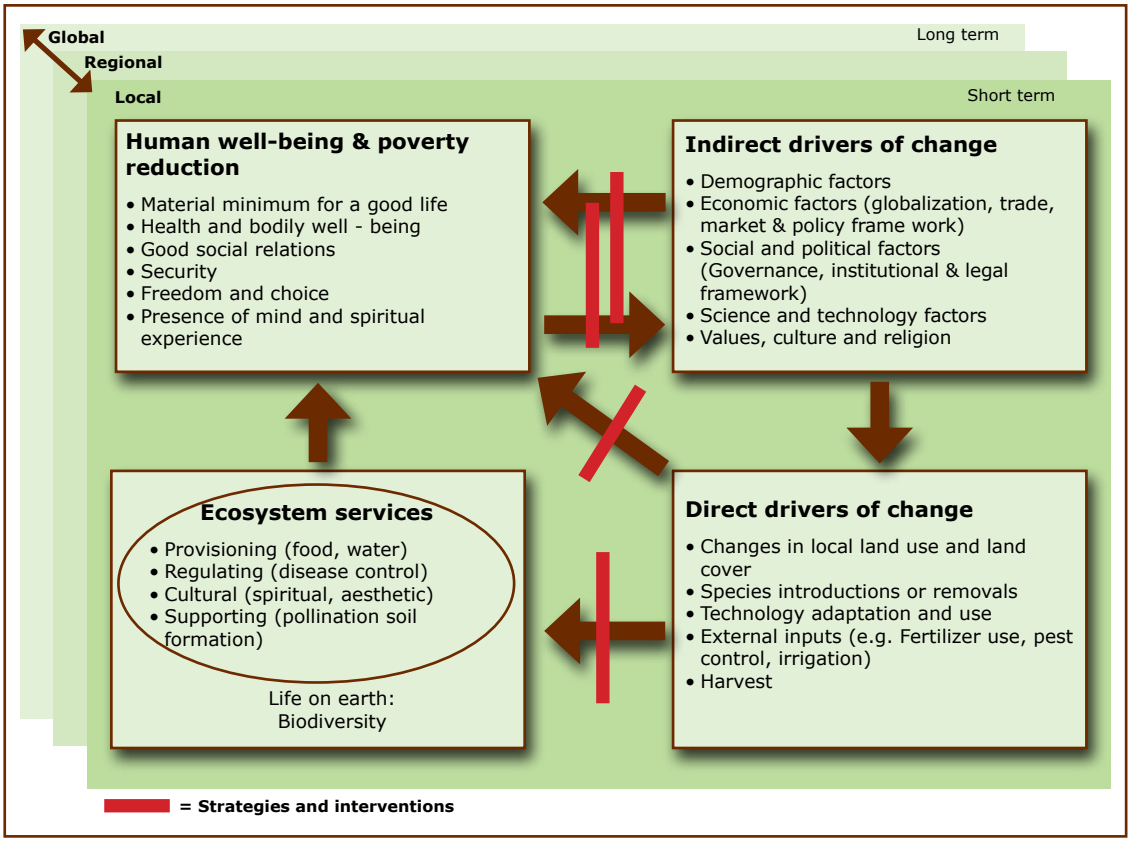


Figure 1. Conceptual framework of the millennium ecosystem assessment

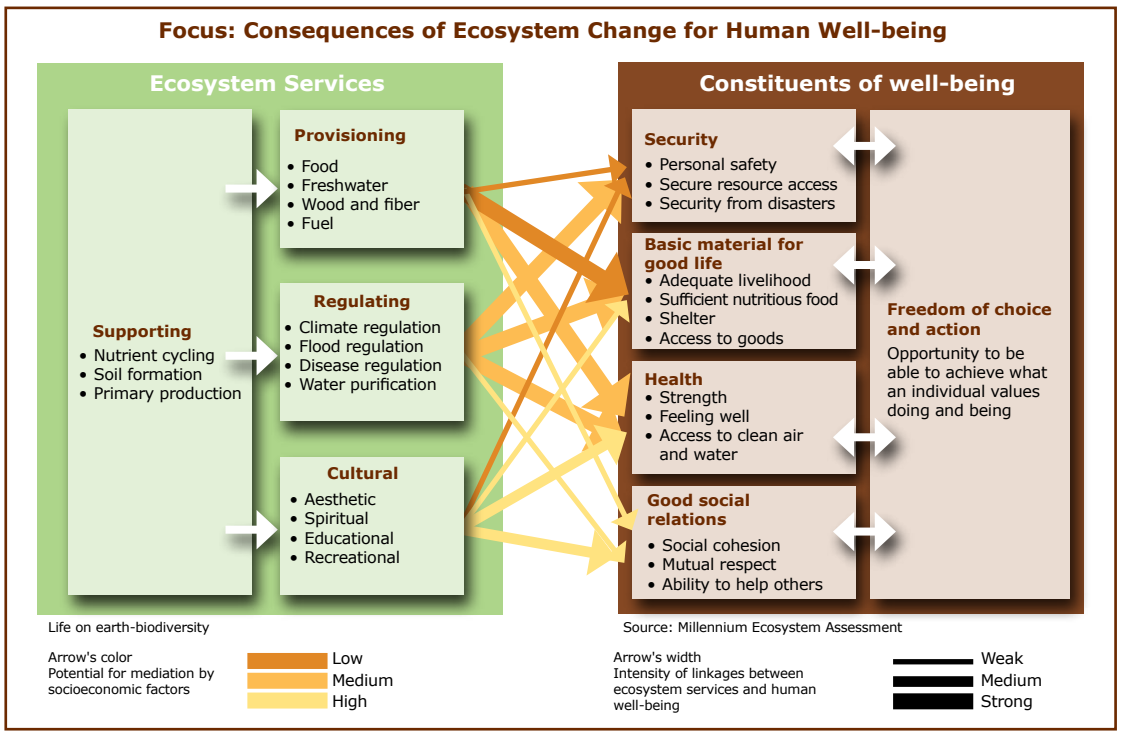


Figure 2. Consequences of ecosystem change on human well-being

on the planet. In Africa, for example, an estimated 500 million hectares of land have been affected by soil degradation, including 65% of the region's agricultural land. The loss of potential productivity due to soil erosion is estimated to be equivalent to some 20 million tons of grain per year. And this is happening worldwide not just in Africa or Asia (UNEP 1999).

The Millennium Ecosystem Assessment

The Millennium Ecosystem Assessment (MA) is an international initiative carried out between 2001 and 2005 to "assess the consequences of ecosystem change for human well-being and to establish the scientific basis for actions to enhance the conservation and sustainable use of ecosystems and their contributions to human well-being". The MA responds to government requests for information received through four international conventions, the Convention on Biological Diversity, the United Nations Convention to Combat Desertification, the Ramsar Convention on Wetlands, and the Convention on Migratory Species, and is designed to meet the needs of other stakeholders, including the business community, the health sector, non-governmental organisations and indigenous peoples (MA 2003). The sub-global assessments, of which this volume is one, aim to meet the needs of users in the communities, countries, or regions in which they were undertaken.

The MA Conceptual Framework and Ecosystem Services

An ecosystem is "a dynamic complex of plant, animal, micro-organism communities and the non-living environment interacting as a functional unit" (MA 2003). Ecosystems form a landscape and are connected often by streams, rivers, and wildlife. Ecosystem services represent the benefits human populations derive, directly or indirectly, from ecosystem functions (MA 2003; Daly et al., 1997).

The MA conceptual framework (Figure 1) classifies ecosystem services as: provisioning services such as food, water, timber, and fibre; regulating services that affect climate, floods, diseases, wastes, and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as soil formation, photosynthesis, and nutrient cycling. Figure 2 shows the linkages between human well-being and ecosystem services.

Ecosystems and Poverty

The relationships between poverty and environment, and between poor people and natural resources, are complex and have been the subject of extensive debate. Poor people are often impoverished by an austere resource base, and thus forced by their circumstances to degrade the environment even further (World Commission on Environment and Development 1987; Durning 1989; Cleaver and Schreiber 1994; Ekbom and Bojö 1999). Poverty reduction is becoming a global issue. The Millennium Development Goal (MDG) objective of halving the number of poor people by 2015 is one of the major driving forces in this field.

In many under-privileged communities, mostly in rural areas where the majority of people are poor, ecosystem services become life-supporting elements, and their role becomes more conspicuous. A World Bank (2007) report indicated that in low-income countries natural resources account for an estimated 28% of the capital stock; for high-income countries, this figure is only 2% (Figure 3).

Definition of Ecosystem Assessment

An assessment is a critical evaluation of information and knowledge of guiding decisions on a complex public issue. It should also refer to a situation at a specific time in a particular geographical and societal domain. Stakeholders, including decision-makers, play a major role in an assessment module, orientation, and outcome. Ecosystem assessment is usually conducted by a large group of people with different backgrounds and interests.

It aims to address a vast portion of the population, with special reference to decision-makers and the like. It should also present scientific endeavours in an explicit manner. Another definition considers, assessment as "a social process that uses published peer-reviewed material, and other forms of knowledge/ publications to bring the findings of science to bear on the needs of decision-makers" (UNEP and IISD 1999).

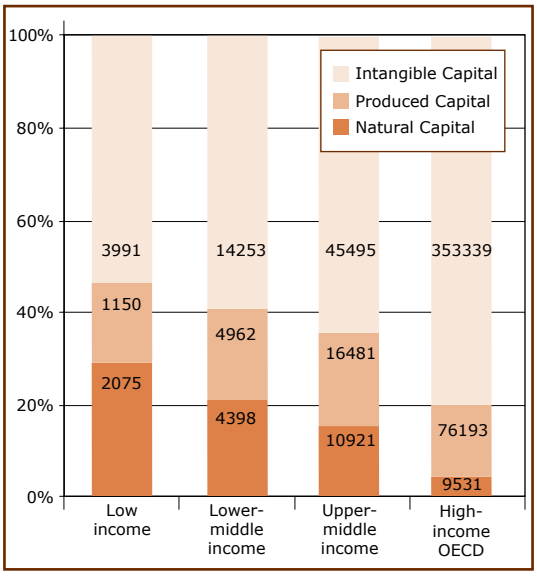


Figure 3. Proportion of capital stocks in-country in different income groups (World Bank 2007).

Global and Sub-global Assessments

The MA is a multi-scale assessment consisting of interlinked assessments undertaken at local, national, regional and global scales. The global and sub-global assessments analysed ecosystem services and the consequences for human well-being from different perspectives and with different stakeholders involved. Meanwhile, sub-global assessments are conceived as integrated assessments to analyse the relationship between direct and indirect drivers of ecosystem change, their impact on ecosystem services, and the consequences for human well-being.

Assessments at sub-global scales are needed because ecosystems are highly differentiated in space and time on the one hand and because sound management requires careful local planning and action on the other hand. However, local assessment alone is insufficient since some processes are of wider scale and because local goods, services, matter, and energy are often transferred across regions. The MA process included 34 sub-global assessments from around the world at various scales (Figure 4). They were undertaken to directly meet the needs of decision-makers at that particular level while also strengthening the global findings through reality checks on the ground and by reinforcing the local and regional findings with global perspectives, data, and models.

Arab Millennium Ecosystem Assessment

The Arab region sub-global assessment started in the latter stage of the MA as an associate assessment; as such, it was intended to go beyond the global MA. Three sites: Sinai peninsula, Egypt; Tafilalt oasis in Morocco; and Assir National Park in Saudi Arabia were selected to be the focal sites for the Arab Millennium Ecosystem Assessment (Figure 5). The objectives of the Arab MA include:

- to meet the needs of and communicate the assessment information to decision-makers concerned with the pilot sites at national and local scales, and integrate the findings into regional and global perspectives;
- to build capacity to undertake integrated assessments of ecosystems of key partners;
- to help develop and test methodologies for integrated multi-scale ecosystem assessments and methodologies for integrating local and "scientific" knowledge;
- to promote widespread adoption of integrated assessment approaches in the region;
- to build a framework for the collection, analysis, and synthesis of ecosystem-wide data for decision-making at multi-level, including the local community;
- to link and incorporate the outcomes into global assessments; and
- to identify networks of actors and organisations playing critical roles in the sustainable management of ecosystems of those sites and to bridge gaps between science, technology, and sustainable development and define the existing resource base devoted to bridging these gaps.

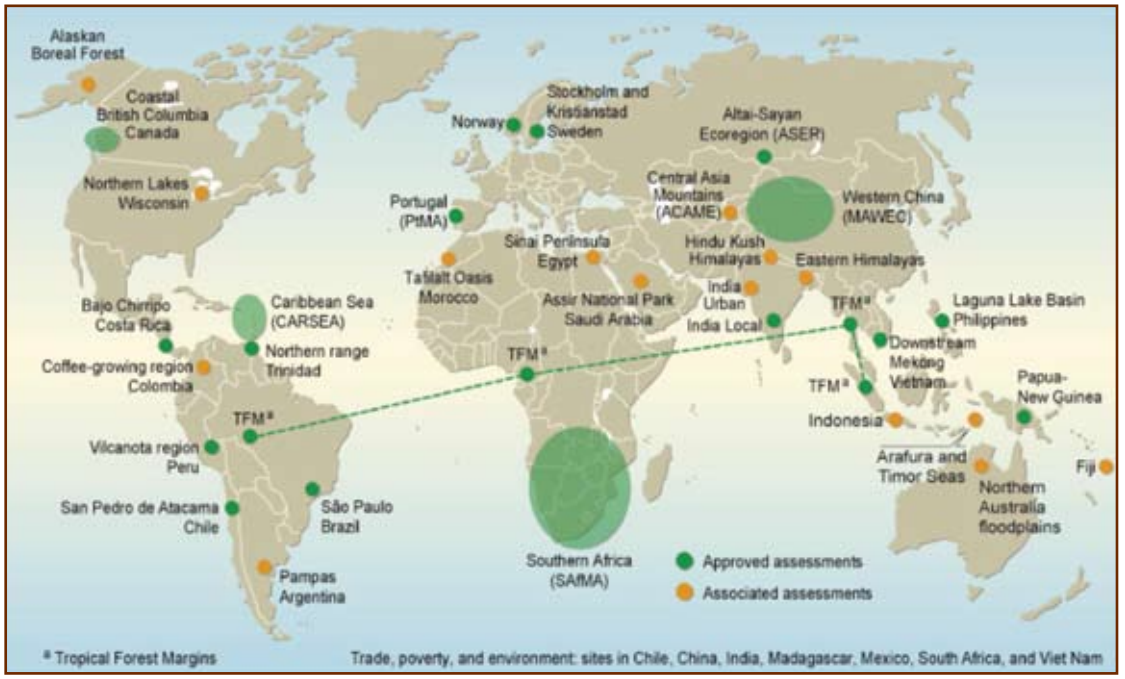


Figure 4. Map of sub-global assessments worldwide (MA, 2005).

The Arab MA also intended to generate problem-solving knowledge that facilitates action on critical issues of sustainable development and protection of the environment through the design of institutional arrangements that foster the generation, collection, analysis, diffusion, and use of scientific knowledge for the sustainable use of ecosystems.

The Egypt Sub-global Assessment at Sinai Peninsula, El Maghara

Egypt's sub-global assessment is a community-based assessment, conducted in the El Maghara area, North Sinai. Community-based assessments are necessary components of multi-scale assessments such as the MA. They capture real

Figure 5. Location map of arab MA

life experience of changes in ecosystems and human well-being.

Sinai, located between the Nile Valley in Africa and West Asia, is an important heritage site embracing a unique collection of sacred shrines and ecologically valued landmarks, including a number of rare animal and plant species. St. Katherine monastery, located in Southern Sinai, is one of the oldest Christian establishments. The original chapel is believed to have been established in 330 AD at the place of the Biblical Burning Bush. Other sacred sites include Gebel Mousa (Mount Sinai), where Moses received the Ten Commandments.

Because Sinai is a land bridge between Asia and Africa, it combines a distinguished faunal and floral wealth. Sinai also has a diverse landscape encompassing wetlands, desert terrain, sand dunes, and mountainous highlands. The unique culture and traditions of the Bedouin, the main inhabitants of Sinai, is another salient factor in the

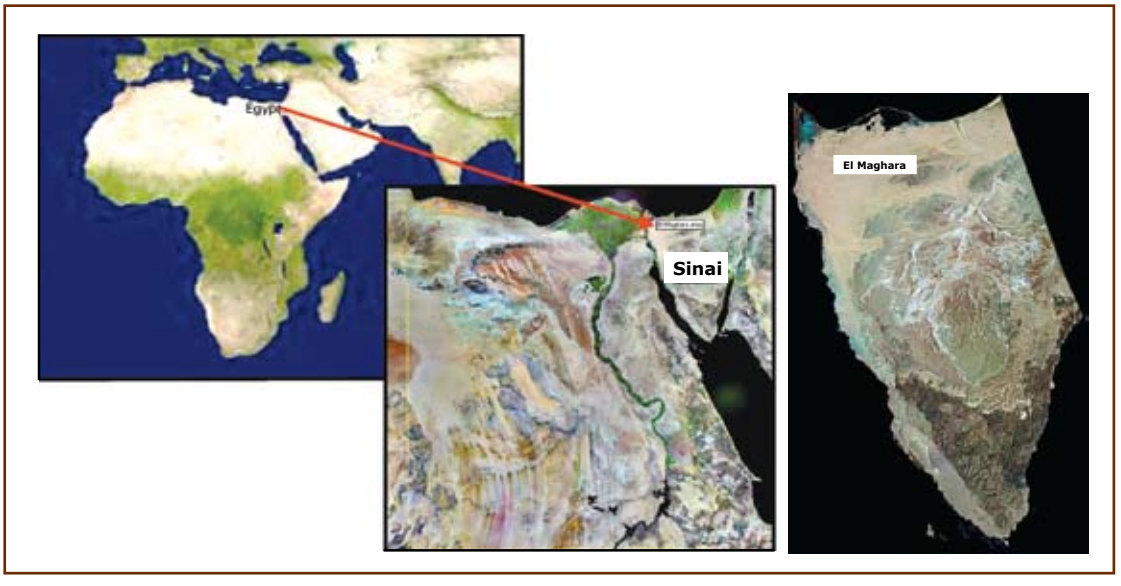


Figure 6. Location map of El Maghara area with reference to Middle East region

mosaic diversity of Sinai. Their local knowledge, wisdom, and experience is an important historical feature of Sinai that has allowed them to survive the harsh spells Sinai has frequently faced.

References

Carson , R 1962, *Silent spring*, Houghton Mifflin, Boston.

Cabinet Information and Decision Support Center 1997, *Description of Sinai*, IDSC, Cairo.

Central Agency for Public Mobilization and Statistics 2008, *Final results of general census*, CAPMAS, Cairo.

Cleaver, KM & Schreiber, GA 1994, *Reversing the spiral*: *the population*, *agriculture, and environment nexus in Sub-Saharan Africa*, World Bank, Washington DC.

Daily, GC, Matson, PA & Vitousek, PM 1997, 'Ecosystem services supplied by soils', in GC Daily (ed.), *Nature's services: societal dependence on natural ecosystems*, Island Press, Washington DC.

Dames & Moore International 1985, *Sinai development study phase I final report*, Ministry of New Communities, Reconstruction and Development, Cairo.

Duffyn, P 1966, *Maghara coal project: report on reserves and relevant geology*, General Organisation for Industrialisation, Cairo.

Durning, AB 1989, *Poverty and the environment: reversing the downward spiral*, Worldwatch paper no. 92, Worldwatch Institute, Washington DC.

Ekborn A & Bojo, J 1999, *Poverty and environment: evidence of links and integration in the country assistance strategy process*, Africa region discussion paper no. 4, World Bank, Washington DC.

Farnsworth, NR & Soejarto, DD, 1991, 'Global importance of medicinal plants', in O Akerele, VH Heywood & H Synge (eds.), *The conservation of medicinal plants,* Cambridge University Press, New York.

Khaled, AA 2000, 'Geophysical study to determine the impact of structural elements on the groundwater occurrence in El-Maghara area, North Sinai, Egypt', PhD thesis, Faculty of Science, Al Azhar University, Cairo.

Bennett, E & Hassan, RM 2003, Ecosystems and human well being: a framework for assessment, Island Press, Washington DC.

Capistrano, D (ed.) 2005, Ecosystems and human well being volume 4: multiscale assessments, Island Press, Washington DC.

Migahid, AM, El-Shafei, AM & Abdel-Rahman, AA 1959, 'Ecological observation in the western and southern Sinai', Bull. *Soc. Geogr. Egypt*, vol. 32, pp.105-165

Egypt well evaluation conference Egypt 1995, Schlumberger.

Shata, A 1956, 'The Jurassic of Egypt', *Bull. de Inst. Desert*, vol. 1, no. 2, pp.68-73

Geological Survey of Egypt 1963, Report on Maghara coal deposits, GSE, Cairo.

Pinter, L, Zehdi, K & Cressman, D 1999, *Capacity building for integrated environmental assessment and reporting: training manual*, UNEP & IISD, New York

United Nations Environment Program 1999, *Global environment outlook*, Earthscan Publications, London.

World Bank 2007, 3rd international expert meeting on the 10 year framework of programmes on SCP (Marrakech process) background paper 2, Stockholm

World Commission on Environment and Development 1987, *Our common future*, Oxford University Press, Oxford.

Chapter 1




Assessment Methods

Lead Author

Mohamed Tawfic Ahmed

Contributing Authors

Ahmed Abdelrehim
Ali Amasha
Mohamed O. Arnous
Khairy El Ashry
Hamdy El Sharabasy
Mohamed El Tabie
Mayar Sabet

Main Messages

The sub-global assessments, of which this volume is one, a basic component of the MA initiative. They vary in their scale between community - based, national and regional. However, their aim is to meet the needs of users in the communities, countries or regions in which they were undertaken. Egypt's sub-global assessment, a part of the Arab Millennium Ecosystem Assessment, is a community-based assessment, conducted in the El Maghara area, North Sinai. A main objective of the assessment is to capture real life experience of changes in ecosystems and human well-being. The inhabitants of El Maghara area are among the poorest and least served in Sinai, and probably in Egypt. El Maghara also remains as one area in the whole of Sinai where pristine Bedouin culture and practices prevail.

The area where the assessment was conducted has been exposed to severe environmental degradation and loss of natural resources. The area also lacks basic social, health, and other services.

A key factor in the selection of El Maghara as the study area was to shed some light on the significant problems of the area and to highlight the magnitude of environmental damage and people's needs. The assessment was meant to show decision-makers the extent of degradation and the magnitude of poverty prevailing in the area. The goal was to assess the ecosystem in El Maghara and to examine management options for promoting sustainable development, maintaining environmental integrity, and improving Bedouin quality of life. Toward that end, the assessment:

- established baseline information against which future changes to the ecosystem could be measured, and
- assessed current policies and management practices for sustainable management of the ecosystem in El Maghara.

A variety of field and laboratory techniques were used in the assessment, with special emphases on Geographic Information System (GIS) and Remote Sensing (RS). Meanwhile a number of indicators were used to monitor changes in the ecosystem

1.1 The Selection of the Study Area

The selection of El Maghara as the assessment site was based on a number of factors. The area embraces a number of biodiversity-rich and special ecosystems that undergo changes and transitions that affect the environmental integrity and the well-being of the inhabitants.

El Maghara is considered one of the most important floral centres for medicinal plants in the Middle East. Sixty-one percent of its flora is considered medicinal (Abd El-Wahab et al. 2004; Farnsworth and Soejarto 1991). In addition, it represents an important area of anthropological value due to the presence of a number of Bedouin tribes that each has unique traditional knowledge. An appreciation of biodiversity and the importance of each and every living organism is deeply rooted in Bedouin culture.

The inhabitants of El Maghara area are among the poorest in Sinai. This hardship has limited the migration of non-Bedouin to the area and has also limited the sweeping urbanisation that has sprawled over other parts of Sinai. El- Maghara remains as one area in the whole of Sinai where pristine Bedouin culture and practices prevail.

In El Maghara, extractive industries, especially coal, gravel, and marble, have inflicted a harsh impact on the environment, manifested in heavy pollution, resource depletion, habitat fragmentation, and biodiversity losses.

Sheikh Hemid Wood, a unique environmental asset in the area, is grossly mismanaged, with trees and terrain being excessively degraded because of irrational stone and gravel extraction. The El Maghara coal mine has also had a heavy impact on the area, causing serious land and water contamination and solid waste problems. The area's high environmental degradation is a key factor underlying the high poverty level of local Bedouin.

The remoteness and isolation of the area has also made it very difficult for key decision-makers to understand the magnitude of damage in the area. It also makes it even harder for the people of El Maghara to convey their message to decision-makers. One of the main objectives of the El Maghara assessment was to draw decision-makers' attention to the magnitude of damage in the area, and to provide them with some new leads for better, more rational management of the area's natural stocks.

Crossing the Suez Canal is the first step to reach El Maghara
Source: Mohamed Tawfic

Landscape of El Maghara, a general view, with Gebel El Maghara in the background
Source: Mohamed Tawfic

1.1.1 The Geo-morphology of El Maghara

The northern sub-region of Sinai (8,000 km^2, about 13 per cent of the total area of Sinai), (Figure 1.1), where El Maghara is located, consists of a wide plain sloping gradually northwards. It narrows in the east because of the presence of Gebel Maghara. There are sand dunes extending for several kilometres landward in this wide plain, forming a continuous series parallel to the Mediterranean Sea. The sand dune near Maghara mountain extends from southwest to northeast, perhaps because of the influence of the mountains (Abu Al-Izz 1971). (Figure1.2)

El Maghara lies between longitudes 33° 10' and 33° 40' E and latitudes 30° 35' and 30° 50' N. It lies about 182 km to the northeast of El-Ismailia and 120 km to the southwest of El Arish. The area has an elevation rate, ranging from 200 - 650 meter, a.s.l (Figure 1.3). El Maghara region is of interest to many authors who have conducted studies dealing with the area's geology, hydrogeology, and geophysical features (Khaled 2000). Shata (1956) measured the Jurassic section of El Maghara as about 2,000 metres thick. Schlumberger (1984) subdivided the Jurassic rocks around El Maghara into six formations. The micro-faunal assemblages of the Jurassic rocks were investigated by Bircher (1940), who noticed that the Jurassic fauna of El Maghara corresponds to those of the Middle European province.

Since the first discovery of coal in El Maghara in April 1959, various attempts have been made to investigate this important energy source. The Geological Survey of Egypt (1963) drilled 91 boreholes in an area of about 30 km^2 around El Maghara. Laboratory examinations of the coal of El Maghara were made by Duffryn (1966).

Al-Far (1966) measured the section below the cretaceous around Shushet El Maghara and subdivided it, on a lithological basis, into six alternating continental and marine formations. He indicated also that the Safa formation is the main coal-bearing horizon of economic potentialities. Abdel-Khalek (1973) studied the petrographic characteristics of El Maghara coal to evaluate its economic potential. Abd El-Hak (1987) studied the petrography and lithostratigraphy of the Safa formation in Wadi El Rakeb in the El Maghara area. He subdivided the Safa formation, on a

Figure 1.1. A regional map showing where the assessment was conducted
Source: Nasa-Modis, February, 29, 2000

lithological and geochemical basis, into a lower Rakeb coal member and an upper calcareous elastic member. Dominant land cover in El Maghara area is sand dunes, north of the main road, while the southern area is predominantly drainage and mountainous landscape, with scattered settlements (Figure 1.4).

1.1.2 Climate of El Maghara

El Maghara area is characterised by an arid climate; hot and dry in summer, cold with rare rainfall in winter. The mean annual temperature is 20°C and the relative humidity is 47 per cent. The mean annual rainfall is about 50 mm. This amount of rainfall lies in the middle of the rainfall resources of North and Central Sinai, which ranges from 15 mm at Nekhel to 150 mm at Rafah. (Migahid et al., 1959).

El Maghara anticlines are characterised by a high evaporation rate (9 mm/day), which plays an important role in soil and rock enrichment with an important source of water, the dew in the first hours of the morning. Large areas of limestone slopes characterised by rocky outcrops are covered mainly by different types of lichens that depend mainly on dew as a major source of water.

1.2 Assessment Users

The anticipated users of the assessment were identified in a workshop attended by representatives of user groups. The identification and engagement of various users were further investigated through field visits and meetings with stakeholders. The process identified the following users.

1.2.1 The Bedouin Community

Bedouin are the main inhabitants of Sinai and the focal group of the present assessment. Bedouin need the assessment findings for many reasons, but particularly because of their need for sound ecosystem services to help address their needs for food, water, shelter, and security.

Addressing these needs in turn requires a sound and caring governing body that provides understanding, logistical support and commitment to alleviate their immense suffering and social injustice. This assessment is a sort of fact sheet that documents the state of the Bedouin.

1.2.2 North Sinai Governorate

North Sinai governorate is a focal stakeholder, with direct involvement in this assessment. It represents the official and logistic reference in all activities, services and civic affairs of El Maghara. Enforcement of the law and observing sound environmental conduct is embedded in governance dedication and efforts to stop industry violations of sustainability codes, protecting the environment and providing due care to the Bedouin. The assessment represented a close reflection of what El Maghara conditions are like, so remedial action could be contemplated.

1.2.3 Department of the Environment and Environmentalists

El Maghara embraces some of the most distinguished environmental assets in Sinai and Egypt at large. The momentous collection of floral diversity, terrain landscapes, and historical sites are among the most renowned. The Department of the Environment, along with environmentalists, are potential stakeholders. Their role in including the El Maghara area in their future conservation and maintenance plans is crucial. The Department of the Environment, along with the Governorate of North Sinai, should bear the responsibility for rescuing El Maghara from the unprecedented damage that industry, inferior service and remoteness have inflicted on the area.

1.2.4 Department of Tourism

The involvement of the Department of Tourism in the present assessment stems from its direct responsibility for rescuing the unique tourist assets tarnished by waves of negligence. Tourism is a potential source of revenue to boost the economics of the area and improve the quality of life of the Bedouin in El Maghara. The numerous wadis and exotic terrains are most appealing assets that can support a flourishing safari business and tourism industry if given a proper outlet. Additionally, the Bedouin's special culture, handicrafts and pattern of life are major attractions for both national and international tourists, environmentalists and other visitors whose frequent visits and activities can help the area thrive economically and socially.

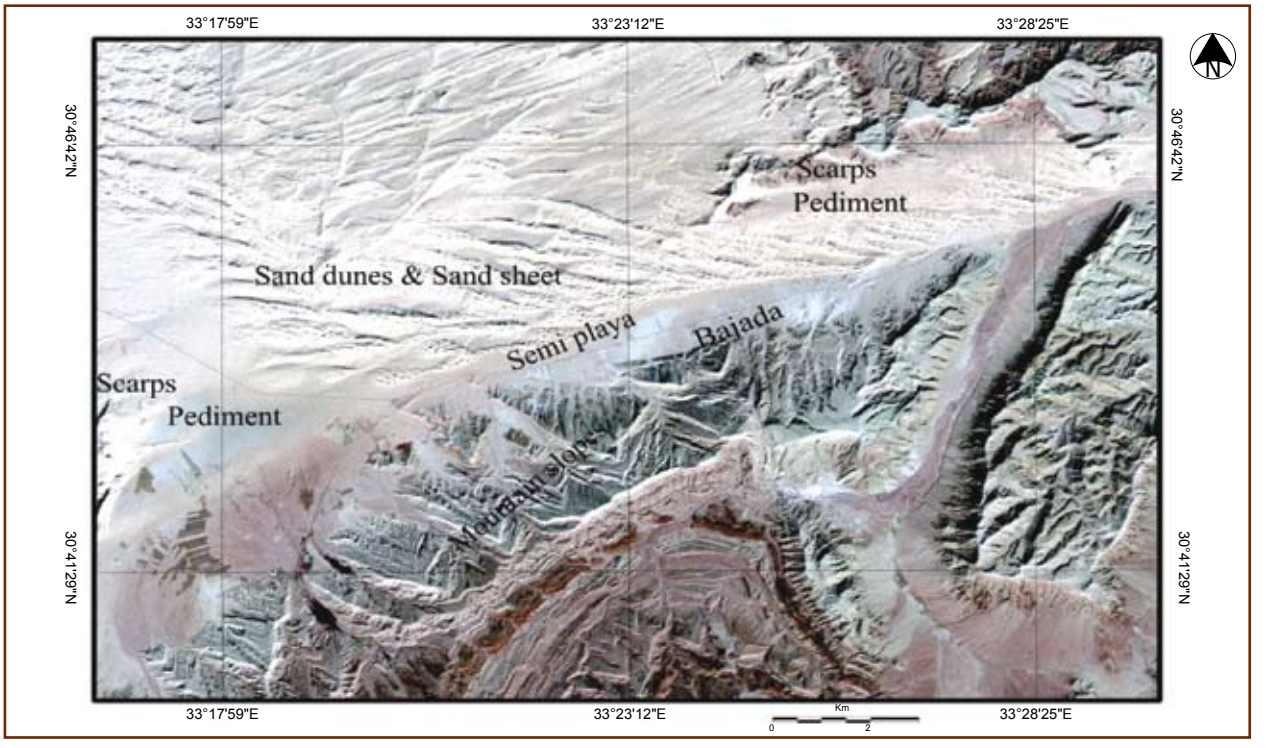


Figure 1.2. Satellite image of El Maghara area showing main geo-morphological units

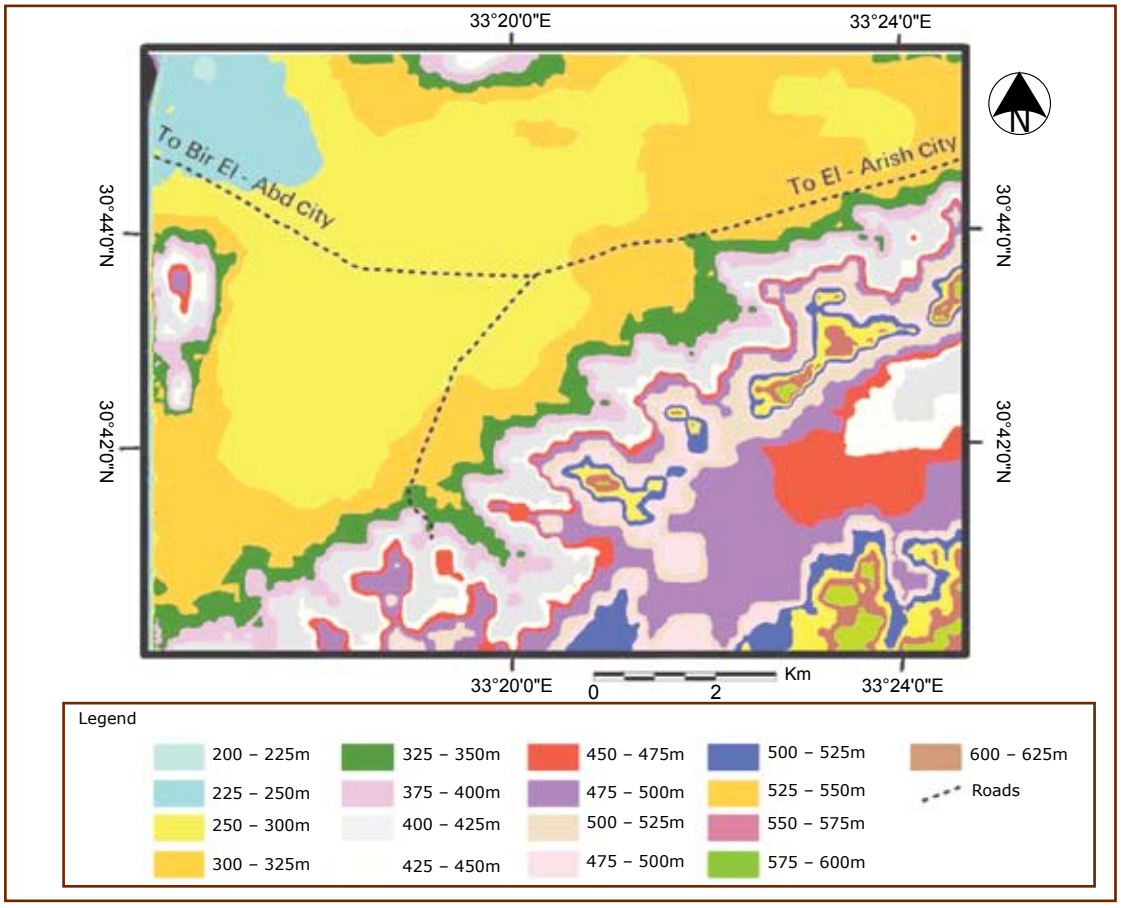


Figure 1.3. Digital elevation model (DEM) of El Maghara area

The Department of Tourism is one of the guardians of the heritage of the Bedouin communities, their local knowledge, and its application in various fields.

1.2.5 Department of Agriculture

Agriculture is the main activity of most of the Bedouin in the study area. Thus the involvement of the Department of Agriculture is an important way of improving agricultural conditions, with the main tasks including promotion of agro-diversity, improvement of medicinal plant production and embedding good water management programmes.

1.2.6 Department of Water Resources and Irrigation, DWRI

A central mandate of the Department of Water Resources and Irrigation is to supply the area with water for people's domestic use and also for agriculture. Most of the deep wells in the area belong to the DWRI, especially their operation, monitoring and maintenance. To make optimum use of flashfloods, the DWRI is also constructing small dams, located to harvest the floods for eventual use and also to protect cities and populations from the risks of flashfloods. The study area embraces El Karma dam, built by the Department of Water Resources and Irrigation to supply the Bedouin with water and also for seasonal irrigation and to recharge ground water.

1.2.7 Suez Canal University

Suez Canal University is the scientific organisation running the assessment project. Fostering development and prosperity in Sinai is a major objective of Suez Canal University, which is also oriented more than most to community service and environmental studies. The university's facilities in Sinai include: a) an environmental research station in South Sinai (St. Katherine); b) an environmental agriculture faculty in North Sinai (El Arish); and c) a marine science research station at Sharm El Sheikh.

1.2.8 User Needs and Interests

Against a background of increasing human and natural pressures, the Sinai Peninsula in general, and the selected sites in particular, need sound management in order to conserve and protect the ecosystem and improve the quality of life of the local inhabitants. There is an imminent need to address both the decision-makers and the inhabitants of Sinai in order to establish the essence of sustainability at all levels to reverse the current trend of environmental degradation. Equally important is the need to establish the dynamic linkage between the ability of an ecosystem to provide services and the sustainability of agricultural production and people's livelihoods.

However, within the tangled web of interests in any society, including El Maghara, needs vary depending on the angle through which the issue is examined. Nevertheless, the Bedouin, the main group of stakeholders, may be looked at as the main users of the assessment, and their needs are probably the most legitimate to address.

These needs would entail the ability of the ecosystem to provide the services used to support Bedouin life, and to help them cope with the remoteness and isolation that taint their life. With plant biodiversity as the main asset of the area and the main repository of food supplements and other services, their needs include identifying disappearing species of fauna and flora in the study site, exploring the reasons behind their disappearance and learning how to maintain the biodiversity of the areas being studied.

The need for raising awareness among the Bedouin seems evident in order to help restore threatened species and overcome water scarcity and other impacts caused by the major drivers. At the same time, decision-makers should be informed about the consequences of development and its impact on environmental quality and

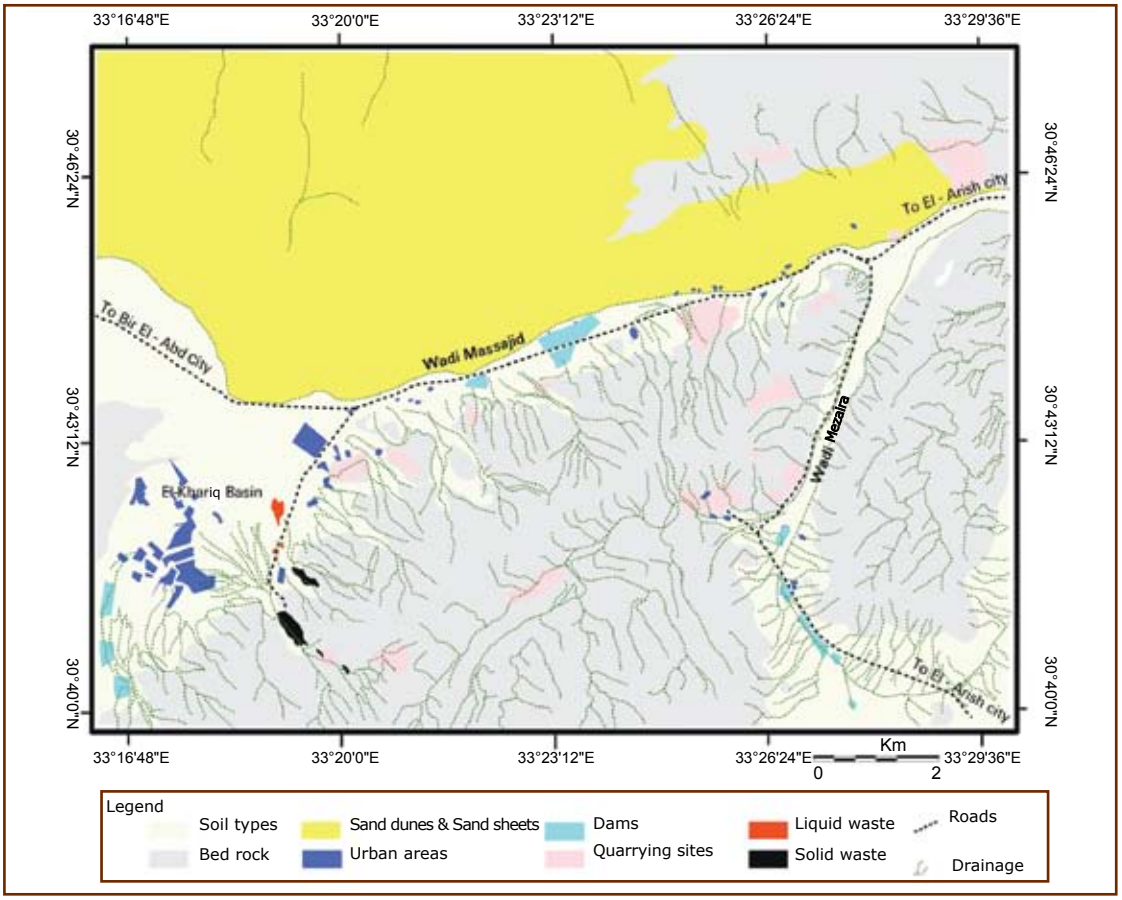


Figure 1.4. Land use / land cover map of El Maghara area

Bedouin of El Maghara during a Meeting
Source: Mohamed Tawfic

human well-being. Local knowledge seems to be on the retreat as the young generation expresses little interest in learning from the elder clan members. The loss of local knowledge could have significant repercussions on the Bedouin community and there is an urgent need to keep the flow of this knowledge within the community.

1.2 Assessment Objectives

A major aim of the study was to assess the ecosystem in El Maghara and examine management options for empowering sustainable development, maintaining environmental integrity and improving the Bedouin's quality of life. Towards that end, the assessment:

- established baseline information against which future changes to the ecosystem could be measured.
- assessed current policies and management practices for sustainable management of the ecosystem in El Maghara
- promoted partnership and participation among the local communities, the scientific community, non-governmental organisations and development agencies in the management, protection and conservation of the ecosystem; promoted the concepts of sustainability, agro-diversity and the role of stakeholders in managing environmental issues; helped in alleviating poverty by providing some technical help and infrastructure
- identified major drivers of ecosystem change, areas of environmental deterioration, and how to implement restoration methods
- introduced alternative policies and strategies at the local level that would ensure sound management to achieve sustainable development; adopted and refined a model methodology for ecosystem assessment that could be transferred and applied in different parts of Egypt and the Arab region.

1.3 Assessment Methodology

As a community-based assessment, a central feature of the El Maghara assessment is to give a genuine depiction of real life as well as to give information about existing management systems for obtaining ecosystem services and the role played by the community. The Sinai sub-global assessment was performed by a team of 50 scientists, with a wide and diverse set of interests and specialisations coming from various institutes and scientific bodies.

The assessment was led by Suez Canal University, with contributions from a number of institutes

A Bedouin community in the vicinity of the study area
Source: Mohamed Tawfic

that included, but were not limited to: Cairo University, El Menoufia University, El Mansoura University, the Centre for Environment and Development for the Arab Region and Europe (CEDARE), the Center for Future Research, the Cabinet Information and Decision Support Center (IDSC), the Ministry of Energy, the Ministry of Water Resources and Irrigation and the Desert Research Centre.

The Sinai sub-global assessment followed the MA conceptual framework, focusing on major ecosystem services.

Current conditions and historical trends of natural ecosystems in the assessment area are further highlighted with their capacity to provide services. Special emphases were laid on major services in the assessment area, namely floral diversity and the provision of water and minerals.

The primary (underlying) drivers and the proximate (pressure) drivers of ecosystem change in the assessment area were identified with their assessed impact. A detailed study of scenarios and how plausible futures may unfold were examined in the course of the study. Four scenarios were produced using different methods and simulation programs.

1.3.1 Use of Indicators

A number of indicators were used to illustrate the conditions of some of these services and to depict changes and variations caused by drivers. Floral diversity and contamination with heavy metals were used as indicators of land degradation and land contamination. Heavy metal concentrations and microbial count were also used as indicators of the impact of environmental and man-made factors on the quality of drinking water.

1.3.2 Techniques for Assessing Ecosystems

A number of techniques were used throughout the study including laboratory techniques and field observation techniques. The use of Geographic Information Systems (GIS) and remote sensing tools were particularly useful in detecting changes in land use (man made), and land cover (natural). Remote sensing and GIS technologies are tools that facilitate the investigation and monitoring of ecosystem changes leading to a better understanding of the natural and human impacts on El Maghara ecosystems.

Applying these techniques to monitoring characteristic features of the El Maghara landscape

on different dates and in different years provided ample land cover information. By comparing enhanced satellite images of the study area in years 1986 and 2000, the land cover showed change caused by either human activities or changes made naturally. Several steps and procedures were implemented to set up the geographical database. Some of them are:

- image processing of the satellite data and geometrical corrections
- geographic positioning validation of reference points using GPS
- field verification of enhanced satellite images
- map digitization converting raster and analogue data into a digital format (layers)
- design of a coordinate grid pattern for sample representation
- manipulation and integration of data coverage layers.

1.3.3 Grid Representation

In the present study, an elemental step was to design an approximate square grid network for the El Maghara area. Every point is defined by its x, y, and z geographic coordinate values. This grid cell network gives a precise representation of its ground surface information. The chosen square grid pattern of the El Maghara area is used with 0.5 longitudinal and 0.5 latitudinal minute intervals. Various layers of thematic data coverage are prepared for the area under investigation in a digital format to be easily manipulated by GIS programs.

Bedouin of El Maghara
Source: Mohamed Tawfic

1.3.4 Techniques for Socioeconomic Studies

The socioeconomic profile of the Bedouin in the assessment area was studied through extensive meetings and interviews with many of the local community. Regular visits were made, during which the assessment team mingled with the locals in order to build a basis of trust and confidence and to allow the smooth flow of information. The socioeconomic survey was preceded by medical screening and counseling of a large number of the community.

Box 1.1 Ecosystem, Natural Resources, and Social Fabric Development in Sinai

For some time, development of the desert areas of Egypt was almost ignored or at least had low priority in national planning. A good appreciation and understanding of natural resources and the socioeconomic fabrics that prevail in these areas was missing. Several reasons account for the low priority profile of the desert ecosystem. A deeply held belief associating the desert with risk, uncertainty and hardship, has halted the process of building a scientific base for that arid ecosystem. Inhabitants of desert areas in Egypt have always maintained a different lifestyle that distinguishes them from the rest of Egypt.

Being of different ethnic and cultural background, the Bedouin have always felt a different identity. On the other hand, the political turmoil that engulfed Sinai for many years had its negative impact on development work and the stewardship of resources. The concept of sustainability is fairly new in Egypt, especially at district and governorate levels where a full comprehension of the trajectory that sustainability leads to is in its infancy. As a result, a gap still remains in addressing ecological and socioeconomic problems at district level. In Egypt, there is a growing need for an integrated cross-sectoral approach to reconciling apparent conflicts that alienate those living in the desert. The emerging issues of sustainable development and poverty alleviation may provide this reconciliation.

El Maghara coal mine, a landmark of the assessment area
Source: Mohamed Tawfic

Being cut off and isolated from the rest of the country, the Bedouin have developed cautious feelings about strangers who come to their areas and would always suspect their intentions. For this reason, efforts were made to bridge the gap between the assessment team and the local inhabitants of the area. Medicine, biscuits and other items were often offered during the visit.

1.3.5 Introducing the Questionnaires to Local Bedouin in El Zawadin Community

Three questionnaires were produced and used throughout the study to map out the socioeconomic profile of the population in the assessment site. A group of assessment team experts with diverse backgrounds that included medical care, psychology, sociology, economics, and environmental science were involved in producing the questionnaires and analysing them.

The first questionnaire was designed to examine the ability of the Bedouin sample to respond and communicate with the team. It was also meant to pave the way to discover other issues to be discussed in subsequent questionnaires. Because the vast majority of the Bedouin were illiterate, the study team completing the questionnaire had to interview each person individually, explaining the question if necessary before writing down the information. Female team members were involved in conferring with Bedouin females, who constituted about one third of the sample. The first questionnaire dealt with basic life activities and the generic social issues of the community, as it was meant to establish a mutual relationship between the study team and the Bedouin. The questionnaires that followed were more structured and targeted to ascertain more subtle and indirect information such as the quality of life, environmental awareness, local knowledge, and the role of medicinal plants in Bedouin life. A large part of the interview process was incorporated into a medical examination so that Bedouin would be encouraged to talk and express their views.

1.3.6 Sample Size

Questionnaires were completed with about 100 people (69 men and 29 women) from the various small villages and sub-villages in the assessment area.

1.3.7 Elders as a Source of Information

Elders in the El Maghara community represented a reliable source of information on a variety of topics, especially those related to local knowledge and the use of medicinal plants and floral and faunal species. Women are good sources of information about the floral species since they obtain this experience when grazing the animals, a job done by girls in the Bedouin community. Elder women are also more familiar with the use of medicinal plants in the management of childhood diseases (although the medical doctor on the assessment team noted that some of these practices are not necessarily useful and may even aggravate the situation). The elderly are also the main source of local knowledge and its application to the various walks of life, including water management and crisis management during the hardships of wars and political conflicts.

1.4 The Socioeconomic Profile of El Maghara Bedouin

Sinai is principally inhabited by Bedouin communities whose ethnic composition is one of the striking features of the Sinai area. The Bedouin in Sinai constitute 75 per cent of the total Bedouin in Egypt. The ethnicity of the Sinai

population differs conspicuously from the south to the north, with some fundamentally distinguishing features. The Bedouin of Sinai belong to seven tribes and each tribe controls a different part of the Peninsula. Tribes are made up of a number of clans, which include a family up to the fifth generation. The tribal sheikhs or heads make all the important decisions regarding tribal affairs.

The tribe is considered a social structural unit of rural nomadic society (Bedouin community) that has the same social, cultural, economic, and psychological characteristics. While the majority of Sinai's inhabitants are of Bedouin descent, their status has changed to urban dwellers with increasing urbanisation and settlement. Sub-regional differences in the Bedouin population reflect both the proximity to the rest of Egypt and the urban build up of the sub-region.

The Upland sub-region, where the assessment was performed, is the most remote area of Sinai. It remains remote, with sand dunes and rock formations covering nearly 42 per cent of Sinai. It is the least populated area, containing only 11 per cent of the population of Sinai. The sub-region is characterised by high out-migration by young males seeking employment. Average family size is the lowest in Sinai reflecting out-migration by young males and delayed marriage. Because of the prevailing poverty and harsh conditions, the Bedouin in the Upland have the highest illiteracy rate in Sinai. Their clothing and practices are typical of traditional Bedouin.

The dispersion of the Bedouin population is dictated by their primary occupation, which is livestock grazing and agriculture. Bedouin live in tents or temporary shelters made from palm tree leaves or other plant fibres; however, some have been settling in permanent houses of concrete block structures.

Customary law is the Bedouin's unwritten law that has been developed over many years by the tribes. It is highly developed and has a complex structure mostly based around the Muslim Shari'a.

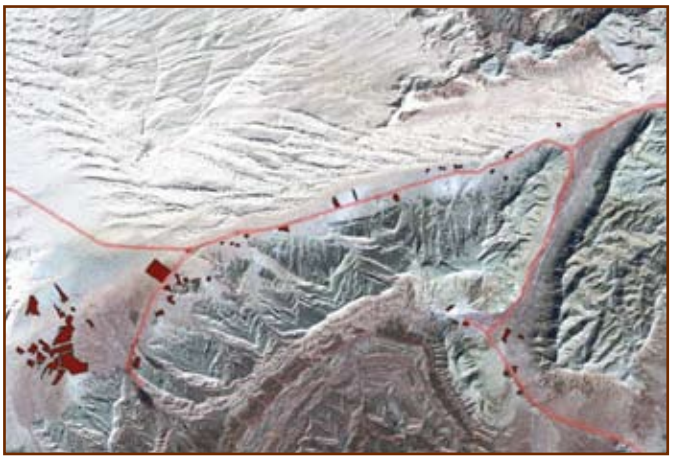


Figure 1.5 Populated areas around El Maghara (coloured in pink)

1.4.1 Poverty in El Maghara Area

Poverty in El Maghara is partially an environmentally caused phenomenon. Throughout history, nature has provided the primary sources for Bedouin nourishment and well-being through the wealth of floral and faunal diversity. Ecosystem services in El Maghara are a core component of human well-being and survival. Diversity in ecosystems is an important factor in reducing communities' vulnerability, as it buffers people against shocks and surprises such as climatic and economic fluctuations. It may be contended that land degradation, lack of precipitation, and other man-made environmental impacts have had profound effects on natural resources.

It is argued that poverty in El Maghara is not restricted to the economic dimension but goes far beyond, to include lack of access to schools, clean water and social services. Lack of good governance, at a local level, and the massive change in land-use patterns have caused irreparable damage to a number of environmental attributes, with a strong bearing on the quality of Bedouin life: water resources have been polluted, land has been degraded, floral and faunal species have been disappearing and some alien species have emerged causing considerable damage. Some of the unique biodiversity features were mismanaged or destroyed through irrational human activities such as quarrying, etc.

Sheikh Elyan, a major source of information
Source: Mohamed Tawfic

A key factor in the selection of El Maghara as the study area was to shed some light on the significant problems of the area and to highlight the magnitude of environmental damage and people's needs. The assessment was meant to help decision-makers understand the extent of degradation and the magnitude of poverty prevailing in the area.

1.4.2 The District of El Maghara

El Maghara region, one of the administrative districts of El Hassana Centre, is located 160 km from El-Arish city and has a total area of 24 km^2. It comprises several villages, including El-Mangam, El Maghara and Al-Masaged village (Figure 1.5). El-Mangam village consists of two communities: El-Zawadin with a total population of 1,000 and Sheikh Hemid with a population of 500. El Maghara village consists of Minaisie and Al-Hireg communities with a total population of 1,000. El Maghara area has the highest percentage of Bedouin in all areas of Sinai, with almost no inward migration by outsiders. It also has the highest rate of aged, dependent Bedouin. Bedouin in the area have the highest illiteracy rate in Sinai (Dames and Moore 1985).

1.4.3 Basic Demographic Features

The Bedouin population in the two centres of Central Sinai, namely El Hassana and Nekhl, is in the range of 25,000, including 13,800 in El Hassana, 11,000 in Nekhl (Central Agency for Public Mobilization and Statistics, 2008). El

Grazing, a main activity for women
Source: Mohamed Tawfic

El Maghara school children
Source: Mohamed Tawfic

Hassana Centre has 20 villages and a number of small sub-villages. The average annual population growth is in the range of 1.3 per cent. The ratio of males to females in Central Sinai is 52.6 per cent to 47.4 per cent, respectively. The average family size in El Hassana is about five members, with the highest ratio of persons per one room in North Sinai governorate. (Cabinet Information and Decision Support Centre, North Sinai Governorate 1997).

1.4.4 Income

In El Maghara, according to the survey findings, 34 per cent of families have a monthly income

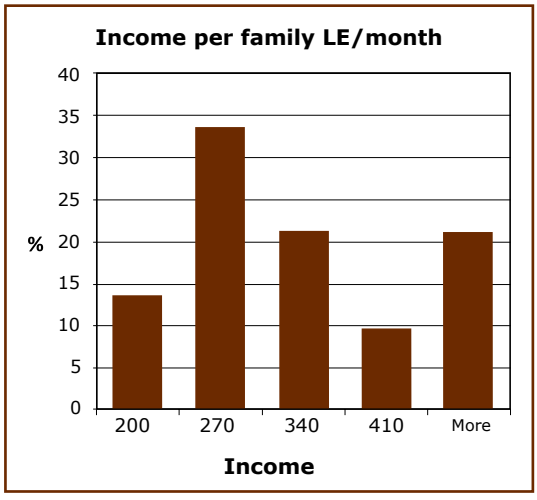


Figure 1.6. Proportion of the El Maghara population at various income levels (LE per month)

Box 1.2 Crisis and People: A Sinai Perspective

Throughout human history, crises have been the hard way for mankind to gain experience, knowledge, endurance and wisdom. Sinai's history is tainted with crises since its very early days. Sinai has witnessed an array of natural as well as man-made crises. Drought is one of the most serious natural crises Sinai has frequently confronted. The toll of drought is profoundly felt in a variety of ways, including social, environmental, economic and household impact. Local knowledge has played a pivotal role in mitigating drought. One of the main mitigation measures is the diversified cropping system that Bedouin adopt to minimise the risk of crop failure. The Bedouin have also developed their own methods of water harvesting that include dikes, small dams, digging contours, and allowing water to collect in holes. A careful study of the flash floods has enabled the Bedouin to predict their routes, taming and diverting the flood path to cover wider, pre-sown areas to provide them with water.

Political conflicts and wars are the most serious man-made crises in Sinai. The bitterness of wars has left the Bedouin with deep scars, but also with a rich experience of self reliance. Being cut off in the middle of endless conflicts, the Bedouin had to build a self-reliance system that would ensure the flows necessary to meet their basic needs. Medicinal plants were their ever-secure drug store, while herbs, shrubs, and trees were their sources of fodder, fuel, raw materials for constructing their homes, and many other things. Camels and goats were their main sources of milk, meat and fibres used not only for clothing but for building shelters and the production of a variety of farming tools. There is no doubt that crises have built the integral part of Bedouin independence and self reliance. But on top of that, crises have ironed out the gaps that tribal structure tended to provoke, and cemented the solidarity of Bedouin society.

Typical Bedouin homes around El Maghara
Source: Mohamed Tawfic

ranging from 200 Egyptian pounds (LE) to less than LE 270, with 21 per cent having an average monthly income ranging between LE 430 and LE 480 (Figure 1.6). The questionnaire showed that the highest proportion of the Bedouin's income (17 per cent) is spent on tea, coffee and sugar. Tea is the Bedouin's favourite beverage and the drink of choice during family gatherings and social events.

1.4.5 Education

In Egypt, primary education is compulsory by law. Parents who fail to send their children to primary school for their basic education are violating the law and are liable to face fines. Though basic education is free, parents have to pay extra for copybooks and other items that a pupil needs. The only preparatory school in the area was built only a few months ago. However, for years, there was no preparatory school in El Maghara and pupils had to travel a long way to the nearest one, which is 20 km away, for their classes. Many parents cannot afford the cost of travel and consider it unsafe for young children to travel on their own. The government has provided boarding opportunities for these pupils to spare them the difficulty of commuting to school every day, but most parents are not inclined to let their children leave home and stay in these dormitories. Very recently, a preparatory school was built in the area. However the Bedouin complain that teachers are hardly present, except for a few hours a day, and for the rest of the day pupils have no classes.

There is a large gap between school attendance by boys and girls, as well as a gap between the

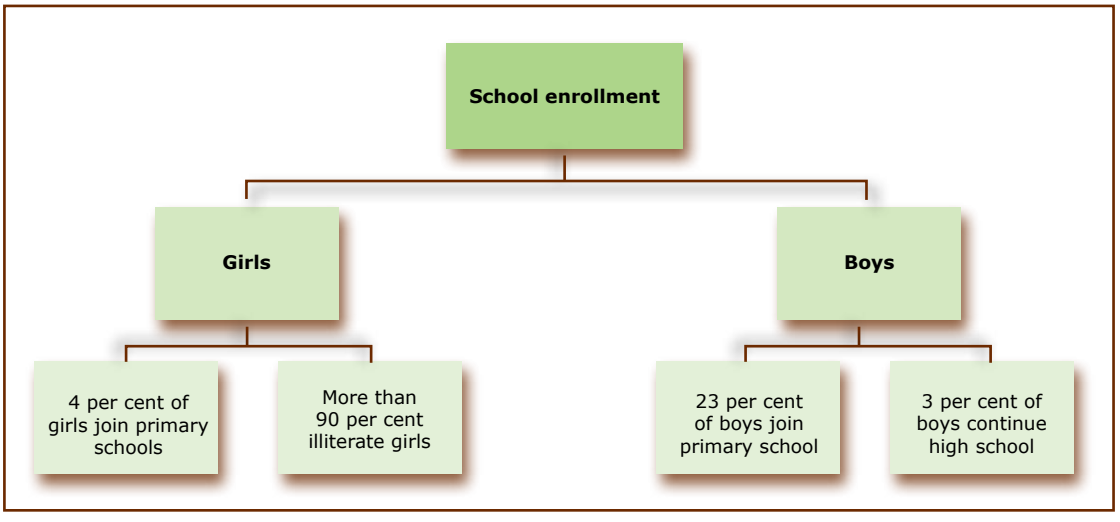


Figure 1.7. School enrollment, El Maghara area

proportion of those who attend primary school and secondary school. 23 per cent of boys attend primary school and only 3 per cent attend high school. 4 per cent of girls attend primary school, but almost all leave school at a very early age for family reasons and because of cultural constraints (Figures 1.7, 1.8). El Hassana district, where El Maghara is located, has the second highest illiteracy rate in Sinai and the second highest rate of school leavers (Central Agency for Public Mobilization and Statistics, 2008).

In the sample studied, 56 per cent of men were illiterate, while 24 per cent could manage to read and write but had no certificate of completion for any stage of education. Only 20 per cent of men had a primary school certificate (Figure 1.8). Among women, 90 per cent were illiterate.

1.4.6 Employment

Unemployment is one of the most chronic issues in Central Sinai, particularly in the El Maghara area. Agriculture and grazing are well established types of employment. With the long-lasting shortage of water, neither of these activities can sustain the same numbers of people it once did.

Grazing, an old and traditional activity, is mostly done by girls and young boys. Older men pass on information about the best places to graze, types of plant, the properties of plants and other relevant information to young girls. The Bedouin had to make new routes to collect flashfloods so it can spread and nourish the vegetation cover, securing grazing potential.

El Maghara coal mine used to employ a number of Bedouin in non-technical jobs. With the closure of the mine, most Bedouin were laid off. Other extractive industries, such as sand and gravel extraction, provide a few jobs for the Bedouin. The scarcity of employment opportunities has compelled many young Bedouin and some Bedouin families to migrate to other parts of Egypt, either on a seasonal or permanent basis.

1.4.7 Health Profile

Frequent visits by the medical members of the assessment team showed that the inferior quality of drinking water is the most influential factor on health. Water quality studies based on samples collected from a number of the wells and dikes used for drinking showed the deteriorating quality of drinking water.

Mining and gravel extraction industries have affected the quality of water in the nearby wells to a serious extent. Levels of heavy metals and pathogenic microorganisms were detected in samples taken at random from some of the widely used wells in the area. Moreover, the quality of flash floods, one of the main sources of drinking water, has been seriously contaminated by heaps of solid waste disposed of in their path.

Bedouin children
Source: Mohamed Tawfic

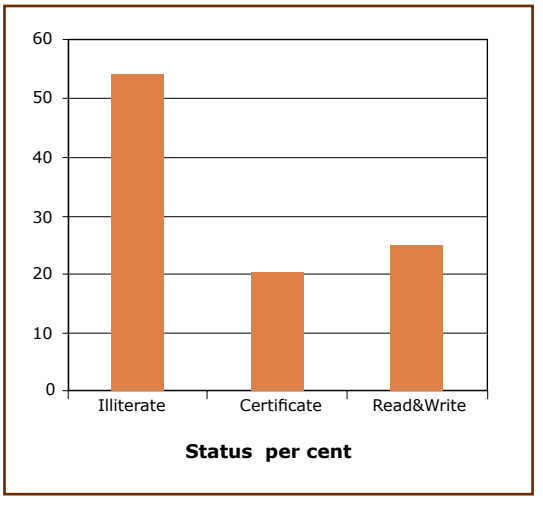


Figure 1.8. Men education status, El Maghara area

Desalinated water, source of drinking in some big villages
Source: Mohamed Tawfic

The medical team visits also revealed the following (Table 1.1):

- for children, the common complaints are mostly protozoa intestinal diseases. The cause of this infection lies in the polluted water and consumption of unwashed fresh vegetables. Sporadic cases of chickenpox were also reported. Lack of simple hygienic care was a common and strongly observed feature that all children had in common.
- women's complaints were mainly due to the excessive consumption of foods with high salt content. Other complaints included epigastria pain due to excessive tea drinking and the high use of fats in food. Some dermal diseases, such as allergies, were due to over-exposure to the sun.
- men's complaints were mainly common colds and hyper-acidity. Older men also suffered from arthritis, a normal complaint for their age.

People around El Maghara generally appear anaemic due to the absence of some basic elements, such as vitamin-rich food. Sporadic cases of pulmonary tuberculosis, bronchitis, gastritis, and urinary tract problems were also reported. However, anaemia was the most common illness reported through the frequent visits. Nonetheless, one of the remarkable features recorded in El Maghara is the very low incidence

Table 1.1. Health Conditions, El Maghara Area

Age Group	Common diseases	Causes
Infants below one year old	The most common disease in this age is eye infections Common cold diseases	Bad hygiene and wrong mothers traditions Lack of medical care Exposure to weather changes Bad housing
Children above 2 years and up to school age	Most of the cases suffe from amoebiasis and other intestinal parasites which need a stool analysis	Bad hygiene
Adult group	Renal colic	Excessive use of fat in cooking Excessive consumption of tea Heavy smoking in case of men Consumption of saline water Hyper acidity

of high blood pressure among the inhabitants, including old people, who in other societies are likely to have high blood pressure levels.

One of the main reasons behind the deteriorating health conditions in El Maghara is the lack of sanitation and a potable water service. El Hassana Centre in general has one of the lowest ratios of population supplied with sanitary service and clean potable water (Central Agency for Public Mobilization and Statistics, 2008).

1.4.8 Transhumance

Central Sinai has been subject to severe drought for the last few years, affecting the grazing capabilities of the area and limiting agricultural activities. As a result, the Bedouin have tended to move, searching for residence where water and rangeland are available. They construct special dikes (harraba) in areas where rain is available. Water is stored in these harraba and the land adjacent to them becomes suitable for growing crops. The Bedouin travel to these areas and settle there temporarily. After harvesting the crop, a Bedouin may travel again, looking for another area or may return to his home area where his family lives. Most of the traveling Bedouin leave their families behind in their main permanent residence. However, traveling Bedouin tend to visit their families on a regular basis at their permanent residence.

1.4.9 Bedouin Alienation and Desperation

A number of factors have contributed to spreading a feeling of alienation and desperation in the community of El Maghara. The inferior infrastructure, difficult terrain, and poor communications have impeded the industrial development of the area and provided low employment potential for the local people. The only industrial development in the area is the exploitation of natural resources, rendering the environmental setting largely disrupted. Public services and utilities such as schools and health care units are poorly and inefficiently run, because of the severe shortage of qualified staff. The Bedouin in the assessment area feel the

Source of drinking water with used containers for storage and transport
Source: Mohamed Tawfic

Desalination facilities supplied by the project
Source: Mohamed Tawfic

disparity in the pace of development and services, compared with other parts of Egypt or Sinai. They are also unhappy about the discrimination they feel they receive from El Maghara coal mine, in comparison to non-Bedouin workers, who come from other parts of the country.

The Bedouin tell, with deep resentment, how the mine provides those workers with health insurance, but not the Bedouin. The mining industry is known to cause some serious diseases and non-Bedouin workers are normally covered

Water supplied by the well donated by the assessment project to local Bedouin
Source: H. El Sharabsi

by a health insurance policy that protects them from occupational diseases.

1.4.10 People's Needs and Aspirations

One of the questionnaires explored the Bedouin's demands and wishes and their priorities. They were asked to list their demands according to their importance and priority. Clean drinking water and the availability of schools were the highest ranked, with 93 per cent of the Bedouin citing these two issues as a top priority. The other most urgent priorities were the availability of irrigation water for agriculture, cited by 83 per cent, and the availability of electricity, cited by 62 per cent (Figure 1.9).

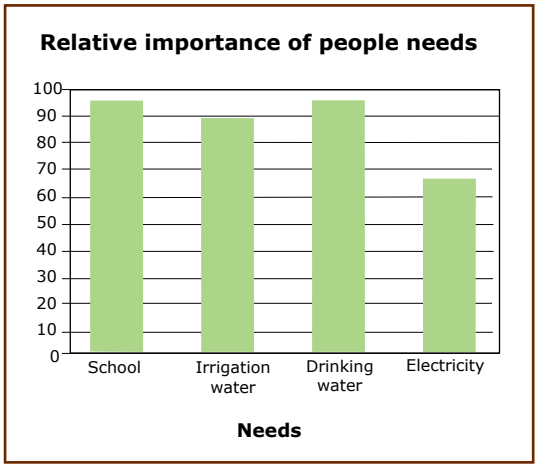


Figure 1.9. People's aspirations and needs in El Maghara area, as indicated by questionnaire

1.4.11 Power Supply

Nowadays electricity is a basic amenity for the quality of human life as well as for economic development. El Hassana Centre has the lowest number of families and people in North Sinai supplied with electricity from the national grid (Central Agency for Public Mobilization and Statistics, 2008).

In El Maghara a generator is installed which operates for several hours, after which no electricity is available. This limited electricity supply to the area casts a negative shadow over the people, their social life, health and welfare. There is no regular power supply in the assessment area and people depend on power generators that only work during certain hours every day providing a limited source of energy.

The government is planning to provide the area with a centralised power supply in the near future and the infrastructure for the grid is being installed. Village power production and distribution systems run by the people need to be developed and regularly upgraded.

This in turn would have a number of fringe benefits, including a reduction in the consumption of wood for fuel. The replacement of traditional wood fuel used by electrical heating systems would also reduce pressure on non-renewable energy sources like kerosene. Fuel wood is the major source of energy in the study area. Firewood demand is met by slashing small bushes and shrubs growing in the area or in areas further from the community that are accessible to women gathering wood. Fuel wood is used mainly for cooking, making tea, and as the only source of heating during winter. Until recently, there was no market for fuel wood for household uses and it was considered a free commodity. In recent years, Bedouin women have begun selling fuel wood on main roads.

1.4.12 Community Service Project in El Maghara

A community service project to provide the people of El Maghara with freshwater was an integral part of the current project. One of the

abandoned wells in the vicinity was refurbished and provided with the infrastructure to pump out enough water for the domestic needs of El Zawadin, the main populated satellite in the El Maghara area. A desalination unit was also provided to turn the brackish water of the well into potable water suitable for drinking, cooking and other domestic use.

References

Abdel Wahab, RH, Zaghloul, MS & Moustafa, AA 2004, 'Conservation of medicinal plants in St Catherine protectorate, South Sinai, Egypt: evaluation of ecological status and human impact', *Proceedings of the first international conference on strategy of Egyptian herbaria*, pp.231-251

Abd El-Hak, M 1987, 'Petrographic and lithostragraphic studies on the Safa formation in El-Rakib area west of Gebel El-Maghara, North Sinai, Egypt', MSc thesis, Faculty of Science, Al Azhar University, Cairo.

Abdel-Khalek, ML 1973, 'Characteristics and utilisation potential of Jurassic coal from Sinai peninsula', *Egypt J. Coal*, vol. 17, no. 1, pp.71-81

Abu Al-Izz, MS 1971, *Landforms of Egypt* (trans. Dr Yusuf A. Fayid), AUC Press, Cairo.

Al-Far, DM 1966, Geology and coal deposits of Gabal El Maghara, North Sinai, Geological Survey of Egypt, no. 37, pp. 1-59

Bircher, W 1940, 'Paleotological report on a collection of Jurassic fossils from the El Maghara area', (CE Thichoud's collection). AEO. Geol. Rep. no. 334, 35p.

Chapter 2




El Maghara Ecosystem Trends, Conditions and Impacts

Lead Authors

Mohamed Tawfic Ahmed
Mohamed O. Arnous
Mohamed A. El Ghawaby
Kamal Ouda Ghodief

Contributing Authors

Raafat Abdelwahab
Mohamed El Shafie
Hamdy El Sharabasy
Mohamed A.A.Hassan
Naglaa Loutfy
Mahmoud Zahran

Main Messages

Focal ecosystem services in El Maghara included in this assessment are the provision of:

- plant products (plant biodiversity)
- water resources
- agriculture and grazing
- mineral resources

El Maghara's ecosystem has undergone some profound changes in land cover and land use patterns that significantly influenced the ability of the system to provide its usual services.

Spatial and temporal change patterns of land use were quantified by interpreting remote sensing (RS) data and using Geographic Information Systems (GIS). Changes in land use between 1986 and 2000 were compared; these changes are illustrated by multi temporal satellite images taken in 1986 and again in 2000.

The satellite images show the magnitude of land use change in El Maghara area; they were also used to classify and study service conditions and trends. Among the findings:

- a massive increase in the area of sand dunes and sand sheets
- introduction of massive quarrying activities, never known before 1986
- generation of a large volume of solid and liquid waste covering a large surface area
- development of a large area of rangelands, mostly with shrubs, for grazing animals
- a substantial decrease in the area covered with naturally grown medicinal plants

In El Maghara, extractive industries, especially coal, gravel and marble, have had a harsh impact on the environment, which is manifested in heavy pollution, resource depletion, habitat fragmentation, and biodiversity losses. Sheikh Hemid Wood, a unique environmental asset of the area, is grossly mismanaged, with trees and terrain being excessively degraded because of irrational stone and gravel extraction. El Maghara coal mine has also impacted heavily on the area, causing serious land and water contamination and solid waste problems. The area's high environmental degradation is a key factor underlying the high poverty level of local Bedouin.

2.1 El Maghara Ecosystem Services, Landscape Pattern, and Land Use Change: A Trend Analysis

In the last few decades, El Maghara's ecosystems have undergone profound changes in land cover and land use patterns that have significantly influenced the ability of the system to provide its usual services. Farmar-Bowers (2003) suggested that most of the land use change in the last two centuries has been done to create "wealth". For centuries wealth creation has aimed at generating products that can be sold, and this puts land into the category of a "producer good" used to produce products that eventually reach the consumer.

In El Maghara, stone- and sand-extraction contractors unlawfully carve new alleys to reach distant stocks without regard for the land use pattern of the area. Very often the newly established alleys intercept the flow of flashfloods and prevent water reaching storage basins made by the Bedouin (Figure 2.1).

Around El Maghara, the spatial and temporal change patterns of land use were quantified by interpreting remote sensing (RS) data and using geographic information systems (GIS). Changes in land use between 1986 and 2000 can be seen by comparing (Figures 2.2 and 2.3). These changes are illustrated by using multi temporal landsat satellite images taken in 1986 (Figure 2.4) and again in 2000 (Figure 2.5). Images were used in this study to classify and study service conditions and trends around El Maghara.

The enhanced landsat satellite images highlight the following changes (Table 2.1).

- a massive increase in the area of sand dunes and sand sheets
- introduction of massive quarrying activities, unknown before 1986
- generation of a large volume of solid and liquid waste covering a large surface area
- development of a large area of rangelands, mostly with shrubs, for grazing animals
- a substantial decrease in the area covered with naturally grown medicinal plants.

In El Maghara area, a variety of anthropogenic (man-made) and natural factors have caused the environmental damage recorded in this study.

New roads unlawfully built by gravel contractors in the El Maghara area prevent water from reaching the collection basin

Source: Mohamed Tawfic

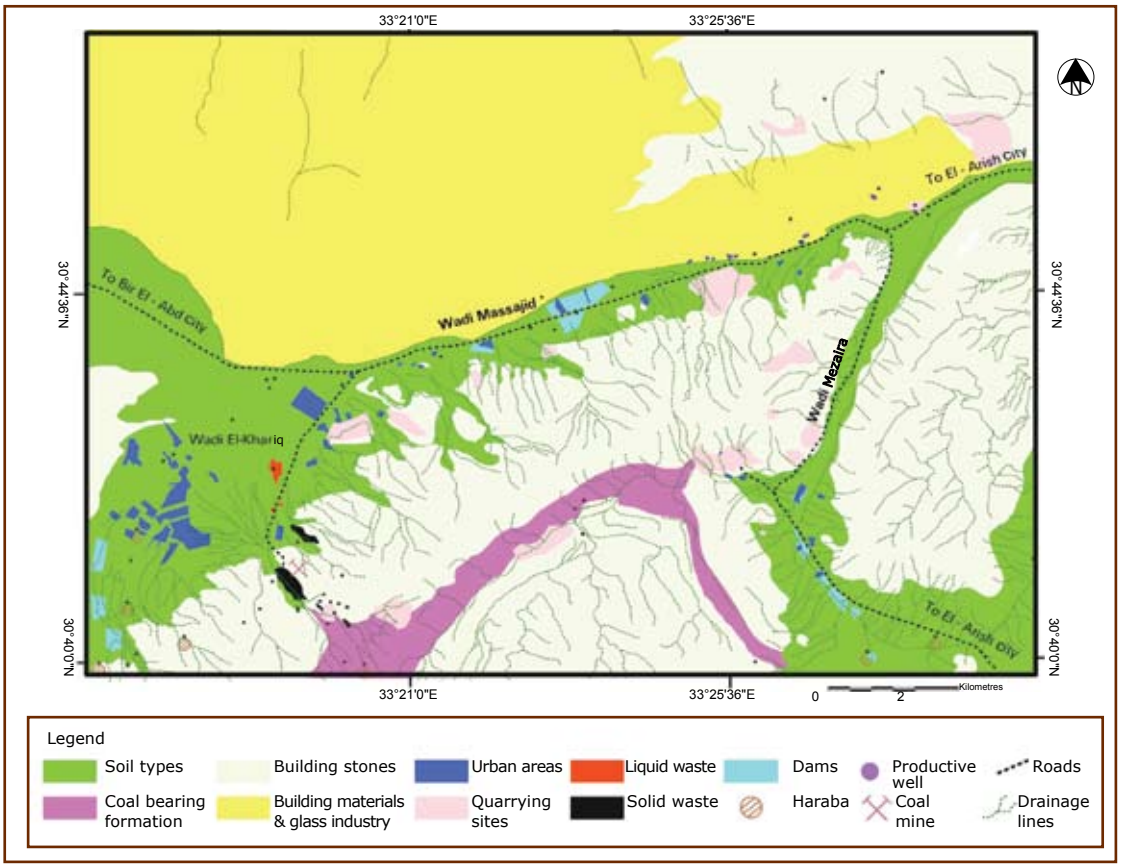


Figure 2.1. Land use / land cover map, El Maghara area, 2007

2.1.1 Root Causes of Environmental Degradation: Anthropogenic Factors

The major anthropogenic causes of environmental degradation are the mining and quarrying industries and land use change due to agriculture, overgrazing, clearing shrubs for fuel wood, and building new roads and alleys for quarrying.

2.1.1.1 El Maghara Coal Mine

El Maghara coal mine is one of the main landmarks of the area. The mine has been operational for about 25 years, during which several million tons of rocks have been extracted. Huge volumes of extracted coal have been left behind, in the vicinity of Bedouin communities, as surface tailings. Waste water effluent, with its content of heavy metal residues, coal particulates, and hydrocarbon constituents, is released and spread over a vast open surface area after the coal dewatering process. In many locations around El Maghara, soil was covered with a black layer of coal and other hydrocarbon residues, turning the soil infertile and leaching into the groundwater, causing substantial pollution.

2.1.1.2 Acid Mine Drainage

Acid mine drainage is mainly produced during mining operations. Rainfall sweeping over the tailing wastes of the mine, along with the dewatering effluent, are other sources of acid mine drainage. The acid formed lowers the pH of the soil. Bodies of water become contaminated with the mine drainage and leachates from the coal dumps, tailings and detritus mounds found scattered all along the landscape of the mining area.

The mine drainage and leachates also contain high concentrations of metals such as iron, copper, cadmium and zinc. Trace elements, namely titanium, rubidium, strontium, zirconium, barium, lead and others, are reported by-products of coal mining activities. The acid and metal ions adversely affect the fertility of soils and, if they

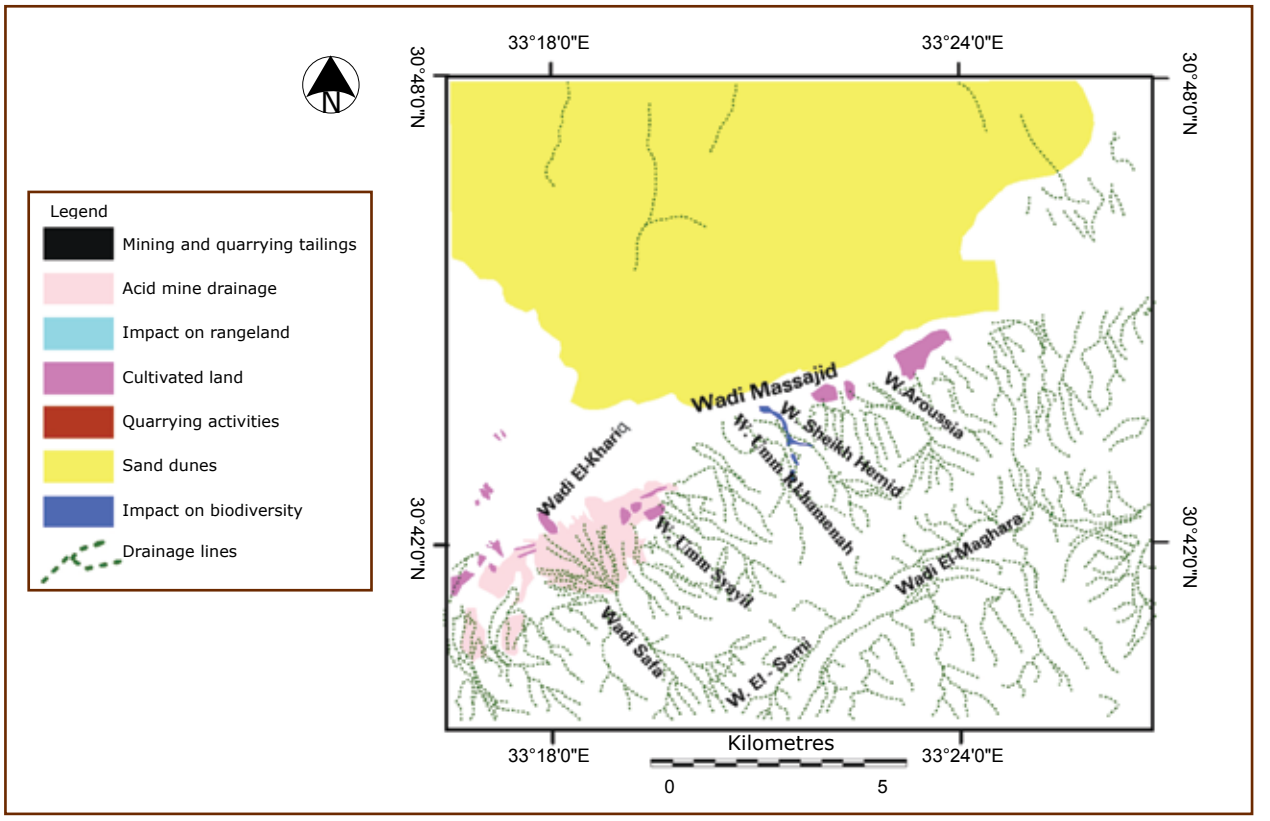


Figure 2.2. Land use pattern in El Maghara area, 1986

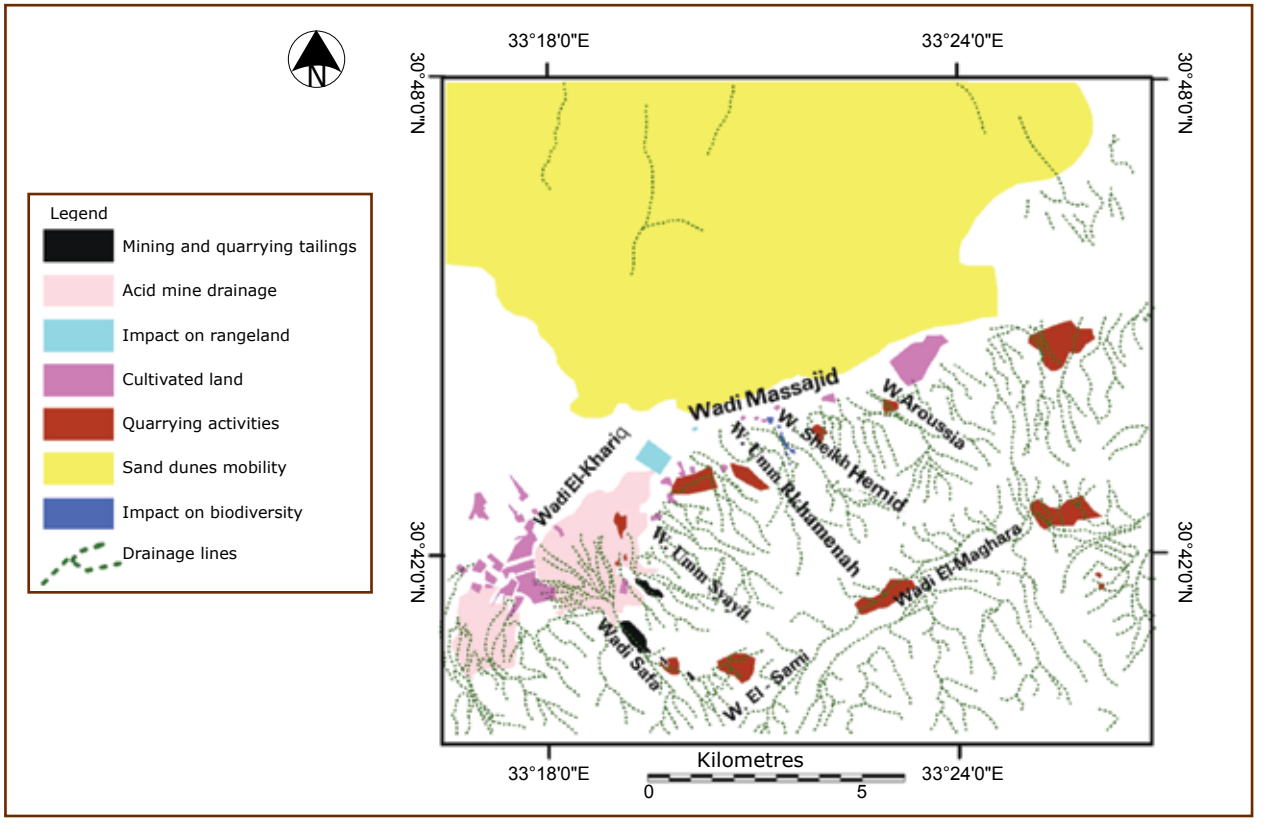


Figure 2.3. Land use pattern in El Maghara area, 2000

Table 2.1. Changes in land use and land use pattern in the study area, 1986–2000

Land Cover Type	Area, 1986 (m^2)	Area, 2000 (m^2)	Avgerage Annual Change (m^2)
Soil cover of different classes	48,794,020	47,631,352	83,047
Exposed bed rock surface	114,390,972	114,390,972	No change
Sand dunes and sand sheets	86,815,008	88,013,304	85,592
Intensive vegetative cover «mostly medicinal plants»	89,703	69,413	1,450
Rangeland, mostly grazing shrubs	Not detected	347,386	Not detected*
Quarrying activities	00	3,677,873	262,705
Crop land	1,716,837	2,650,565	66,700
Mining tailings solid wastes	00	375,119	26,800
Liquid waste	00	122,816	8,772
Contaminated soil	6,670,713	8,413,937	124,516

* Not detected for poor resolution

reach groundwater, can cause serious pollution. Acid mine drainage also impacts on floodwater and wadi ecosystems through acidity, ferric ion precipitation, oxygen depletion, and by increasing the mobility of the heavy metals associated with coal mining. The formation of acid mine drainage can occur long after mines have been abandoned.

2.1.1.3 Quarrying Industries

The Central part of North Sinai is heavily exploited for sand, gravel, and marble extraction. Supplies from the area are considered some of the highest quality in the construction industries in Egypt. Heavy machinery is used to cut stone and marble rocks, followed by further work on grading and polishing stones, with massive amounts of solid waste left behind. Quarrying requires a license issued by the governorate of North Sinai, located at El Arish, the capital of the governorate.Licenses allow a contractor to quarry at particular sites, outside of which quarrying is not allowed. Information collected from the local Bedouin revealed that contractors seldom restrict themselves to the authorised site but tend to cut rocks anywhere, especially in the absence of official supervision and follow up.

2.1.1.4 Agriculture, Overgrazing and Fuel Wood Collection

Agriculture is the main activity of most Bedouin living in El Maghara. The satellite images indicate

Residues of coal and other hydrocarbons covering the land at El Maghara, with the wastewater in the background
Source: Mohamed Tawfic

Residues of coal in soil around El Maghara coal mine
Source: Mohamed Tawfic

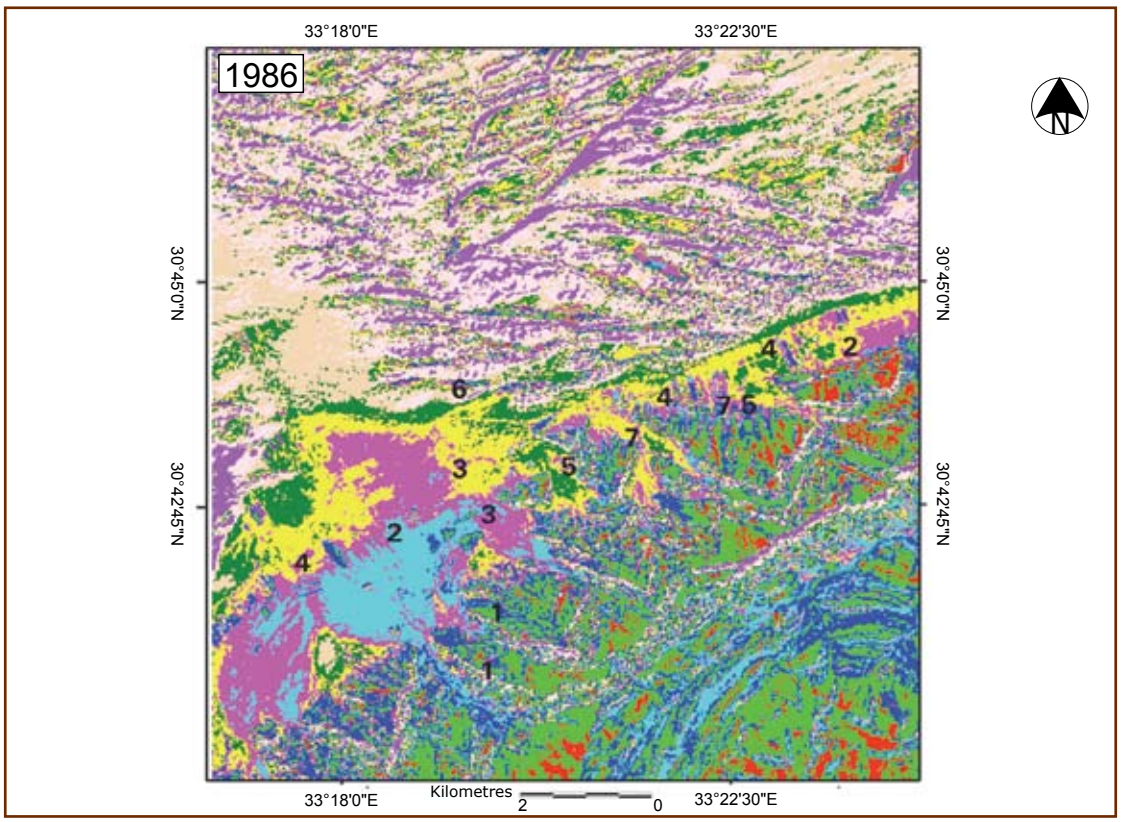


Figure 2.4. Enhanced classified landsat satellite image of El Maghara area, 1986

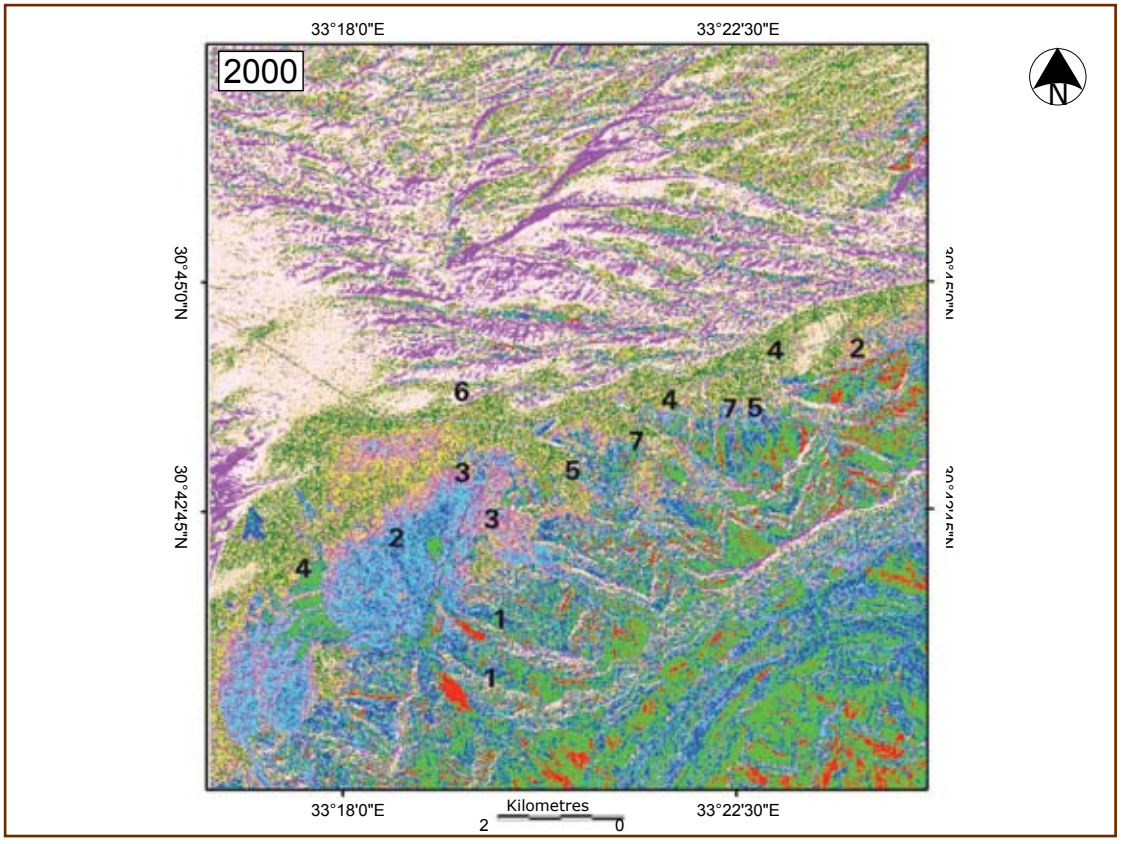


Figure 2.5. Enhanced classified landsat satellite image of El Maghara area, 2000

Stone and marble mining around El Maghara
Source: Yasser Hanafy

that a vast area of El Maghara has been converted to crop land, where the Bedouin grow field crops, orchards and vegetables crops. They have also cleared considerable areas of shrubs for use as domestic fuel as well as for selling. Grazing activities have also increased despite the fragility of the ecosystem caused by severe drought.

2.1.2 Root Causes of Environmental Degradation: Natural Factors

The natural factors contributing to environmental degradation are mainly water scarcity, sand mobility, and wind erosion.

2.1.2.1 Water Scarcity

Water scarcity is, beyond doubt, the most important driver in the study area. It has a number of impacts on a wide variety of issues, including agriculture, health, economics, education and migration. Agriculture is mostly sporadic because of water shortages and very often crops fail to grow.

The lack of clean water causes a number of diseases that affect the community at all ages and life stages. The water shortage is also the main reason for the migration of many young men and families, who seek a better income and better quality of life in other parts of the country.

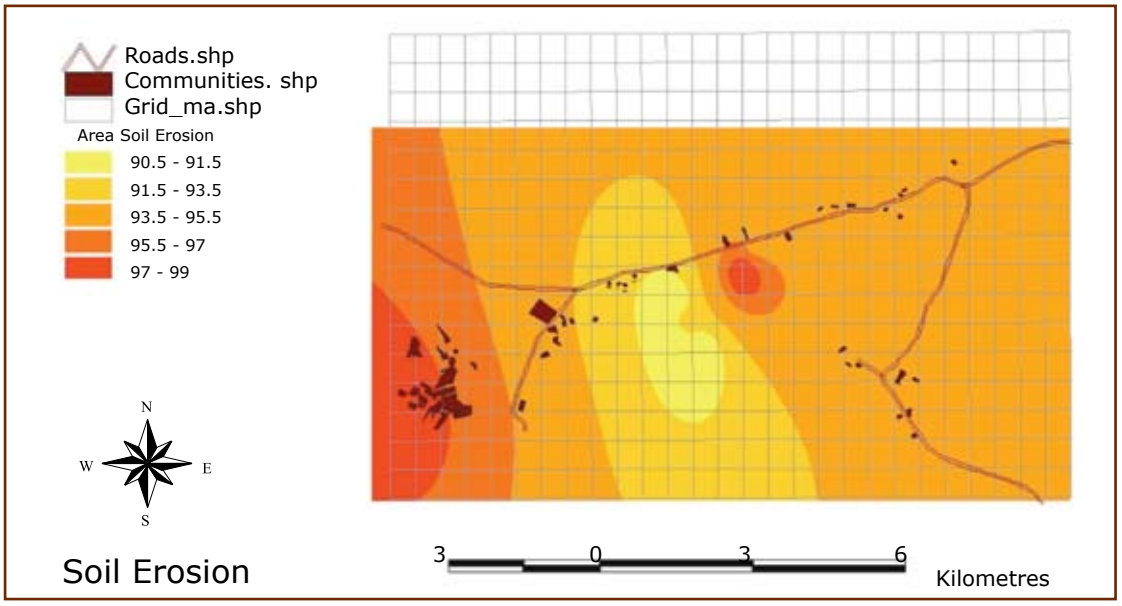


Figure 2.6. Soil erosion map, El Maghara area. The map shows higher erosion rates in the vicinity of gravel and sand extraction activities.

It has also affected the age structure of the people, leading to a high ratio of elder Bedouin, in comparison to other age stages. The water shortage has also had economic repercussions. Cash flow is very limited, as grazing and agriculture, the most important activities in the area, are badly hit by the long-lasting droughts.

2.1.2.2 Sand Movement

Changes in soil quality and the loss of vegetative cover are the main causes of sand encroachment recorded in El Maghara. Enhanced images showed extensive and large sand accumulations and encroachment covering large areas. Roads, especially during winter, are often covered with massive volumes of moving sand, hampering the use of roads and posing serious risks to travelers. Moving sand has a serious impact on the infrastructure and interrupts the mobility of the already meagre public bus services in the area. It also stops the small trucks the Bedouin use to move around, exacerbating their sense of isolation and remoteness.

2.1.2.3 Wind Erosion

Strong winds dismantle scarps, deepen hollows and erode exposed rock. These eroded particulates are emitted in the atmosphere as dust, accumulated in the form of sand sheets and dunes, or left behind as coarse lag deposits. Figure 2.6 indicates the erosion rate around El Maghara, showing a relatively high rate of erosion around the area where most of the gravel and sand extraction processes take place.

Impact of sand encroachment on infrastructure around El Maghara
Source: Mohamed El Shafie

The main road of El Maghara area covered with sand
Source: Mohamed Tawfic

2.2 Plant Biodiversity in El Maghara: A Trend Analysis

Biodiversity is the foundation for sustainable development, constituting the basis for the environmental health of our planet, and is the source of economic and ecological security for future generations (Kumar 1999). Biological biodiversity is "the variety of life" and refers collectively to the variation at all levels of biological organisation. In developing countries, such as Egypt, biodiversity provides the assurance of food; many raw materials such as medicine, fuel and fodder, etc.; shelter; and a source of work energy in the form of animal traction. Biodiversity also maintains the ecological balance necessary for planetary and human survival.

2.2.1 Plant Diversity of Sinai: Background Studies

The vegetation and flora of the Sinai Peninsula have attracted the attention of many explorers and botanists since the eighteenth century and even

earlier. These include Forsskal (1775); Delile (1809, 1812); Fresenius (1834); Decaisene (1834); Redhead (1866), Muschler (1912), Range (1921), Tackholm (1932, 1956, 1974); Zohary (1935, 1944); Shabetai (1940); Boulos (1960, 1995, 1999, 2000, 2002, 2005); Zahran (1967); Danin (1969, 1972, 1973, 1983); El-Hadidi (1969); Batanouny (1985); Gebali (1988, 2000); Zahran and Willis (1992); El Gazzar et al. (1995); Ali (2004); and others.

The Sinai Peninsula is in the middle of three well-defined phytogeographical regions of the world: Saharo-Scindian, Irano-Turanian, and the Mediterranean. Accordingly, the flora of Sinai comprises taxa of these three regions (El-Hadidi 1969). Boulos (1995) stated that the flora of Egypt in its four geographical regions (Western Desert, Eastern Desert, Sinai Peninsula and River Nile) comprises 2,121 species.

Sixty one of these species are endemics, unknown anywhere else in the world. The plant diversity (flora) of the Sinai Peninsula, with its three geographical sub-regions (southern, central, and northern), comprises 1,285 species, of which 33 are endemic to Sinai only and another 4 species, which are endemic to Sinai but also known to other regions on the mainland of Egypt. This means that the flora of Sinai comprises 60.7 per cent of the total number of the endemic species in Egypt, of which 54.1 per cent are restricted to Sinai. The southern, mountainous, sub-region of the Sinai Peninsula contains the highest number of endemics (20 species), followed by the central sub-region (10 species) and then the northern sub-region (7 species).

2.2.2 Plant Diversity and Bedouin Daily Life

Plant coverage in the El Maghara area and in Sinai at large is a prominent component of Bedouin life and well-being. Plant coverage constitutes a major source of food, beverage, animal feed, raw material for building houses, as well as trade in medicinal plants. Plants are also used to produce household and agricultural tools such as ropes and plates.

2.2.3 Use of Medicinal Plants

The Bedouin are well-versed in the value of many of the medicinal plants available in the vicinity. One element of the questionnaire was to ascertain the relationship between the Bedouin and the medicinal plants in the assessment site. Information showed clearly that those aged 30 years and older are intimately familiar with the use of medicinal plants. This age group's interest in using medicinal plants is 73 per cent higher than for those below this age. Those in the younger generation might have the same strong belief in medicinal plants, but they also believe that these plants on their own may not be good enough to treat many diseases and that there is a real need to supplement their use with commercial pharmaceutical products.

Fagonia Mollis, a rare species
Source: Yasser Hanafy

Asparagus Stipularis, a rare species
Source: Yasser Hanafy

There is no state control over medicinal plants in Sinai, thus the intensity of exploitation depends on the natural availability of the medicinal plants and the Bedouin's capacity to extract them.

It is impossible to work out precisely the market value of medicinal plants since it is difficult to obtain the right information from those involved in this business. However, it is apparent that most of the benefits go to the shop owners who buy medicinal plants from the Bedouin, then sell them to consumers, either locally or by marketing them to outlets in other parts of the country.

2.2.4 Plant Diversity of El Maghara: Trends and Conditions

The harsh environmental conditions caused by severe aridity, coupled with other human-made impacts, have caused damage to the floral and faunal diversity of the area.

A Bedouin home made of local plants
Source: Mohamed Tawfic

Household tools made from local plants
Source: Mohamed Tawfic

Frequent meetings with the Bedouin indicated that a number of the plants they use in their daily life have disappeared, or are becoming very rare. At the same time, some other species that they don't know have started to appear and sometimes cause problems for their crops. This view was not only expressed by the people of El Maghara but also by the Bedouin in other parts of Sinai.

The impact on the vegetation cover and floral diversity around El Maghara was one of the focal investigations in the assessment work. The study included the following parts:

- a survey to map out the status of the flora. The study also attempted to compare present records of plants around El Maghara, with records from previous surveys of floral diversity in the area
- a survey to ascertain the percentage coverage of plants in the study area, with reference to dominant species and their distribution.

2.2.5 Impact on Biodiversity

The assessment team carried out several field studies on the flora in eight wadis around Gebel El Maghara: Wadi El Maghara, Wadi El Hemma, Wadi Mezare, Wadi Masajid, Wadi Aroussia, Wadi El Safa, Wadi Um Sayala, and Wadi Sheikh Hemid (Abdel Wahab 2005). In these wadis 25 sites were selected, representing the habitat diversity of the wadis: the main channels, the deltas, sandy dunes, sandy plains, gravelly plains, alluvial plains, alluvial fans, slopes of the mountains and gorges (Figure 2.7).

A comparative study of the floral diversity was done to compare the present findings with those reported by Boulos (1960). The study revealed the following:

1 Total number of families = 54. Out of these, 38 families were recorded both in 1960 and 2005, 11 families were recorded in 1960 only and 5 families were recorded in 2005 only.
2 Total number of genera = 179. Out of these, 67 genera were recorded in 1960 and 42 genera were recorded in 2005 and 70 genera in both 1960 and 2005.
3 Total number of species = 247; 87 annuals and 160 perennials. Out of these, 68 species

Vegetation on the high plateau of Aroussia valley
Source: Yasser Hanafy

were recorded both in 1960 and 2005, 123 species were recorded in 1960 only, and 56 species were recorded in 2005 only.

4 Total number of the medicinal plant species = 103. Out of these, 44 species were recorded in both 1960 and 2005, 33 species were recorded in 1960 only and 26 species were recorded in 2005 only.

5 Total number of other-uses plant species = 144. Out of these, 27 species were recorded in both 1960 and 2005, 86 species were recorded in 1960 only and 31 species were recorded in 2005 only.

6 Family compositae comprises the highest number of species (37 species), followed by gramineae (25 species), leguminosae (18 species), cruciferae (17 species), caryophyllaceae (13 species), chenopodiaceae (12 species), labiatae and zygophyllaceae (9 species each), boraginaceae (8 species), resedaceae (7 species), covolvulaceae, euphorbiaceae, geraniaceae, hycinthaceae, and scrophulariaceae (5 species each), plumbaginaceae, solanaceae, and tamaricaceae (3 species each), and aizoaceae, cucurbitaceae, dipsacaceae, and orobanchaceae (2 species each). Each of the other 25 families is represented by only one species.

7 Family compositae comprises the relatively highest number of medicinal plants (21 species), followed by cruciferae (12 species), chenopodiaceae (9 species), and labiatae (9 species). All species belonging to the 20 families in the study area are considered medicinal plants, e.g., families aizoaceae, alliaceae, asclepiadaceae, asphodelaceae, cleomaceae, cucurbitaceae, cupressaceae, iridaceae, labiatae, rutaceae, solanaceae etc.

8 Family zygophyllaceae comprises the highest number of the dominant species (4 dominants) followed by leguminosae (3 dominants). Each of chenopodiaceae, compositae, gramineae, solanaceae, and tamaricaceae is represented by 2 dominant species whereas each of cruciferae, cupressaceae, thymelaeaceae and umbelliferae is represented by only one dominant species.

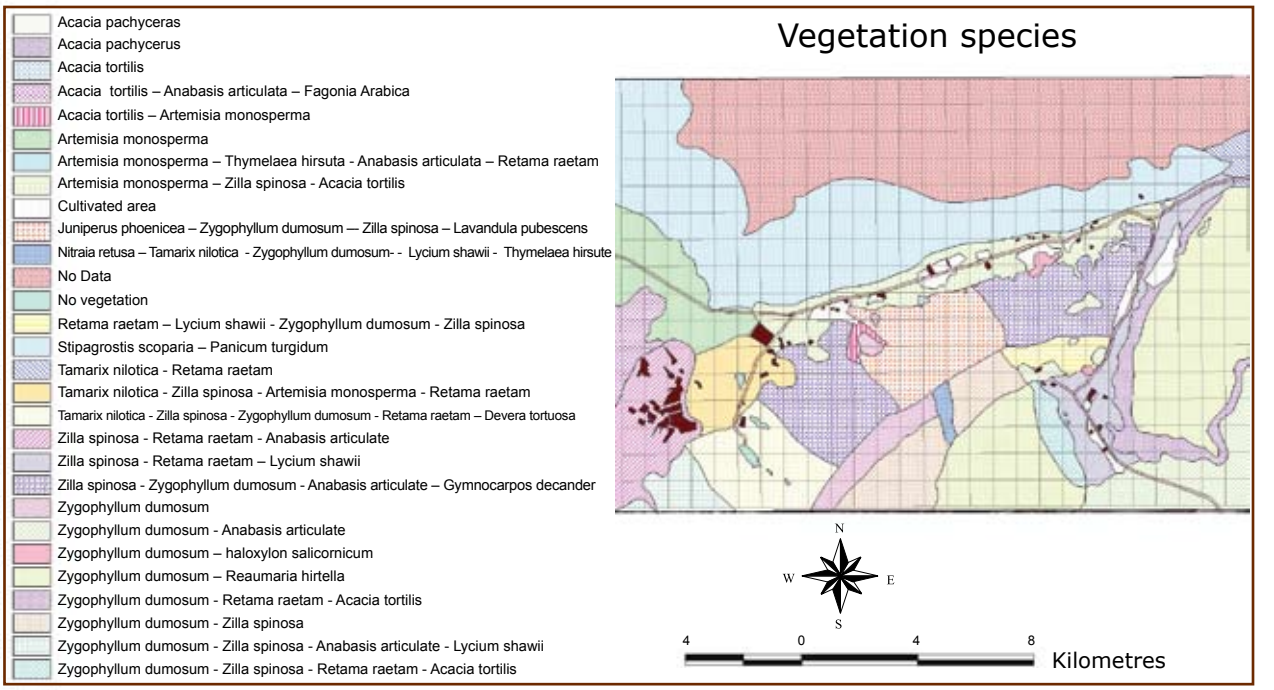


Figure 2.7. Distribution of plant species around El Maghara, 2006

The study indicated a continuous decline in the number of taxa (families, genera, and species) making up the plant diversity (the flora) around the Gebel El Maghara of the Sinai Peninsula.

Many of the palatable species recorded in 1960 are absent from the 2005 list, e.g., species belonging to families: compositae, convolvulaceae, cruciferae, geraniaceae, gramineae, hycinthaceae, leguminosae, orobanchaceae, papaveraceae, plantaginaceae, resedaceae, rutaceae and scrophulariaceae (Boulos 1960). The only endemic species (Rorippa integrifolia, cruciferae) and the only liane (Cocculus pendulus, menispermaceae)

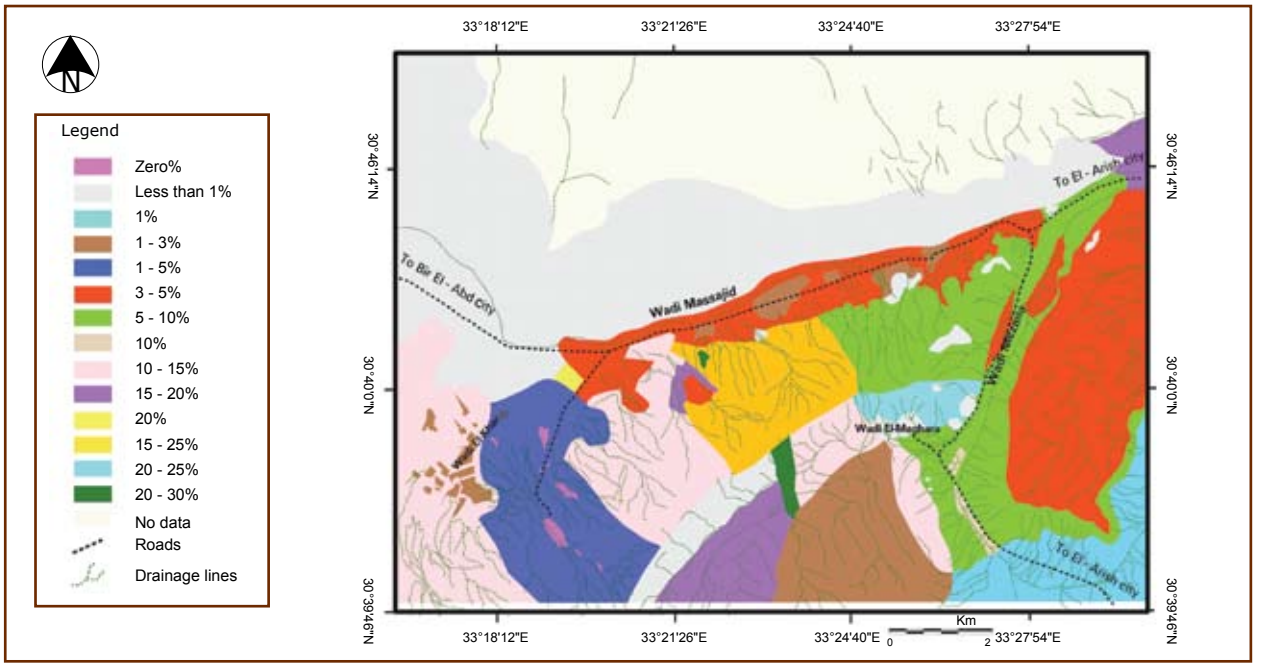


Figure 2.8. Percentage vegetative cover, El Maghara

Acacia wood at Sheikh Hemid, one of the main ecological features around El Maghara
Source: Mohamed Tawfic

recorded in 1960 were absent from the 2005 list. In addition, many of the still-growing species that are considered medicinal (e.g. *Juniperus phoenicea*) are threatened or endangered. Apart from that, all woody trees and shrubs are subject to uncontrolled cutting as they are widely used as fuel.

2.2.6 Impact on Acacia Wood

The impact of quarrying activities was particularly strong on Sheikh Hemid acacia wood. The acacia wood is one of the main landmarks in Sinai, with its historic, biological, and folklore value. Quarrying work was ruthlessly performed around the trees, resulting in irreparable damage to many of them.

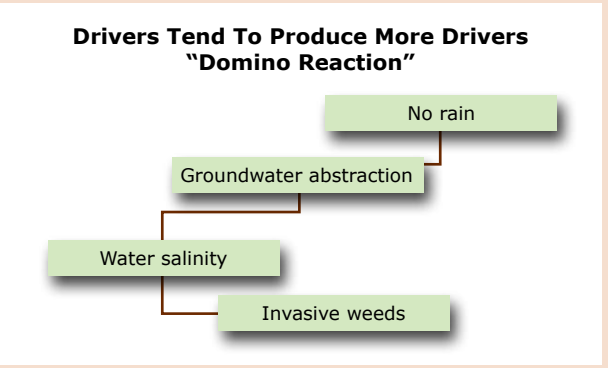
Acacia is one of the most popular trees in Sinai. It provides a stable browse for camels and goats. Its forage is available throughout most of the dry season when other sources are scarce. The dense acacia wood makes very good fuel wood that burns slowly and produces little smoke when dry.

Damage caused by sand mining on Acacia trees
Source: Mohamed Tawfic

Mesembrayanthemum Crystallinum: An invasive species in Sinai
Source: Mohamed Tawfic

Box 2.1 Drivers and indirect drivers: A case study illustrating a Domino Reaction

One feature identified in the present study is the introduction of some alien species in Sinai, including ***Mesembrayanthemum crystallinum***, a weed that infests orchards and crops in Sinai, causing serious economic damage. Bedouin report that this potential weed started to show up a few years ago. They also add that the weed showed up in areas fed with groundwater, where salinity is high, then started to infest other parts of Sinai.



One explanation for the massive spread of crystallinum is the significant drop in rainfall within the last few years that forced Bedouin to depend on groundwater in their agriculture, despite their high salinity. Because ***Mesembrayanthemum crystallinum*** has high tolerance for high salinity, it was able to survive and even flourish under these conditions, and become a potential weed.

2.2.7 Percentage of Vegetative Cover

In a separate study, the percentage of the study area covered with vegetation was monitored and the dominant species in each area identified. The study found that the area adjacent to the coal mine is the least vegetative-covered area, with the percentage covered ranging from 1–2 per cent to 1–5 per cent, with some parts totally void of any vegetation cover (Figure 2.8).

2.2.8 Impacts on Land Cover

Land cover refers to the natural vegetative cover types that characterise a particular area. These are generally a reflection of the local climate and landforms, though they too can be altered by human actions. Heavy mining and quarrying activities performed in El Magahara have caused some detectable changes in the physical and chemical properties of the land cover.

On El-Khariq plain, along Wadi Massajid and Wadi Sheikh Hemid, image enhancement, change detection, and post-classification comparison techniques of soil images in 1986 (Figure 2.9) and 2000 (Figure 2.10) show detectable alteration represented by changes of colours, tone and texture. Field verification of the enhanced satellite images shows that mining and quarrying dumps have strongly reshaped the geo-morphology of the area, with some serious bearing on the environmental setting of the area. Solid and liquid wastes emanating from the mine, including hydrocarbon waste, heavy metals, and others have caused significant changes in terrain quality and properties. Further information is provided in later section on agriculture services.

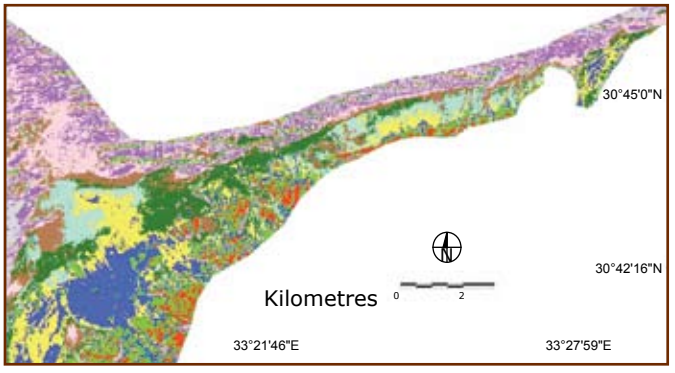


Figure 2.9. Classified enhanced landsat (TM, 1986) image, El Maghara area

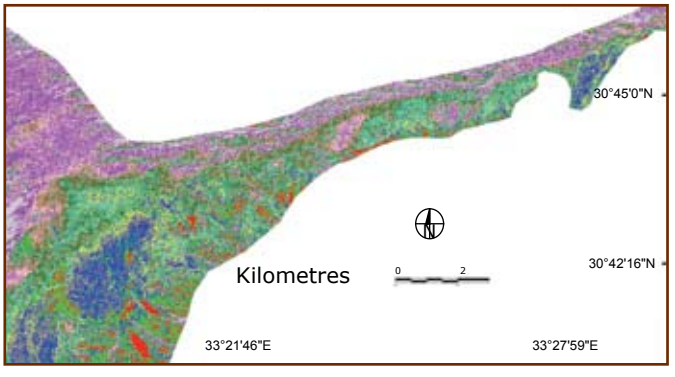


Figure 2.10. Classified enhanced landsat (ETM, 2000) image, El Maghara area

2.2.9 Overgrazing

Overgrazing is one of the most destructive activities. It results in reduction of total plant cover, disappearance of pastoral plants, and an increased number of unpalatable plant species such as *Anabasis articulata*, *Fagonia mollis*, and *Zygophyllum dumosum*. Overgrazing is partially responsible for the change of land cover currently impacting Sinai. In overgrazed areas, medicinal plant species disappear as trampling animals tend to change the soil surface and soil content that allow them to grow.

2.2.10 Fuel Wood Overexploitation

Fuel wood is the main source of energy for the Bedouin in the study area. They use it for cooking, making tea and as a source of heat during the cold winter days. Women, especially young ones, collect fuel wood on their daily grazing routine and bring it back to the family. Regular visits to the area revealed that a vast terrain has been cleared; shrubs and small trees have been removed and taken as fuel wood. In many places the Bedouin, in the current hard economic times, have even cleared shrubs and small trees to put on sale for travelers passing by. Such overuse of fuel wood has had very negative impacts on floral diversity and density, with a number of main shrubs significantly affected.

2.2.11 Responses

The assessment team participated in a series of talks and presentations, in which some of their findings were shown, especially the parts about environmental damage. Repeated calls were made to save the environment of El Maghara, and the assets it embraces. In one of these appeals, Al Ahram, the most influential newspaper in Egypt, focused on the damage inflicted on the area and its environmental attributes. A detailed report was published in the Environment Section of Al Ahram to shed some light on the magnitude of damage to Sheikh Hemid Wood. The report exposed the public to the massive environmental destruction at El Maghara and the appalling environmental conditions for the first time.

Goats grazing on juniperus shrubs, a rare species in Egypt
Source: Yasser Awad

Fuel wood for sale around El Maghara
Source: Mohamed Tawfic

As part of the project activities, different stakeholders, including senior officials, NGO representatives and decision-makers, made visits to the assessment site, and to Wadi Sheikh Hemid in particular, to see the damage caused to the area. However, none of these efforts has yielded any positive change that may help improve the quality of the environment in El Maghara. The long descriptive report published in Al Ahram, a paper widely distributed in Egypt, made it very clear that truly valuable environmental assets are being systematically destroyed. Nevertheless, no official response was made and the report went unheeded.

2.3 Water Resources

Water is the elixir of life; all other ecosystem services are directly related to the quantity

Box 2.2 Juniperus phoenicea, values and uses

Juniperus phoenicea is a small shrub (or tree), a cypress-like tree with erect branches commonly known in Arabic as Ar'ar. It has a characteristic aromatic bitter taste and aromatic odour and is one of the endangered plant species. Due to the medicinal value of the tree, it is subjected to overcutting for medicinal use. The leaves and fruits are sold in the market at herbalists shops for LE 20 to 24 per kilogram. Many uses of this tree are recorded in folk medicine.

The dried leaves are used to cure mild skin inflammations in babies and as a dilator for urinary tract infections. It is also used as a laxative, intestinal disinfectant and to help childbirth by increasing the contractions of the uterus. A mixture of the leaves and cones is used as an oral hypoglycaemic and the leaves are used against pulmonary diseases and as a diuretic. The oils extracted from the plant have antimicrobial activities against food spoilage, pathogenic micro-organisms and fungi.

and quality of water. Arid regions suffer from the scarcity of fresh surface water and, consequently, groundwater represents a main source. Nevertheless, groundwater resources have specific hydrologic and hydrochemical problems that govern their use. These are scarcity, irregularity, and the severe drawdown and salinisation of shallow aquifers. Sinai has an arid climate and depends mainly on groundwater, a resource that should be managed and protected properly. Other water resources include rainfall and flashflood water.

2.3.1 Rainfall and Flashflooding

Rainfall (Figure 2.11) and flashflood (Figure 2.12), represent an important water supply for both domestic and irrigation purposes. Nevertheless, rainfall over the study area varies spatially and temporally (Table 2.2). The map of average annual rainfall on Sinai exhibits large spatial changes over relatively small distances across the region. The average annual rainfall reaches about 200 mm/y at Rafah in the north and decreases to about 10 mm along the Gulf of Suez (Figure 2.11). Rainfall around El Maghara was recorded as 43.7 mm/y in 1966.

There is no continuous record of rainfall data for the El Maghara area, thus rainfall data from the nearest meteorological station at Bir El-Hassana are used throughout. The data are available for nine years of record (1939–47). Rainfall occurs mainly during the autumn, winter and spring months. The average annual rainfall is 27.7 mm and the average number of rainy days of more than one millimeter rainfall is 3.4 mm (Table 2.2).

صحة البيئة enviro@ahram.org.eg

إشراف : فوزى عبدالحليم

فحم المغارة يهدد مواقع التراث الطبيعى بسيناء

شكلت حماية البيئة احد التحديات الكبرى التى يواجهها العالم بأكمله.. فهى مشكلة عالمية.. والحفاظ على البيئة لا غنى عنه لبقاء النوع الانسانى ولما كانت الممارسات البيئية السليمة شرطا تستحيل بدونه التنمية المستديمة اصبحت الادارة السليمة للموارد الطبيعية مسئولية يتحملها جميع بلدان العالم دون استثناء حتى يمكن الحفاظ على البيئة نظيفة ومأمونة للاجيال المقبلة، وتعتبر سيناء إحدى أهم المناطق الغنية بالتراث الطبيعى التى تتعرض لمخاطر التنمية غير المحسوبة بينما وفى إطار عرض نتائج التقييم البيئى للالفية لتقييم تأثير التغيرات فى الانظمة البيئية على حياة وصحة الانسان فى العالم ومساعدة متخذى القرار فى شتى انحاء العالم فى العمل على صيانة المجتمعات البيئية قدم الدكتور محمد توفيق رئيس قسم وحدة تقييم الآثار البيئية بكلية الزراعة جامعة قناة السويس دراسة التقييم البيئى لشبه جزيرة سيناء.. وقد تم اختيارها لما تتميز به من طبيعة بيئية خاصة الى جانب تميزها بتراثها الواسع فى اصناف وانواع الكائنات الحية الموجودة به والعديد منها تنفرد بها سيناء دون اى مكان اخر فى مصر، كما ان هناك بعض النباتات الطبية والاشجار النادرة التى لا توجد فى اى مكان اخر فى العالم سوى سيناء.. كذلك تعتبر سيناء احد الاماكن المنفردة فى العالم بما تضمه من قيم دينية فى المواقع البيئية المنتشرة بها.. الى جانب تميزها بطبيعة سكانية خاصة تتمثل فى قبائل البدو التى تقطن بها وتمثل نمطا مميزا من شعب مصر تتمثل فيه صفات وطبائع خاصة ومتميزة.. ومن ذلك تضح اهمية سيناء التى تمثل ركيزة مهمة للتاريخ الانسانى والتنوع البيولوجى والذى قلما يوجد فى مكان اخر فى العالم.. ومن هنا تبدو اهمية الحفاظ على طبيعة سيناء من حيث تنوعها البيولوجى او مدى جوهرية امكانها المقدسة لجميع الاديان بالاضافة الى الطبيعة المميزة للبدو وما تمثله هذه الطبيعة من تميز ونذرة..

ويضيف د. توفيق لقد تقدمت بدراسة التقييم البيئى لسيناء الى المؤتمر العالمى للتقييم البيئى للالفية بغرض اعتبار شبه جزيرة سيناء واحدة من الاماكن المختارة التى يشملها برنامج التقييم البيئى للالفية لما تتمتع به سيناء من اهمية حضارية هائلة للكيان الانسانى كافة وحتى تمثل مصر فى هذه المبادرة العالمية.. ولاشك أن التغيرات الهائلة التى تشهدها سيناء خاصة فى مجال التطوير والتنمية السياحية والصناعية لها كان لها وقع مؤثر على النسيج البيئى والمكانى لسيناء. وقد ثبت بالدليل القاطع تدهور وتلوث مناطق شاسعة من الاراضى الزراعية بمنطقة المغارة بسيناء، نتيجة للنشاط الخاص باستخدام الفحم من منجم المغارة وما يسببه من تلوث فى المنطقة المحيطة به بسبب انتشار رواسب الفحم والمخلفات الصلبة الاخرى.. مما ادى الى تسرب الملوثات للمياه الجوفية والتى تعتبر المصدر الرئيسى لمياه الشرب وري الاراضى الزراعية.. كما ادت اكوام الفحم المستخرج الى تلوث مياه السيول والتى كان يعتمد البدو على تخزينها فى خزانات خاصة فى مواسم السيول لاستخدامها كمصدر للمياه طوال العام.. كما ادت رواسب الفحم الى تصحر مناطق ضخمة فى المنطقة بحيث اصبحت غير قابلة للزراعة.. كما ادى النشاط المتزايد لشركات انتاج الزلط والرخام الى تجريف التربة تجريفا هائلا مما ادى الى تدمير احدى غابات اشجار «الاكاسيا» التى يعود تاريخها الى اكثر من ٢٠٠ عام والتى تعتبر أحد المعالم البيئية فى سيناء.. كما ادى الاستخراج الجائر للزلط والرخام والتجريف حول الاشجار القديمة خاصة فى منطقة الشيخ حميد الى القضاء على عشرات الاشجار النادرة نتيجة التجريف حول جذور الاشجار لقطع الرخام.. وعمد الكثير من شركات المحاجر هناك الى تغيير طبوغرافية المنطقة بانشاء بعض الطرق والمدقات المستحدثة فى نقل الزلط مما ادى الى تغيير وقطع الطريق الذى كانت تتخذه مياه السيول للوصول الى الخزانات مما ادى إلى فقد مياه السيول وتبعثرها وبعدها عن الممرات التقليدية التى كان يتم عن طريقها حصد هذه المياه لاستخدامها فى الشرب والرى فى مواسم الجفاف.

وأدى هذا التدهور البيئى الى تهديد غابات الاكاسيا والسدر.. فى حين كان يجب اعتبار هذه الغابات محميات طبيعية يجب الحفاظ عليها كمعالم بيئية مهمة فى سيناء.

■ اشجار المغارة مهددة بالجفاف بسبب تجريف التربة

شهيرة الملاخ

Al Ahram newspaper, May 3, 2005

There are also great temporal variations in rainfall intensity from one year to the next. Consecutive years of relatively high or low annual rainfall have an enormous effect on the water resources of the region. High rainfall storms usually occur

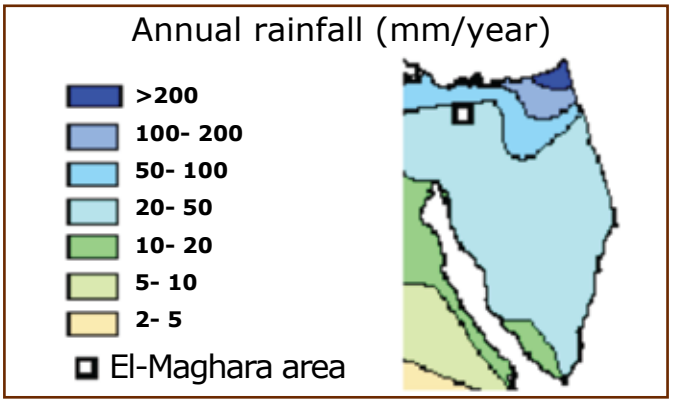


Figure 2.11. Average annual rainfall on Sinai peninsula (After Abou Rayan, M. et al., 2001)

in the study area; about 31 mm precipitated in one day in November 1942.

The average quantity of water available depends on the catchment area's average annual precipitation and evaporation for each basin. The convective storms that occur during autumn and spring have intense rainfall and brief duration. They cause most of the flashfloods in the study area. The average annual storm of more than 10 mm is about 17.9 mm. There are no reliable data about the relationship between rainfall and runoff; however, it was possible to estimate the expected maximum and average flood volume in the main sub-basins of El Maghara area (Table 2.3), while the precipitation rate in some selected parts of Sinai is shown in (Table 2.4).The surface water flow system is mainly from the highlands toward the main wadi systems (Figure 2.13). The Bedouin in the study area manage the water flow through wadis and drains by building loose earthen dams to slow down flood flow. They capture and store the water in a system of cisterns built for that purpose.

2.3.2 Wadis of the Study Area

The study area has three main drainage basins: Wadi El-Khariq, Wadi El-Massajid, and Wadi

Table 2,2. Monthly rainfall at Bir El-Hassana station, 1939–47. R = rainfall in mm; D = number of rainy days

year	Parameter	J	F	M	A	M	J	J	A	S	O	N	D	Total
1939	R	00	00	00	00	00	00	00	00	00	00	00	00	00
	D													00
1940	R	2	00	00	29	00	00	00	00	00	14	00	00	45
	D	1			3						1			5
1941	R	00	00	28	00	00	00	00	00	00	00	00	1	29
	D			4									1	5
1942	R	00	00	12	00	00	00	00	00	00	00	31	00	43
	D			2								1		3
1943	R	00	21	8	00	00	00	00	00	00	00	00	00	29
	D		2	2										4
1944	R	7	00	10	00	00	00	00	00	00				17
	D	2		1										3
1945	R	35	00	4	00	15	00	00	00	00	00	00	10	64
	D	2		1		3							1	7
1946	R	00	00	00	00	00	00	00	00	00	00	6	00	6
	D											1		1
1947	R	6	00	10	00	00	00	00	00	00	00	00	00	16
	D	2		1										3
Average	R	5.6	2.3	8	3.2	1.7	00	00	00	00	1.8	4.6	1.4	27.7
	D	1.8	2	1.8	3	3	00	00	00	00	1	1	1	3.4

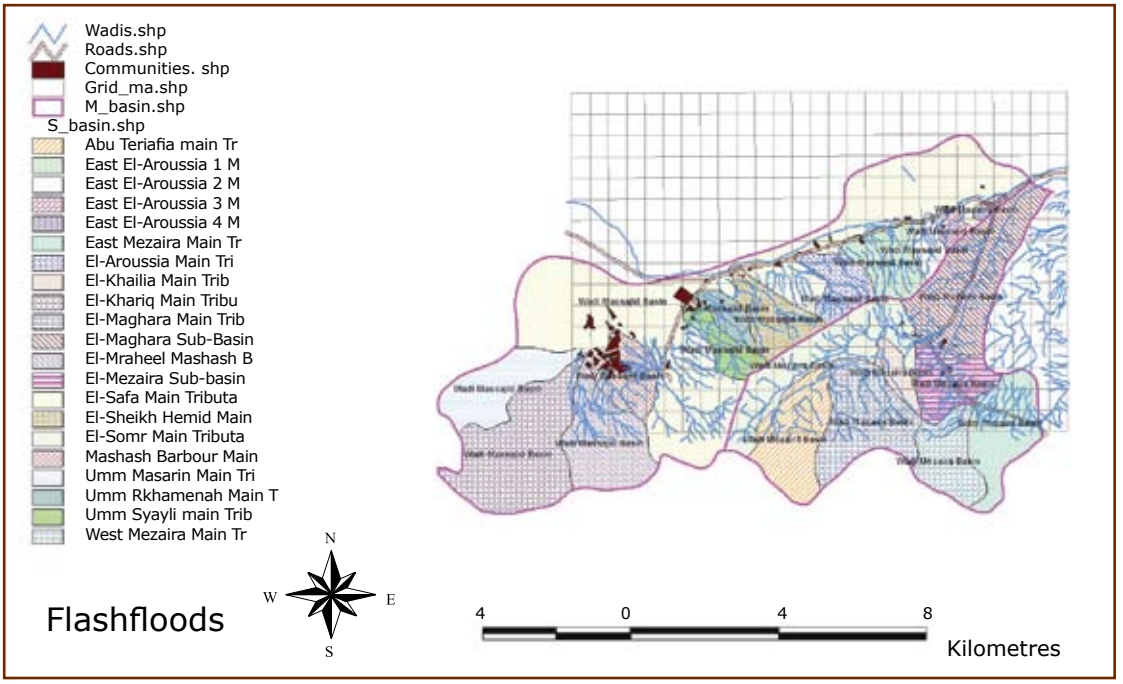


Figure 2.12. Flashfloods in main basins and sub-basins of El Maghara area

Mezaira. Wadi El-Khariq is a closed basin and drains inland within the sand dunes toward the north. Wadi El-Massajid and Wadi Mezaira drain into Wadi El-Fateh, where the Quaternary aquifer is located.

Floodwater quality depends on the type of rocks covering the catchment areas. Salinity, a factor limiting the use of water, is around 262 mg/l for cistern water. Regardless of salinity, cistern water is very prone to bacteriological contamination. It is presumed that such bacterial contamination is one of the main reasons behind the spread of diseases, as the medical survey performed within the study indicated.

2.3.3 Groundwater

Groundwater exists in the pores and fractures of the water-bearing rock units (aquifers) and is commonly exploited from wells and springs. The volume of the openings and the other water-bearing characteristics of the aquifers depend on the mineral composition, texture, and structure of the rocks. Groundwater generally moves very slowly and follows the path of least resistance (most permeable) from the point of recharge (where water enters the aquifer) to the point of discharge (where water leaves the aquifer).

The flow of groundwater may be inhibited by non-water bearing rock units (Aquitards) that consist of clay, silt or shale.

These rocks do not transmit water readily, although

One of the storage structures of a main well at El Maghara
Source: Mohamed Tawfic

Drilled deep well producing water from Massajid aquifer
Source: Kamal Ouda Ghodief

Table 2.3. The expected maximum and average flood volume for El Maghara basins

Basin	Area (m^2)	Max. Storm (mm)	Max. Flood Volume (m^3)	Average Annual Storm (mm)	Average Annual Flood Volume (m^3)
El-Khariq	60,657,140	31	1,046,335	17.9	450,682
El-Massajid	75,153,700	31	1,296,401	19	558,391
Mezaira	73,153,040	31	1,261,889	18	543,527

Table 2.4. Precipitation rate in selected parts of Sinai (Dames and Moore 1985).

Site	Mean Annual Rainfall (mm)	Average No. of Days per Year / Rainfall			Maximum Daily Rainfall (mm)	*Average Daily Evaporation* (mm)
		≥0,1 mm	≥1 mm	≥10 mm		
El Arish	99.7	22	17.8	3.7	59	4.6
El Quseima	63.6	20.2	10.2	2.9	24.2	9
El Tor	10.4	2.9	1.7	0.4	37.4	9.5

*Measured with Piche evaparom

they may hold much water in pore spaces. The importance of an aquifer as a source of water may change from one area to another because of changes in demands for freshwater, variations in groundwater quality, and differences in the hydrogeologic characteristics.

Groundwater is the main source of water in the study area; it provides about 90 per cent of the total water consumed. Shallow dug and deep water wells are used for water exploitation from the different aquifers in the study area. The available water points (wells) in the study area are inventoried and documented in a water point distribution map (Figure 2.14). The complete set of data about these water points is processed and used to compose the groundwater database.

2.3.3.1 Aquifers of El Maghara Area

The study area has four productive aquifers. These are Quaternary formation, Massajid, Safa, and Bir El Maghara aquifers. The distribution of these aquifers is shown in Figure 2.15. The Quaternary aquifer is composed mainly of sand and gravel in the wadi beds and is exploited mainly in Wadi El-Fateh. The Massajid aquifer is composed mainly of fractured limestone, and is exploited in Wadi El-Massajid and Wadi El-Khariq. The Safa aquifer is composed of sandstone and is exploited mainly in Wadi El-Safa. Bir El Maghara aquifer is composed of loamy fractured limestone. It is distributed mainly in Wadi El Maghara, Safat Mouwereb, and Gebel El-Raghaway.

The productivity of these aquifers is generally low, and the quality of the water varies. Geologic structure and lithological properties control groundwater occurrence and flow patterns in aquifers, either by providing barriers restricting flow or by providing pathways for flow. Geologic structure also determines whether the groundwater will be discharged as springs or remain underground until tapped by wells.

The folding system has great impact on groundwater occurrence and its flow system. Bir El Maghara aquifer exists in the dome and thus groundwater depth is shallow, about 5 metres below ground level. On the other hand, the depth to groundwater level in Wadi El-Khariq is about 150 metres below ground level.

Groundwater generally flows down from the highlands, where recharge occurs, toward the lowlands. The data about static water level are not complete and their distribution is not uniform. The available data about static water level distribution in El-Massajid aquifer show that the groundwater flows from southeast to northwest (Figure 2.16).

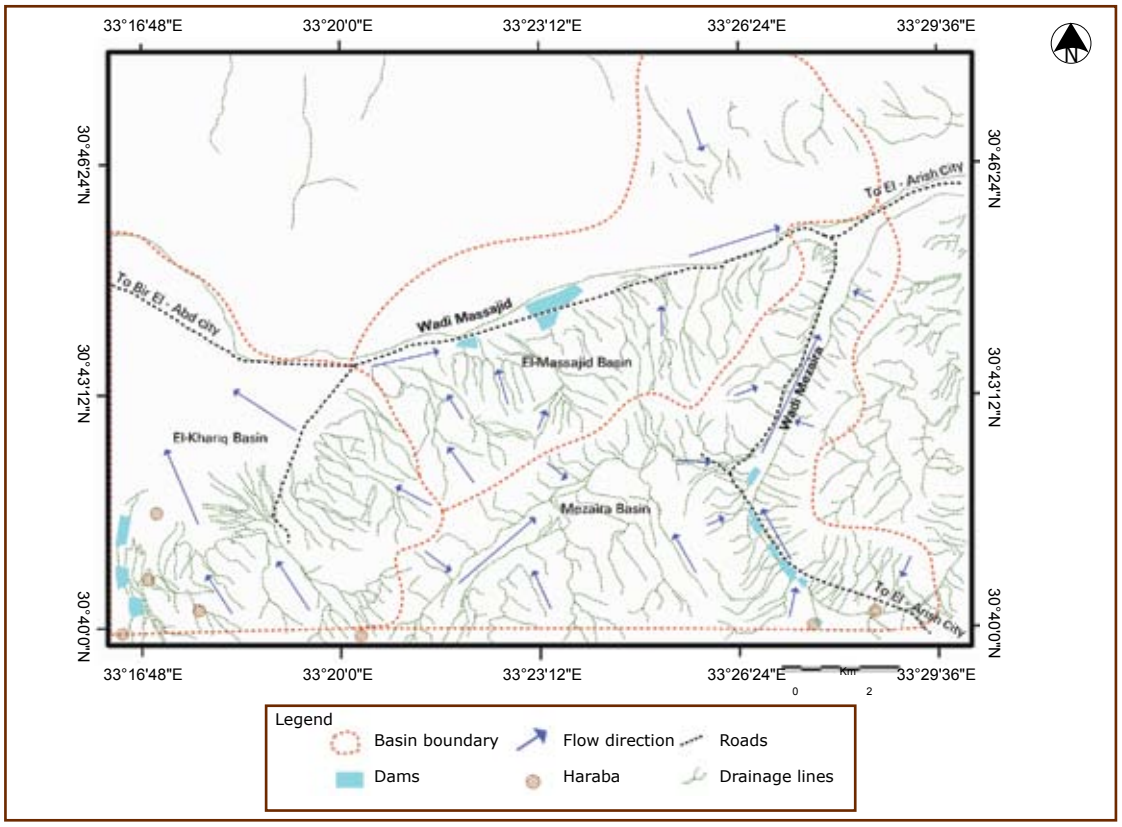


Figure 2.13. Drainage basins and surface water distribution map constructed from ETM image

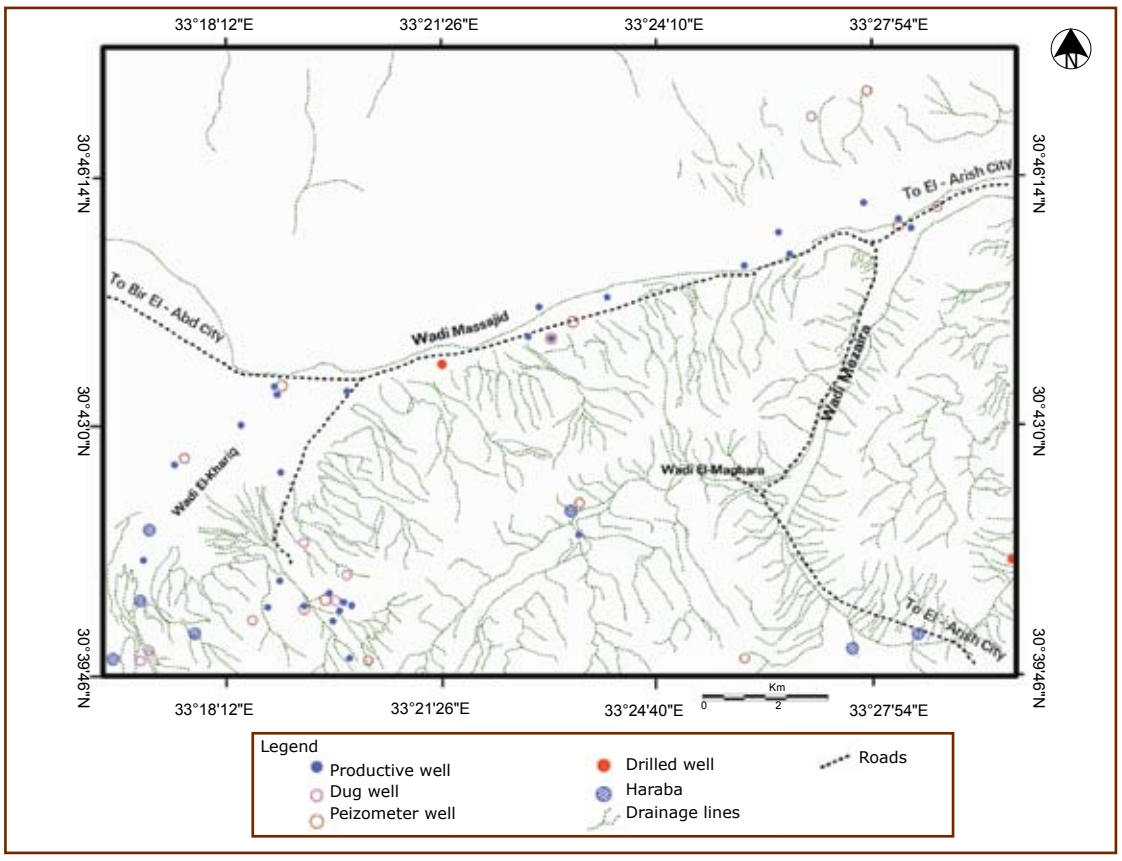


Figure 2.14. The distribution of water points (wells) from different aquifers in El Maghara area

The average well yield from the Quaternary aquifer is about 8 m^3 cubic metres per hour; it operates for about five hours per day (Table 2.5). The depth of groundwater in this aquifer is about 40 metres below ground level, making exploitation economical. With the prevailing conditions, it is recommended to restrict water use from this aquifer to drinking water.

El-Massajid fractured limestone aquifer has a relatively good yield, the average well yield is about 30 m^3/hr, and it works for about five hours per day. Generally, in mountain areas, groundwater is available at shallow levels (Bir El Maghara, Bir El-Raghaway, and Bir El-Mura). In wadis and basins, groundwater is much deeper (Wadi El-Massajid and Wadi El-Khariq). Under natural conditions, aquifers discharge water in an amount proportional to total annual recharge.

Bedouin women filling up water buckets from one of the wells around El Mahgara
Source: Mohamed Tawfic

2.3.3.2 Groundwater Recharge

Precipitation is the main source of water recharge. Water is stored in the system of joints and smaller fractures in the catchment area and then transmits to the dissecting wadis that act as drain and/or local discharge. These wadis convey both surface (after floods) and ground water to the aquifers. The approach used in the assessment is to estimate recharge based on basic field observations and the assumption that the anomalous storms that occasionally occur in such a climate are enough to induce recharge and are in fact the main source of recharge. When rainfall storms happen with a certain intensity, part of the water infiltrates directly through the fracture network and permeable wadi bed deposits, and the other part is collected in the wadis producing runoff or flashflooding. The wadis' catchments areas and their slopes control the expected amount of recharge.

2.3.3.3 Groundwater Salinity

There is a high variability in water salinity among the aquifers in the study area (Figure 2.17). The Quaternary aquifer has the best water quality with salinity of about 1,100 mg/l (Table 2.6). The total hardness ranges from 360 to 400 mg/l of $CaCO_3$. This aquifer has alarmingly high levels of nitrate (4.6 - 5.2 mg/l). The salinity of water produced from El-Massajid aquifer is even higher, ranging from 1,580 to 3,042 mg/l. This aquifer is well protected from surface activities, where nitrate ranges from 1 to 3 mg/l as nitrogen. El Safa sandstone aquifer has relatively saline water, with an average salinity of about 6,370 mg/l. The Bir El Maghara aquifer has moderate salinity, ranging from 2,210 to 2,601.

The sodium absorption ratio (SAR) is calculated for all aquifers to evaluate the suitability of groundwater for irrigation. Water from the Quaternary aquifer is suitable for irrigation while other aquifers have high SAR values, which limits their usefulness for agriculture (Figure 2.18).

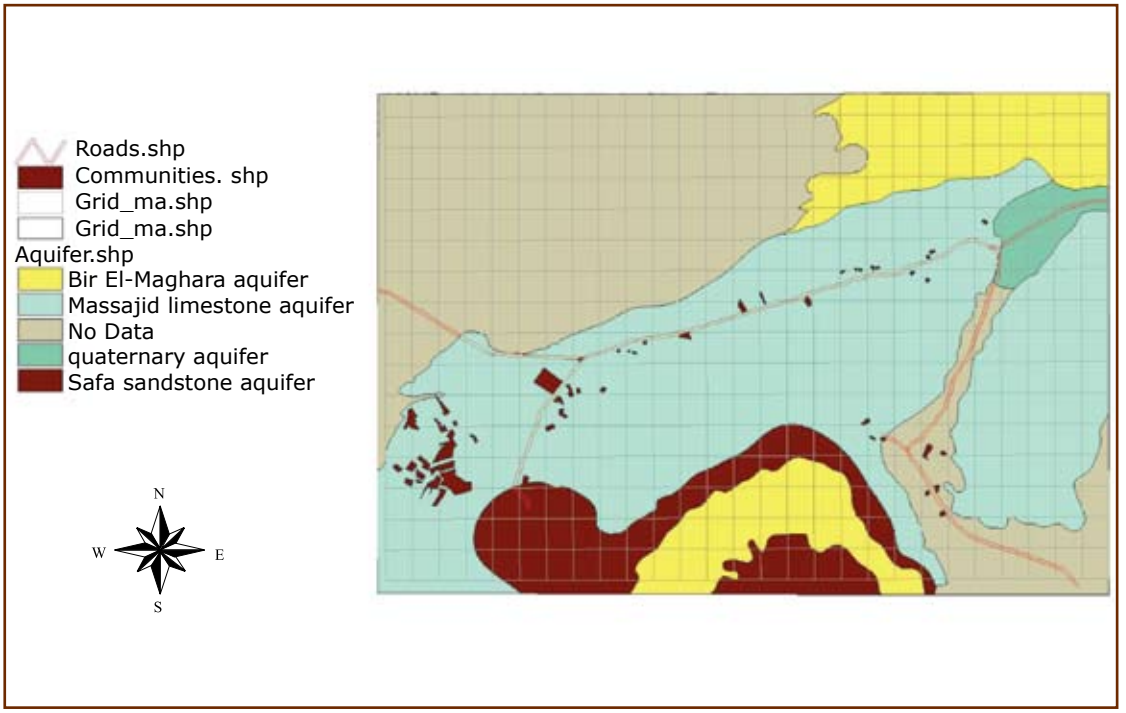


Figure 2.15. Aquifer type distribution map, El Maghara area

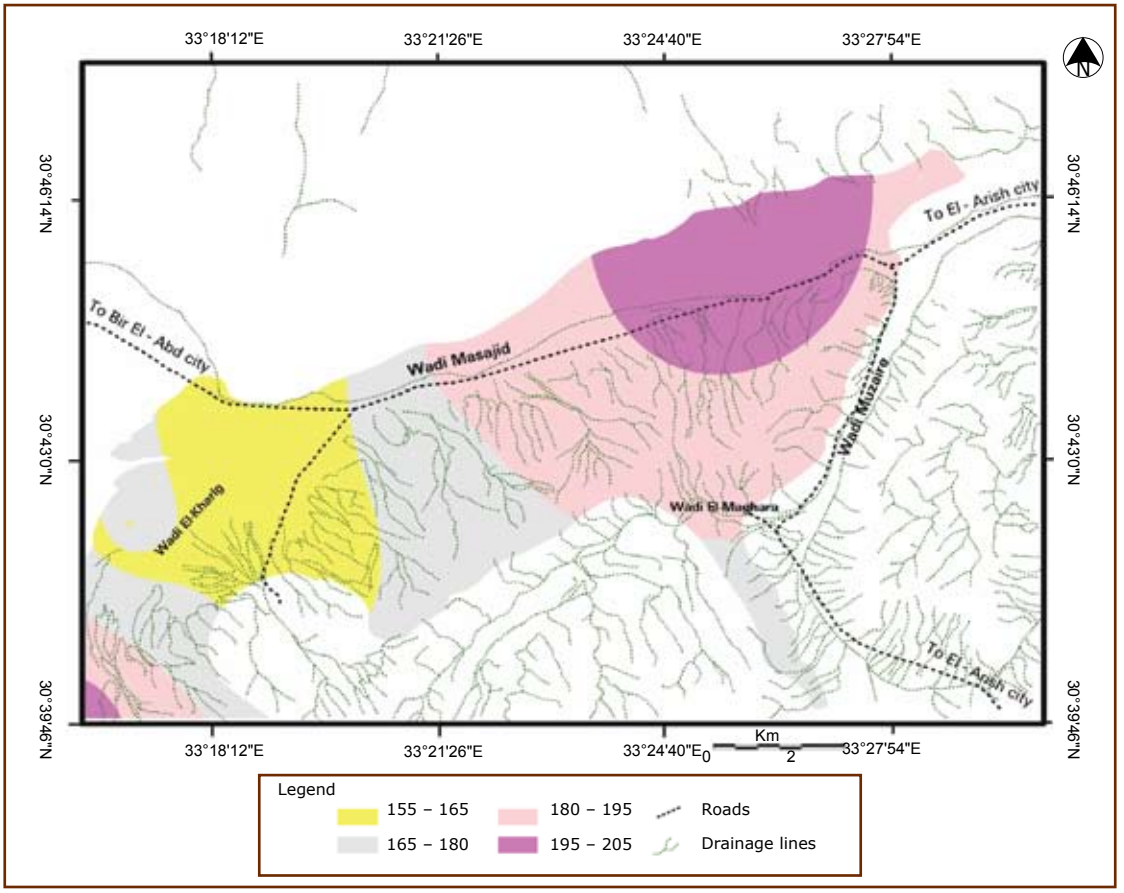


Figure 2.16. Static flow water level map of El-Massajid aquifer

Table 2.5. Well yield and exploitation from active wells, July 2005. Aquifer types key: Q is Quaternary aquifer; M is Massajid aquifer; S is Safa aquifer, and BM is Bir Maghara aquifer, while SW stands for surface water harvesting cistern

Well Local Name / Aquifer type	Well Yield (m^3/h)	Operating Hours (h)	Exploitation (m^3/day)	Use
Bir 5 / M	30	5	150	Irrigation
Bir 12 / M	32	6	192	Irrigation and domestic
El-Fateh 1 / Q	20	6	120	Irrigation and domestic
El-Fateh 2 / Q	8	5	40	Drinking and domestic
El Massora / Q	8	4.5	36	Drinking and domestic
Bir Raghwi / BM	No information	No information	1	Livestock
Coal mine (w. Massjid) / M	27	6	162	Mine workers & water treatment plant
Coal mine (w. Safa) / S	No information	No information	300	Dewatering
Bir Umwerib / BM	No information	No information	1	Livestock
Bir El Maghara / BM	No information	No information	3	Livestock
El-Hedoud / BM	No information	No information	3	Domestic and Livestock
Cistern (Haraba) / SW	No information	No information	No information	Drinking and irrigation
Bir El Malhi / S	No information	No information	2	Livestock
Bir El-Masoutia / BM	30	4	120	Irrigation and domestic

2.3.4 Changes in Water Resources Demand and Supply

Most of the water supply is pumped from groundwater. Mining activities and agriculture are the largest water-use sectors. As shown on Table 2.5, total withdrawals from the aquifers are about 1,130 m^3/day according to our survey. They are distributed as follows: 76 m^3/day from the Quaternary aquifer, 744 m^3/day from Massajid aquifer, 300 m^3/day from Safa aquifer, and 10 m^3/day from Bir El Maghara aquifer. Dewatering, a regular process in the coal mining industry, is done until a decision is taken to continue coal production or evacuate the underground cutting machines. In spite of this, water use will continue to increase with population, agriculture, and economic growth.

The supply of water is limited to that naturally renewed by the hydrologic cycle. Periodically, the amount of natural replenishment can exceed water demand during unusually wet periods or fall far below demand during drought periods. The ever-growing demand for water is one of the main factors driving water conservation efforts.

Bedouin lady bringing a bucket of water back to her home
Source: Mohamed Tawfic

2.3.5 Population Needs and Water Availability: Current Conditions and Future Analysis

El Maghara area contains two main villages and a few Bedouin communities. The main population clusters are found in both El Maghara and in El-Mangem villages. The other Bedouin communities are scattered in different watersheds. Table 2.7 shows the population distribution in El Maghara area. Available renewable water resources (m^3/year) for each watershed are estimated according to runoff and recharge amounts.

The available surface water was estimated according to the volume of rainfall and flashfloods (see Table 2.3). Groundwater recharge is estimated about 10 mm/year for the Quaternary aquifer, where it locates on the low land area and receives recharge from flash floods. The calculated recharge for the Quaternary aquifer is about 754,820 m^3/year. The average net recharge is estimated about 7mm/year for Massajid limestone aquifer where outcrops occupy the high sloping land and has high slope. The calculated recharge for Massajid aquifer is 639,480 m^3/year. This amount is distributed between the two watersheds (W. El-Khariq and W. El-Massajid)

Table 2.6. Results of Physical and Chemical Analyses of the Water Samples. TH = total hardness in mg/l of $CaCO_3$; SAR = sodium absorption ratio; TDS = total dissolved solids; EC = electric conductivity

NO.	Local Name	Temp C^0	pH.	TH as mg/l of $CaCO_3$	EC. Mmhos/cm	TDS ppm	SAR
1	Bir 5	27.50	7.3	1,130	3,990	2,594	9
2	Bir 12	32	7.5	810	3,370	2,191	10
3	El Fateh 1	27.40	7.5	610	2,430	1,580	8
4	El Fateh 2	25.80	7.6	360	1,669	1,085	8
5	El Massora	25.10	7.7	400	1,734	1,127	8
6	Bir Raghwi	23.70	7.9	930	3,460	2,249	10
7	coal mine (w. Massajid)	26.40	-	890	3,530	2,295	10
8	Coal mine (w. El Safa)	-	7.5	4,040	9,800	6,370	11
9	Bir Umwerib	24.30	7.9	1,160	4,001	2,601	9
10	Bir El Maghara	23.80	7.7	900	3,400	2,210	9
11	El Hedoud	26.20	-	1,000	4,190	2,724	11
12	Cistren (Haraba)	-	-	180	403	262	1
13	Bir El Malhi	22.10	-	2,150	8,300	5,395	16
14	Bir El Masoutia	28.10	7.4	1,500	4,680	3,042	9

Cations (mg/l)				Anions (mg/l)					
Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Co_3^{--}	Hco_3^{-}	So_4^{--}	Cl^{-}	NO_3 as nitrogen N	NO_3 as NO_3^{-}
292	96	734	11	Nil	232	510	600	3	13.2
196	77	629	10	12	226	480	475	3	13.2
136	65	470	9	Nil	232	390	300	1	4.4
84	36	365	6	18	250	75	200	5.2	22.9
92	41	376	7	12	238	150	210	4.6	20.2
132	144	669	16	21	232	200	460	2	8.8
204	91	690	10	9	189	400	535	3	13.2
952	398	1,558	28	Nil	354	1,030	2,094	0.1	0.4
240	134	734	19	9	268	250	650	2.1	9.2
188	103	640	12	6	268	200	480	2	8.8
180	132	799	15	15	299	150	665	0.2	0.9
60	7	30	9		214	16	20	3	13.2
440	252	1,681	19	15	329	880	1,525	ND	ND
340	156	799	19	9	214	375	845	ND	ND

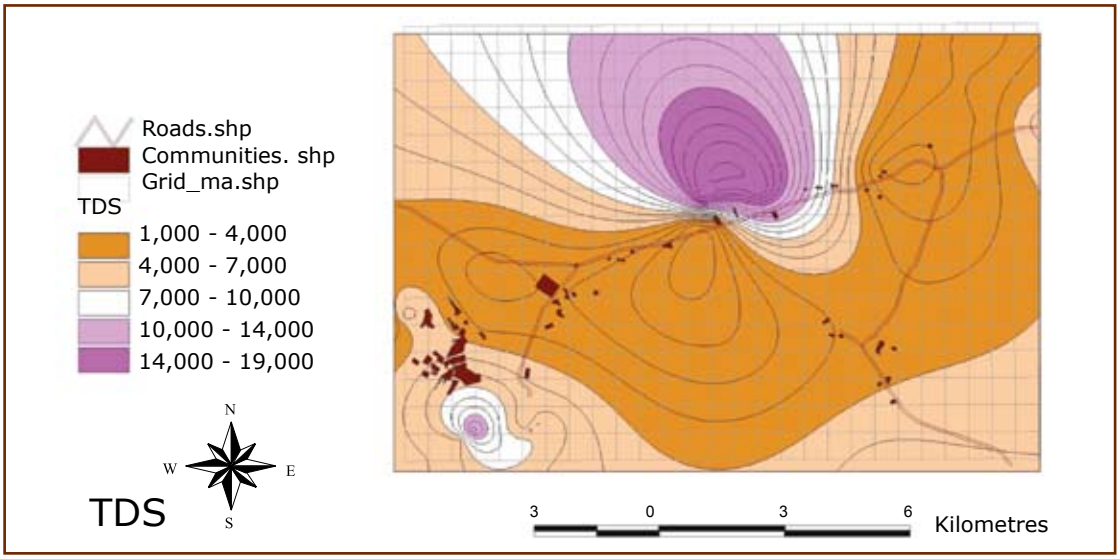


Figure 2.17. Salinity in aquifers map, El Maghara area

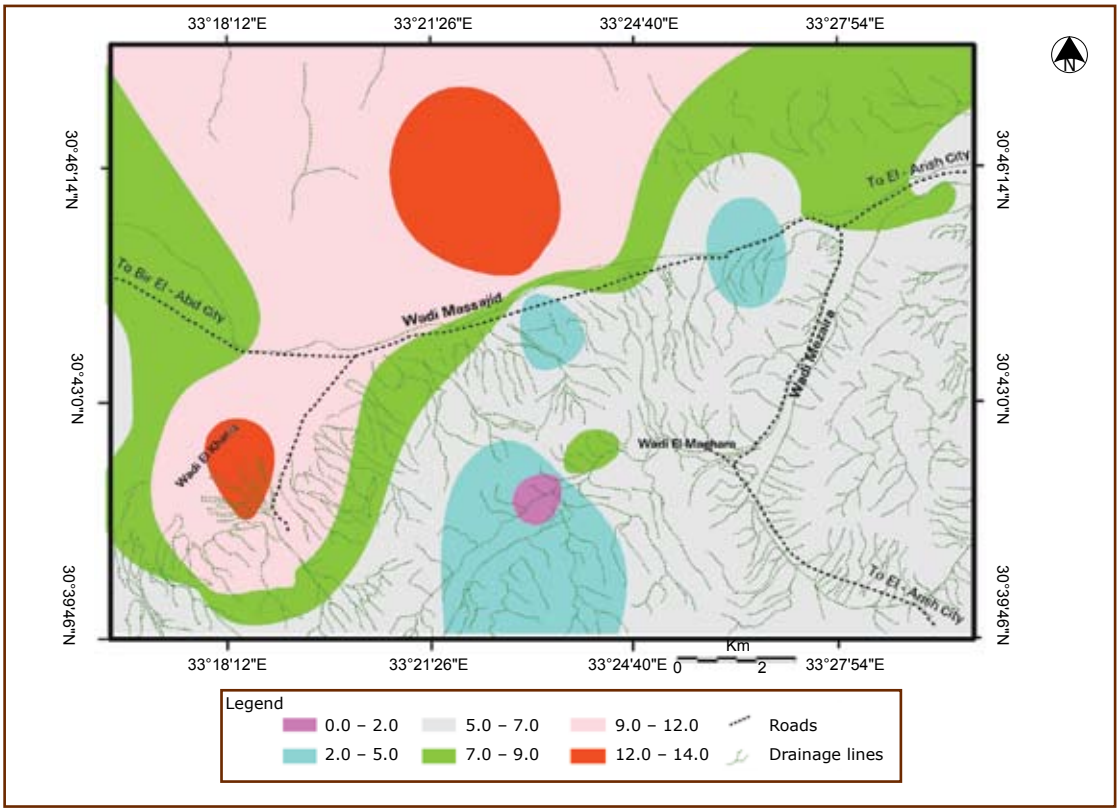


Figure 2.18. Sodium absorption ratio (SAR) map of all aquifers in the study area

according to their corresponding catchment areas. The average net recharge is estimated to be about 5 mm/year for Bir El Maghara aquifer where it locates on the high lands and their fractures are filled with loam. The calculated recharge for Bir El Maghara aquifer is about 81,395 m^3/year (Table 2.7). Around El Maghara, all watersheds have significantly low water supplies except Wadi Mezaira, which is sparsely populated.

In El Maghara area, the local authority (municipality) only supplies inhabitants with brackish water, via water trucks, for their non - drinking use. Bedouin get their drinking water supply either through the collection of rain in earth

Bedouin with a tank on their way to collect drinking water from Bir El Abd
Source: Mohamed Tawfic

collection halls, or buying water in big tanks from Bir El Abd, the closest village centre where clean freshwater is available.Gleick (1993) proposed that international organisations and water providers adopt "an overall basic water requirement of 50 litres per person per day" as a minimum standard to meet four basic needs—drinking, sanitation, bathing, and cooking. Falkenmark and Widstrand use the figure of 100 litres of freshwater per capita per day for personal use as a rough estimate of the amount needed for a minimally acceptable standard of living in developing countries for basic household needs such as drinking, bathing, and cooking, not including use for agriculture and industry (Falkenmark and Widstrand 1992).

Figure 2.19 shows the great variations in current per capita water availability for each watershed in El Maghara area. Wadi Mezaira has over 4,000 cubic metres per person per year (m^3/person/year). The average for both Wadi El-Khariq and Wadi El-Fateh watersheds is under 1,000 m^3/person/year, while that for Wadi El-Massajid is about 1,756 m^3/person/year.

Table 2.7. Water Availability and Actual Water Allocation by Watershed

Watershed	Available Renewable Water Resources (m^3/year)			Population	Per Capita Water Availability (m^3/inhabitant/year)	Actual Water Allocation (for Drinking and Domestic Purposes)	
	Surface Water	Ground Water	Total			Total Population (m^3/year)	Per Person (liters/day)
W. El-Khariq (El-Mangem village & Bedouin communities)	450,682	358,108	808,790	1,500	539	5,000	9
W. El-Massajid (Bedouin communities)	558,391	281,371	839,762	500	1,679	1,500	8.2
W. Mezaira (Bir El-Maghara)	543,527	81,395	624,922	150	4,166	500	9
W. El-Fateh El Maghara village (El-Massora & El-Masoutia)	550,959	754,820	1,305,779	1,500	871	5,000	9
Total	2,013,559	1,475,694	3,579,254	3,650	7,255	12,000	35.2

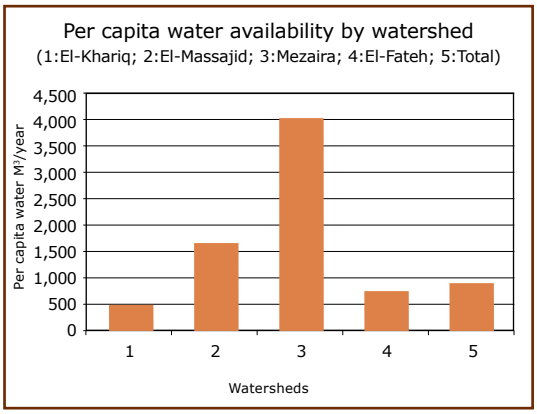


Figure 2.19. Variations in current per capita water availability for each watershed in El Maghara area

2.3.6 Water Scarcity

Water resources in the study area are very scarce. The area has experienced a significant drop in the precipitation rate over the last ten years. With the impact of climate change, the possibility of even less rainfall in drylands seems high.

2.3.6.1 Impact of Land Use Change on Flashfloods Harvesting

Flashfloods constitute a prominent component of the freshwater that the Bedouin use for their daily life and also for growing their crops.

The Bedouin know, through intuition and long experience, the route that flashfloods will take to reach them from the highlands down to the wadis where they live and grow their crops. As the season of flashfloods approaches, they start checking these paths, removing all obstacles that may obstruct the floods to ensure a high harvest. With the large increase in the number of stone and marble quarries in the area, many in the highlands, gravel contractors have constructed new alleys and roads to reach them. The Bedouin claim that most of these newly built roads are intercepting flashflood supply, dispersing water and causing the loss of a large potential source of water.

2.3.6.2 Increased Demand for Freshwater

Prior to the discovery of coal in the study area, the water resources available were enough to sustain the sparse population of nomads and their domestic animals. Once the coal mines came into operation more information about groundwater resources became available. But water resources have been increasingly stressed, as total water demand increased to supply both the domestic and drinking needs of mine workers and to sustain mine operations. In addition, the dewatering processes for coal seams have increased the total discharge from the groundwater reserves.

2.3.6.3 Heavy Metal Pollution of Groundwater

Coal mining processes emit the residues of a number of heavy metals. Wastewater and dewatering processes also involve the emission of heavy metals and other organic pollutants. In El Maghara coal mine both wastewater and dewatering flows are disposed of around the mine.

With the sandy nature of the El Maghara desert, high residues of heavy metals and other pollutants leach through the sand particles, reaching the groundwater, the main source of potable water in the area. In addition, the heaps of coal lined up for transport are often exposed to flashfloods that wash away many of the heavy metal and other contaminants, dispersing them in the soil, leaching parts to the groundwater.

A government built dam to collect flashflood water around the assessment area

Source: Mohamed Tawfic

Water samples collected from various wells in the assessment area were analysed to monitor concentrations of heavy metals. The results (shown in Table 2.8) indicate the presence of a wide spectrum of contaminants in almost all water samples.

2.3.6.4 Microbial Contamination

Another and equally serious source of pollution is microbial contamination of groundwater in El Maghara area (Table 2.9). Samples from main wells in the assessment area were analysed for their microbial load. Results indicate hazardous levels of microbial contamination in almost all water samples tested. The Bedouin store their water supply in open tanks, exposed to dust and air, with almost no sanitary precautions.

2.4 Agriculture and Grazing

Agriculture is the oldest activity of the Bedouin living around El Maghara. Despite water limitation and soil degradation, agriculture is one of the most important services in the assessment area. Only a limited part of the area is supplied with groundwater. Other parts of the region have no regular supply of water; hence agriculture is sporadic, depending mainly on the limited amount of rain. The main crops grown in the area are olive trees, peaches, cantaloupe, barley and almonds.

There are no reliable figures on agricultural productivity but considering the prevailing conditions one would expect a very low production rate. Yet the potential for agriculture is reasonable if a source of water is ensured. Research conducted by the Desert Research Centre indicated the ability

Table 2.8. Residues of Some Heavy Metals in Water Samples Collected from El Maghara (Manganese, Iron, Nickel, Copper, Cobalt, Lead) (n.d, Not Detected)

Local Name	Manganese ppm	Iron ppm	Nickel ppm	Copper ppm	Cobalt ppm	Lead ppm
Bir 5	0.06	n.d	0.4	0.06	1.43	0.26
Bir 12	0.06	0.22	0.4	n.d	0.71	0.26
El-Fateh 1	0.06	0.15	n.d	n.d	n.d	n.d
El-Fateh 2	n.d	n.d	n.d	n.d	n.d	n.d
El-Massora	n.d	n.d	n.d	n.d	n.d	n.d
Bir Raghwi	0.09	0.22	n.d	n.d	n.d	n.d
Coal Mine (W. Massajid)	0.09	0.19	n.d	n.d	n.d	n.d
Coal Mine (W. El Safa)	0.09	0.76	0.4	n.d	1.79	0.4
Bir Umwerib	0.06	n.d	n.d	n.d	n.d	n.d
Bir El-Maghara	0.12	n.d	0.8	n.d	n.d	n.d
Bir El-Hedoud	0.06	n.d	0.8	n.d	n.d	n.d
Cistren (Haraba)	0.32	0.72	n.d	n.d	n.d	n.d
Bir El-Malhi	0.09	n.d	n.d	n.d	n.d	n.d
Bir El-Masoutia	0.09	0.31	n.d	n.d	n.d	n.d

Table 2.9. Levels of Bacterial Contamination of Water Samples Taken from Some Haraba in Central Sinai. TBV = total viable bacteria; CFU = colony forming unit; FC = fecal coliform; FS = fecal streptococci.

Sample Name	TVB cfu/ ml	FC cfu / ml	FS cfu / 100 ml
Mezaira Haraba	1,600	Nil	Nil
El Menissi Haraba	1,900	1	Nil
Karma Dam	2,500	160	Nil
Egyptian Standards	100	Nil	Nil

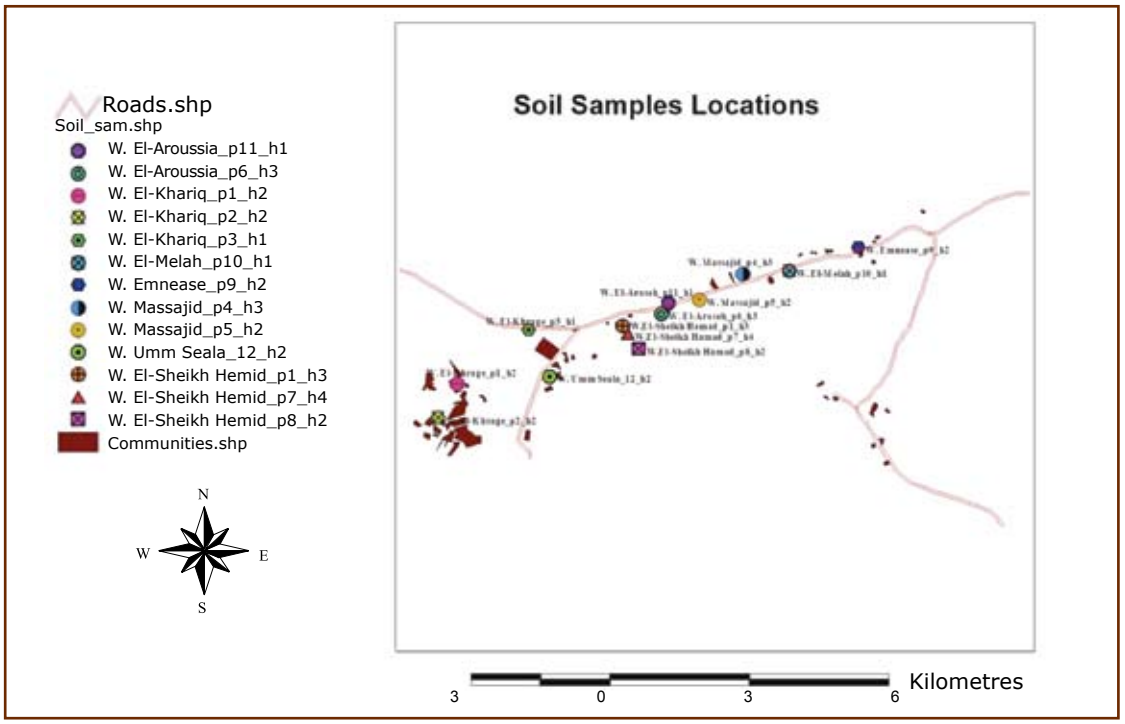


Figure 2.20. Soil sampling sites

to grow a number of economic crops such as nuts, spices, and fruits. Olives are a staple food in the area and olive oil is widely used.

The intercropping system practiced by the Bedouin is a part of agro-diversity. They use barley with olive trees and cantaloupe for intercropping. Barley can tolerate water salinity and can be used as fodder for camels. The intercropping system enables the Bedouin to protect their lands from degradation and erosion; in addition, it improves water use efficiency and increases productivity.

Dewatering of coal seam around El Maghara area, a main cause of groundwater pollution
Source: Mohamed Tawfic

2.4.1 Soil Profile and Soil Quality

Part of the present study was to ascertain the capability of soil to sustain agriculture and the potential for agricultural expansion. Soil samples were collected from different locations to cover El Maghara area (Figure 2.20). Chemical analysis of soil profile samples was performed; meanwhile, Landsat images were studied to ascertain soil suitability and agriculture capacity.

El Maghara landscape is flat or almost flat. Soil parent materials are calcareous deposits and sometimes sand deposits. The natural vegetation varies between scarce to commonly dense vegetation, with some special small farms scattered in the area. The area is well drained. Gravel, sand, loamy sand, sandy loam, and loam are the main abundant textural classes in the study area. Soil is mostly dry all through the year. Soils, in general, are characterised by a coarse to medium sand texture, with high content of $CaCo_3$. Based on the biological, chemical and organic content of El Maghara soil samples, soil fertility, silt content, and organic matter maps could be inferred (See Figures 2.21, 2.22, and 2.23,respectively).

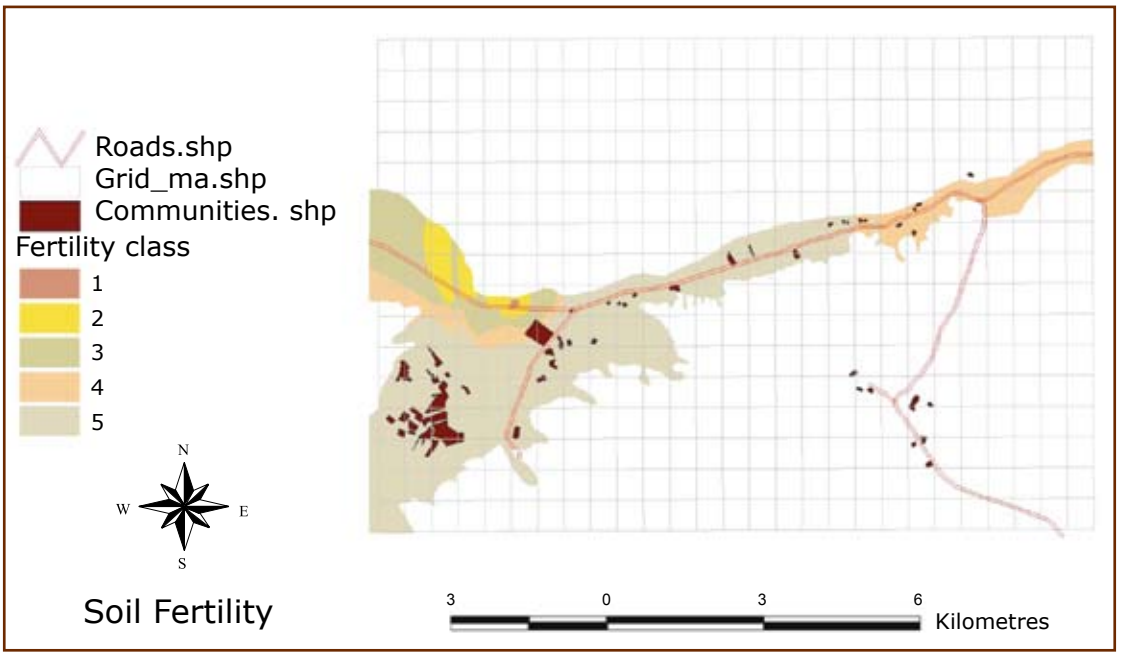


Figure 2.21. Soil fertility map, El Maghara area

2.4.1.1 Potential for Agriculture in El Maghara

The potential for agriculture around El Maghara varies between marginal and high. Areas of good potential for agricultural development tend to have some problems, such as salinity, erosion and the typical issues surrounding sandy terrain, such as poor retention of water and nutrients. Other parts suffer from sand dune encroachment.

2.4.1.2 Soil Evaluation Parametres

Soil samples taken from different locations around El Maghara were evaluated from the agricultural point of view according to the Sys System (1991). The data sets were collected from thirteen soil profiles to build a database representing the study area. Using ARC/INFO GIS software the physical and chemical parametres used in the Sys equation were contoured to construct line digital maps (layers). These layers were converted into polygon layers. An average weight of physical and chemical soil properties was used to evaluate soil capability, fertility and suitability for agriculture.

All layers have been integrated into one layer. The integrated layer is used to classify or rate the soil in the study area into five categories (Figure 2.24) according to the classification criteria given by Sys System (1991). Meanwhile, the integrated map of El Maghara shows five classes, ranging from very low to highly fertile (Figure 2.25). The final capability index ranged between 16.4 per cent and 66.8 per cent; hence, the area is classified as classes C2, C3, C4, C5, and C6 with 66.8, 48.5, 29.8, 16.4, and 10.03 per cent respectively from the total study area (Table 2.10).

Table 2.10. Suitability Rating and Classes for Agricultural Use in El Maghara Area

Capability Class	Average %	Land Suitability Class	Suitability for Agriculture
C2	66.8	Highly Suitable	Good
C3	48.5	Moderately Suitable	Fair
C4	29.8	Marginally Suitable	Poor
C5	16.4	Currently not Suitable	Very poor
C6	10.03	Permanently not Suitable	Nonagricultural

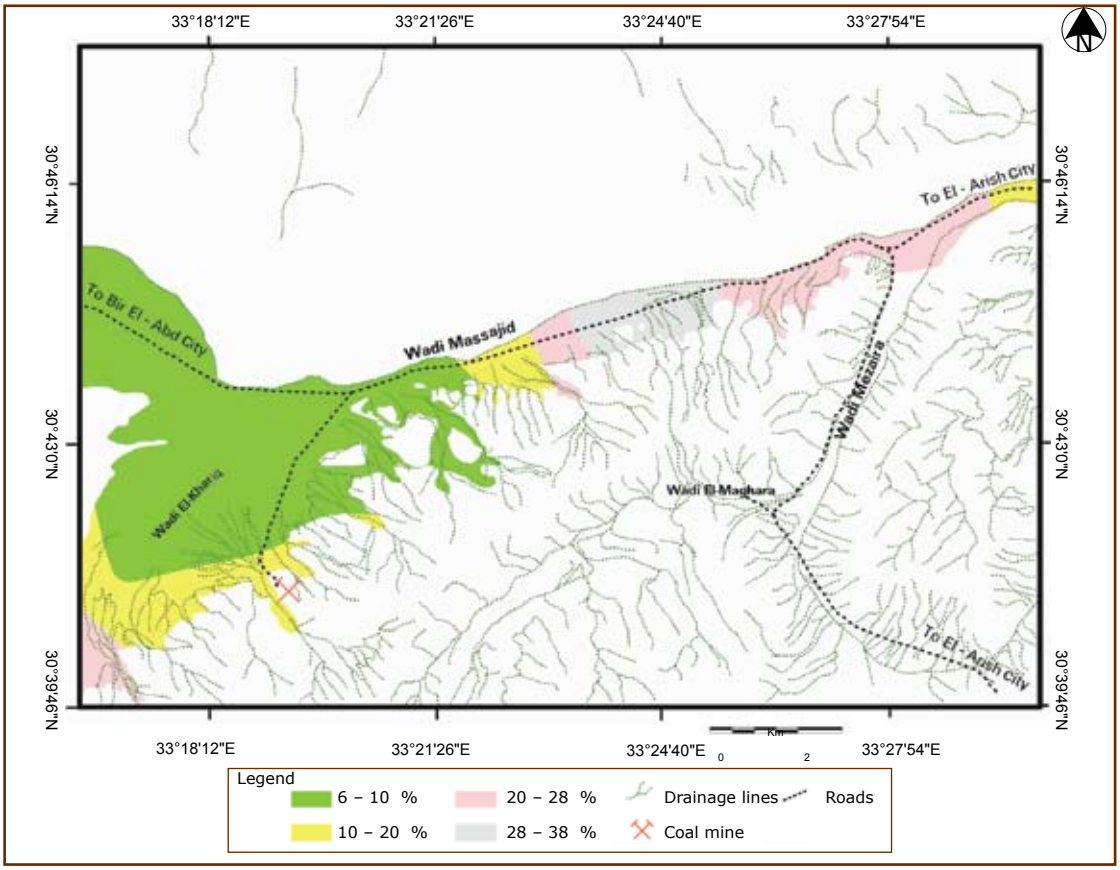


Figure 2.22. Silt content map, El Maghara area

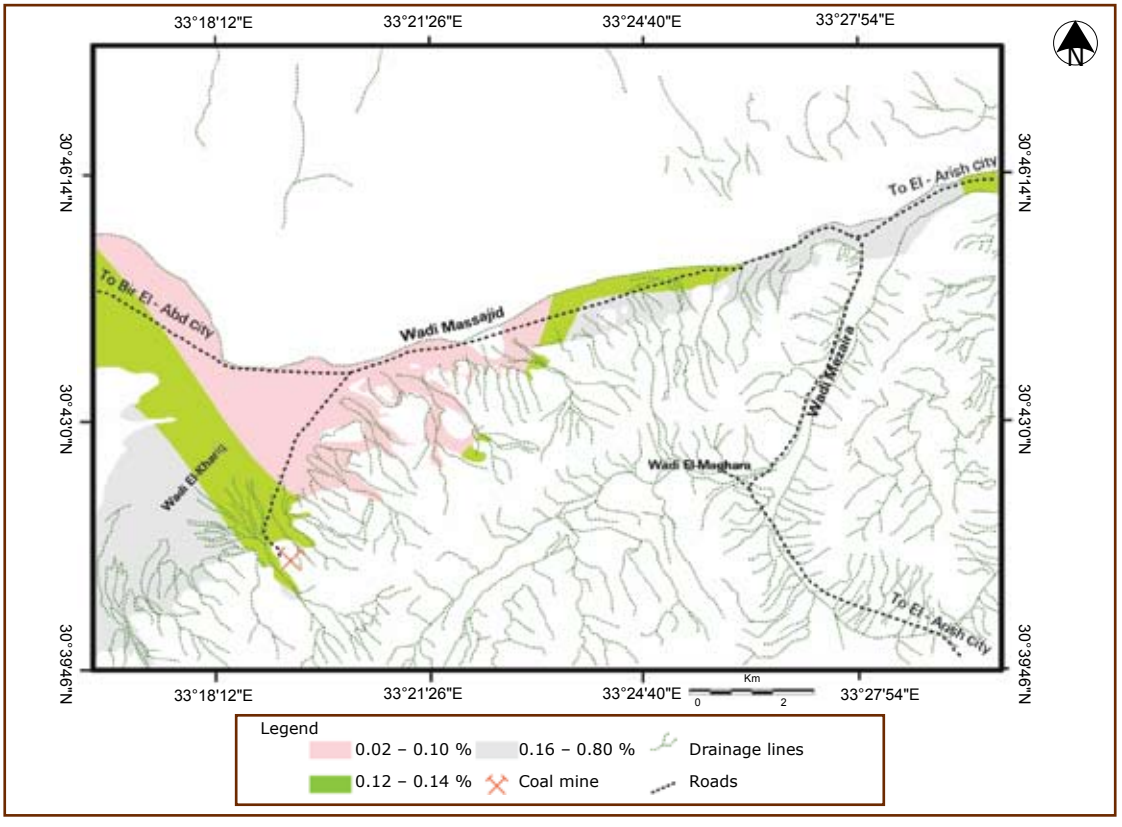


Figure 2.23. Organic matter map, El Maghara area

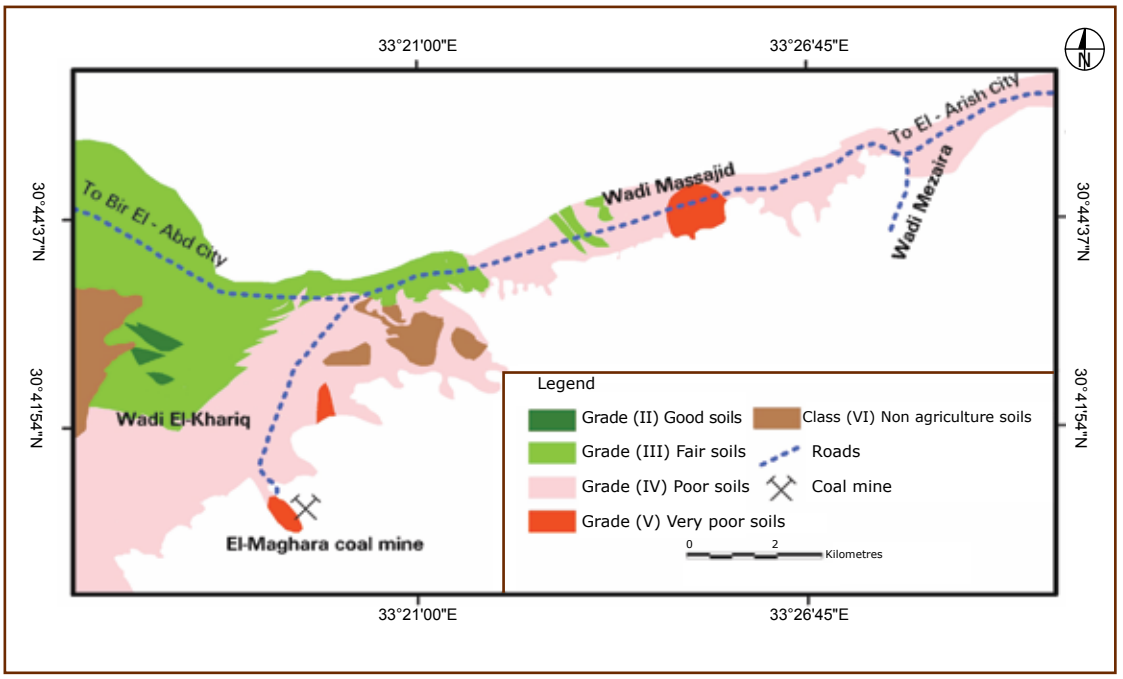


Figure 2.24. Integrated land capability classes map, El Maghara area

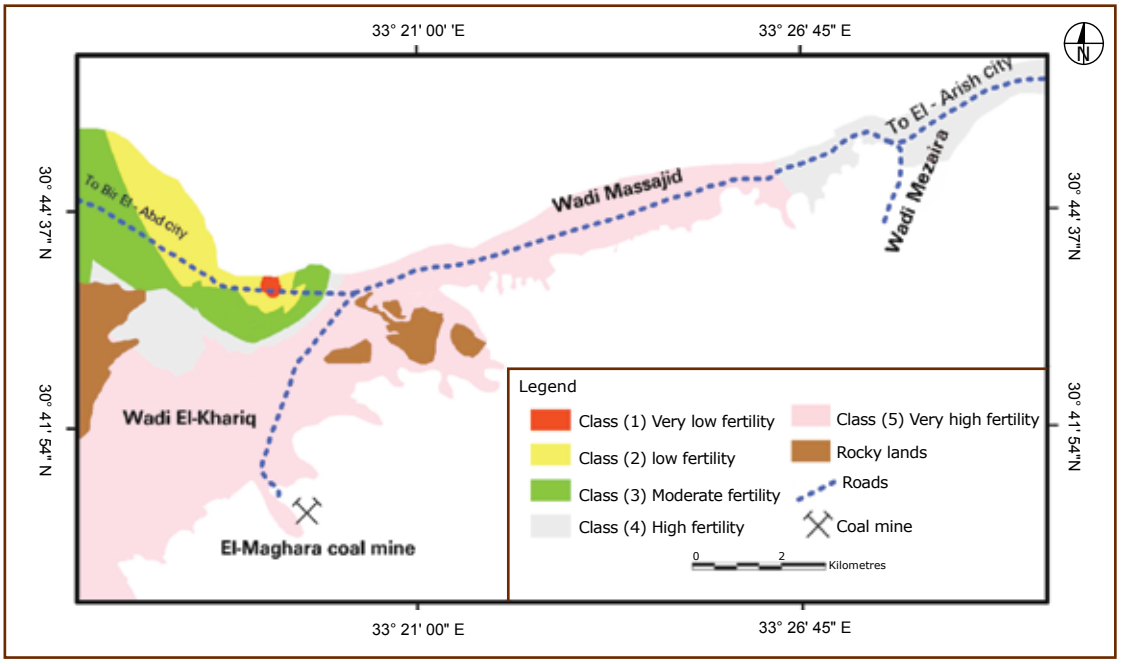


Figure 2.25. Integrated fertility classes map, El Maghara area

2.4.2 Impacts on Agricultural Services

Agriculture has been hard hit by the coal mine located in the area. During the rainy season, wastes produced by the mine are carried by runoff, moving to the surrounding areas, causing soil contamination, killing vegetation, and possibly causing other damage. The mine wastes are drained to a large basin built from cement and located far away from the mine area, but very close to the rain fed area used for agriculture. Because the basin is not well constructed, the drain water seeps from the basin and spreads over the land causing the previously mentioned impacts.

2.4.2.1 The Impact of Coal Mining on Soil Inhabiting Organisms

The impact of coal mining and related activities on some soil fauna and flora was assessed. Soil samples were collected from different sites, at different distances from the mine. The samples were assessed both for their content of total petroleum hydrocarbons (TPH) and for their faunal and floral diversity. The amount of TPH found in a sample is useful as a general indicator of petroleum contamination at that site. TPH released to the soil may move through the soil to the groundwater.

One TPH compound (benzene) has been shown to cause cancer (leukaemia) in people. The International Agency for Research on Cancer (IARC) has determined that benzene is carcinogenic to humans (Group 1 classification). Some other TPH compounds or petroleum products, such as benzo (a) pyrene and gasoline, are considered likely to be carcinogenic to humans (IARC Groups 2A and 2B, respectively) based on cancer studies in people and animals.
Most of the other TPH compounds and products are considered not classifiable (Group 3) by the Agency of Toxic Substances and Diseases Registry, ATSDR (http://www.atsdr.cdc.gov/toxprofiles/phs123.html).

Similarly, the concentration of iron in soil samples indicates a close relationship with proximity to the coal mine site, with the highest concentration recorded in the sample closest to the mine. The results of the sample study showed a significant relationship between proximity to the coal mine and concentrations of total petroleum hydrocarbons and iron (Table 2.11) as well as floral and faunal diversity.

Water scarcity and failing crops, empty row in a barley field
Source: Mohamed Tawfic

Coping with water scarcity in El Maghara
Source: Mohamed Tawfic

2.4.2.2 Impact of Coal Mining on Soil Fauna

Soil fauna make a significant contribution to soil fertility and productivity. They can also be used as a good indicator of soil quality and its pollution content. The soil samples collected at various distances from the mine showed that the total number of isolated fungi, bacteria, nematode, yeasts, mycorrhizal fungi, and protozoa differed significantly according to distance. The samples closest to the mine had the

Table 2.11. Residues of Total Petroleum Hydrocarbons and Some Heavy Metals in Soil Samples Collected from around El Maghara Coal Mine

	S1 around the mine	S2 500 meter distant	S3 1000 meter distant	S4 1500 m distant	S5 1800 m distant	S6 2000 m distant
Moisture%	0.8	0.4	0.3	0.8	0.7	0.3
TPH (ppm)	5,000	300	400	300	300	260
Fe (ppm)	16,500	10,800	10,400	10,700	5,400	5,000

least faunal and floral count, while distant samples showed noticeable increases in population and diversity (Figure 2.26).

The highest number of isolated micro-organisms and nematodes were observed in soil sample numbers S5 and S6; by contrast the lowest number was detected in the soil sample S1. Microscopic examination showed that fungi samples isolated from the soil samples collected in closest proximity to the mine (S1, S2, and S3) had obvious distortions in their structures, accompanied with a noticeable rate of malformation (Figure 2.27).

2.4.2.3 Soil Salinity

Soil quality studies conducted during the present work have revealed the high salinity of soil in El Maghara. (Figure 2.28) Salinity is a major factor contributing to soil degradation. In the absence of rain, the extensive use of highly saline groundwater in agriculture is likely to be one of the reasons for the high salinity recorded in soil samples.

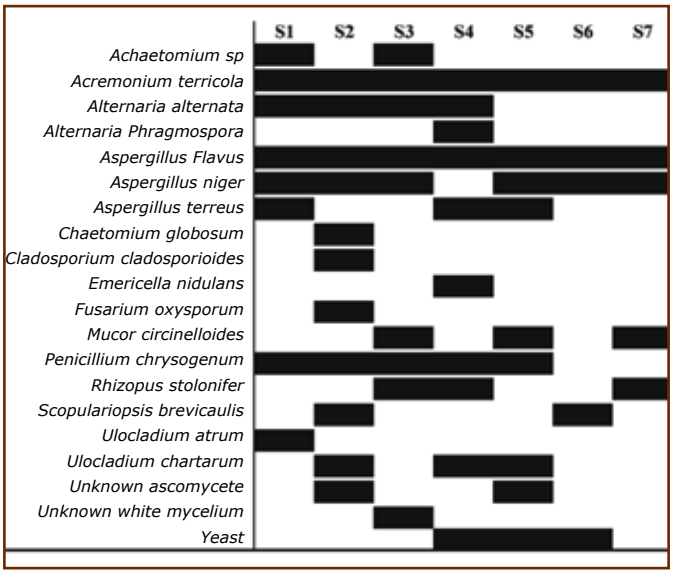


Figure 2.26. Biodiversity and population density of some soil inhabiting organisms around El Maghara coal mine

2.4.3 Grazing

Grazing is the single largest land use pattern in Sinai. Grazing is primarily an activity of Bedouin women, with almost no involvement from men. Women

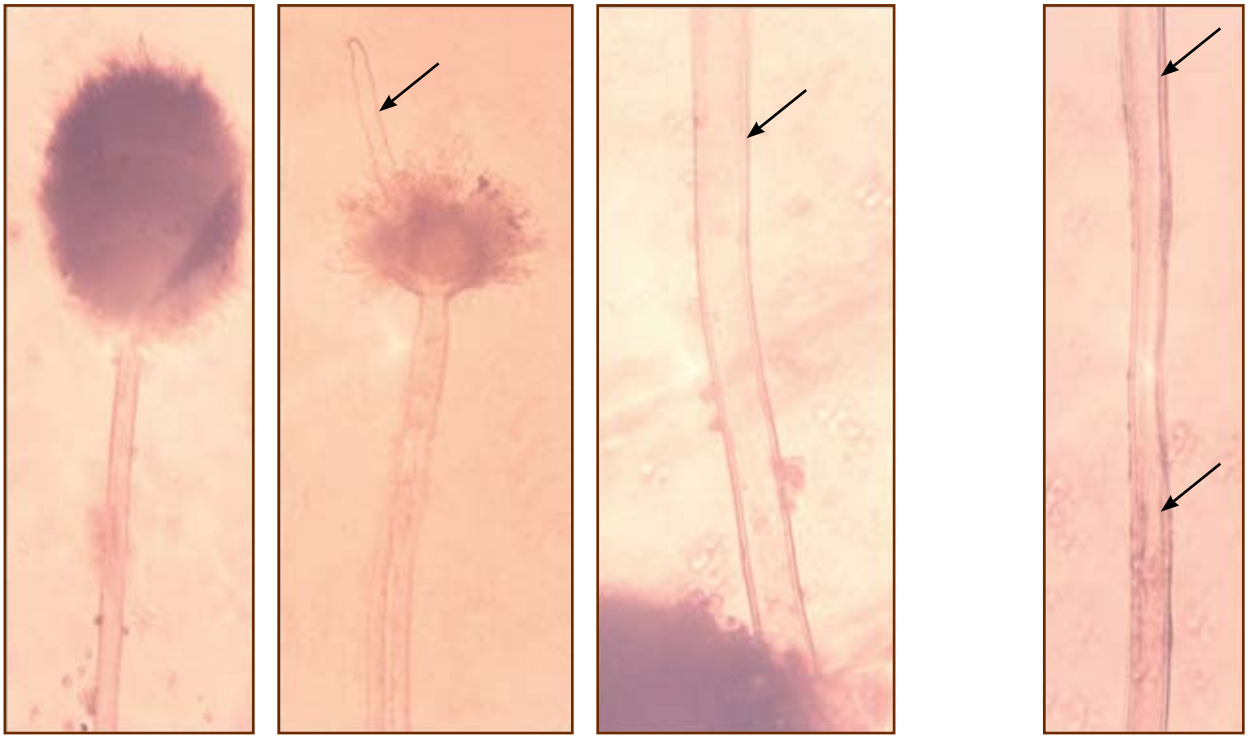


Figure 2.27.
A B C D
The morphological distortion in an isolate of Aspergillus Niger from the study area compared with the normal isolate of the same fungus. A = Normal morphological characters of the fungus; B = abnormal morphological characters in fungus phialides (Arrow); C = Normal conidiophore of the fungus; and D = Abnormal morphological characters in fungus Conidiophore (Arrows)

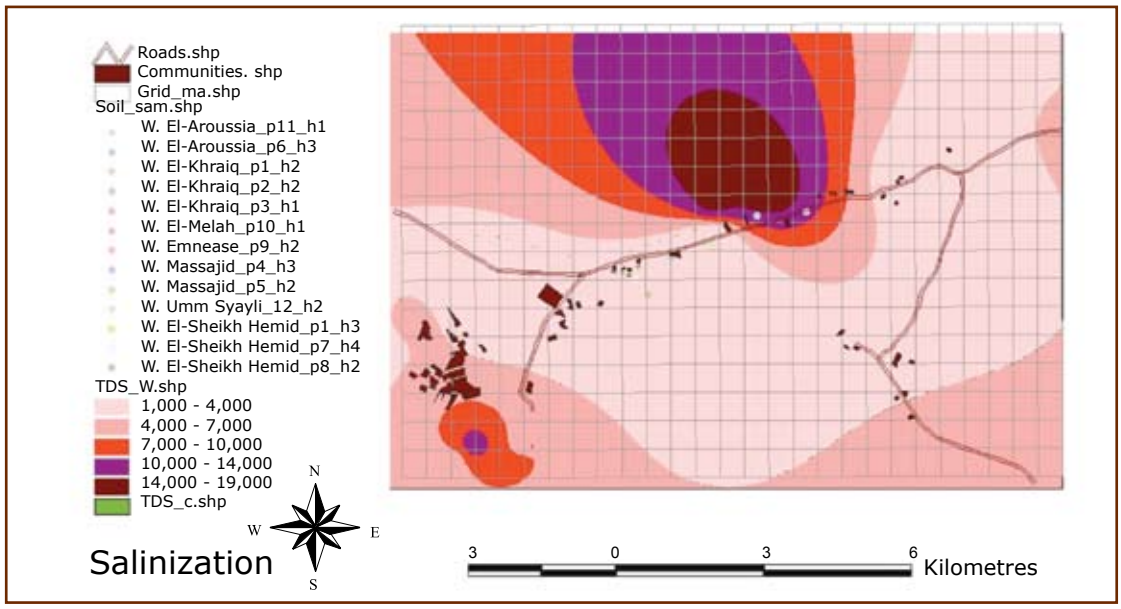


Figure 2.28. Soil salinity map, El Maghara area. (TDS = Total Dissolved Solids)

have developed a good sense for recognizing the various types of herbs that animals feed on, with a remarkable ability to distinguish toxic and harmful weeds. Grazing provides a long list of supporting services that contribute to the well-being of the Bedouin and supports their presence in the Sinai's harsh arid ecosystem:

- meat and milk, the primary production of grazing, supply the Bedouins' need for proteins
- camels provide the primary source of transport
- organic manure is an important livestock product
- the Bedouin construct their shelters from animal skins

Impact of drought on grazing at El Maghara
Source: Mohamed Tawfic

- animal wool is used as the primary material to produce a variety of household and farming tools
- wool is also the backbone of some handicraft industries such as rug making, and it can also be used in bedding and clothing
- in orchards, sheep are often used to control weeds and thus constitute a profit-producing biological control
- animal grazing removes older, less productive plant species and stimulates re-growth of useful plants, and this is in turn reduces soil erosion

Water scarcity is the major driver affecting grazing in the study area. Women are most affected by water scarcity since it forces them to travel longer distances to find the right vegetative cover for their herds.

2.5 Mineral Resources

El Maghara area is rich with mineral deposits. Rock diversity and coal seams allowed many industrial and mining activities in the area. The dominant rocks around El Maghara and their uses are summarised in Figures 2.29 and 2.30. They are:

Quarrying limestone at Aroussia
Source: Mohamed El Shafie

- Safa coal-bearing formation
- some types of shale used for the enrichment of soil fertility
- pure limestone ($CaCO_3$) used in the chemical and pharmaceutical industries
- limestone and clay used in the cement industry
- marble, sand and gravel used as building materials.

Limestone, the most abundant rock in El Maghara, is mostly intercalated with marl, clay, and sandstone beds. Beds of chalk, shale, and dolostone exist sporadically in most of the stratigraphic rock formations, but are not common. Quarrying for limestone-crushed building stones and carbonaceous clays is the most common activity in the study area. Coal seams were discovered in Gebel El Maghara in 1957 by the Geological Survey of Egypt (Al Far 1966; Farag 1975; Jenkins et al. 1982; and Naim 1984). Al Far (1966) recorded a thickness of about 1,900 metres for the Jurassic stratigraphic lithological horizons, where the coal seams are restricted to the lower part of El Safa formation. The geological map of El Maghara region prepared by Al Far (1966) refers to six stratigraphic formations. The formations, from top (the oldest) to base (youngest) are the following:

Box 2.3 Desert and Natural Resources

A sizeable share of mineral and fossil energy used globally is exported from deserts. Given their low productivity and harsh climate, deserts are only expected to support a relatively small human population. Yet the conditions of deserts make them rich in a few non-renewable mineral resources, in quantities much larger than are required to satisfy the local population.

Water-soluble salts (such as gypsum, borates, table salt, and sodium and potassium nitrates) that readily accumulate in desert deposits due to the ambient dryness, have historically been a product of deserts (Walker 1997). Before the widespread use of industrially fixed atmospheric nitrogen, nitrates used as fertilisers and explosives were mainly obtained from the Atacama Desert, whose saltpetre and salt beds also contain 40 per cent of the world's reserves of lithium, used in medicine and technology (Crawford 1990; Global Desert Outlook, UNEP, 2007

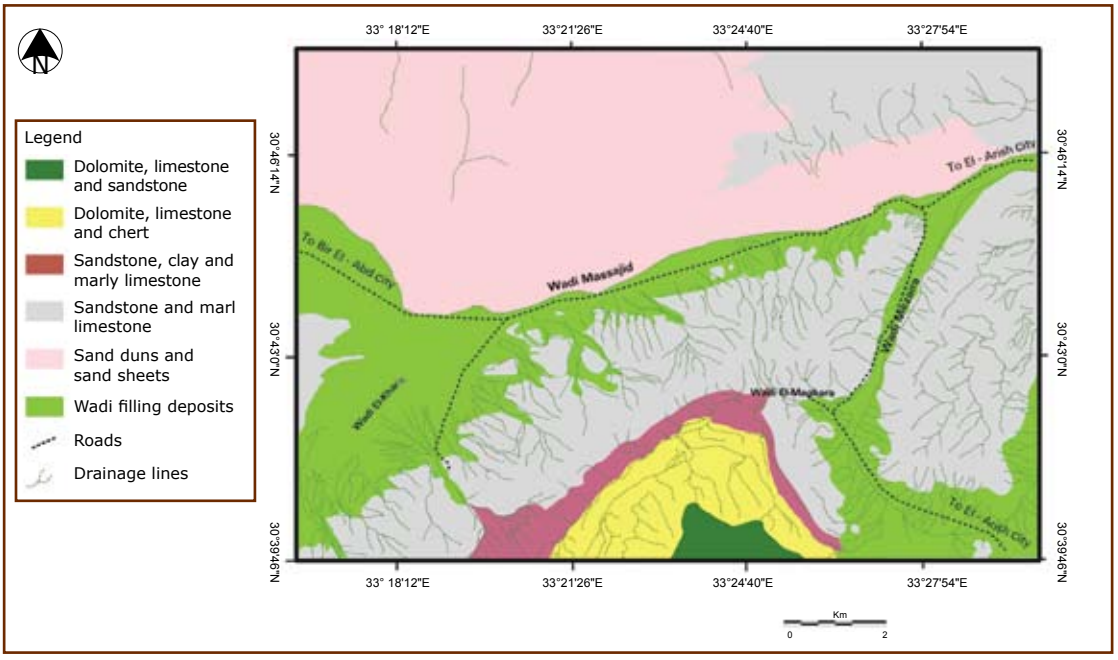


Figure 2.29. Lithological map of El Maghara area

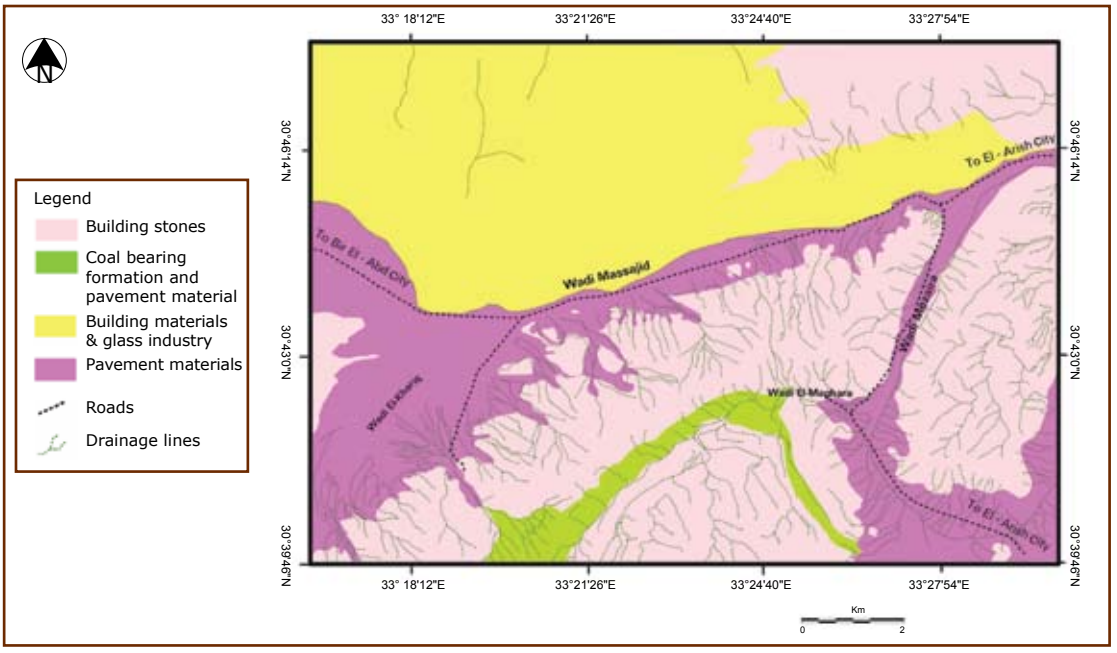


Figure 2.30. Rock use map, El Maghara area

- Massajid
- Safa
- Bir El Maghara
- Shusha
- Rajabia
- Mashabba

Al Far (1966) presented a detailed description of alternating continental and marine sedimentological facies based on calculations of lime, clay, and sand percentages of the strata. Coal seams of "lignite" in Gebel El Maghara area are restricted to the Safa formation (Bathonian age), especially the lower part. Bore hole data show that the upper and main coal seams have a thickness ranging from 90 to 190 cm and that they are economically feasible in two locations:

Stone minning, impact on landscape and air quality
source: Mohamed El Shafie

Safa and Rokb. The total reserve estimation for coal seams at both locations gives about 70 million tons to be extracted (Morsy et al 1992). Exploitation and development mining works have been executed under government supervision for 20 years since the early 1980s.The low grade coal ore, coupled with the high cost of production and extraction processing and poor management, were the main reasons for the big losses incurred which eventually led to the closure of the mine.

References

Abdel Wahab, RH 2005, *Condition assessment of biodiversity of Gebel Maghara. Final report Millennium Ecosystem Assessment*, Suez Canal University, Ismailia, Egypt.

Abou Rayan, M, Djebedjian, B & Khaled, I 2001, 'Water supply and demand and a desalination option for Sinai, Egypt', *Desalination*, vol. 136, pp. 73-81

Al-Far, DM 1966, Geology and coal deposits of Gabal El Maghara, North Sinai, Geological Survey of Egypt, no. 37, pp. 1-59

Ali, MEM 2004, 'On the ecology of Sinai peninsula', MSc thesis, Mansoura University, Mansoura, Egypt.

Batanouny, KH 1985, 'Botanical exploration of Sinai', *Qatar Univ. Sci. Bull*., no. 5, pp. 187-211

Boulos, L 1960, *Flora of Gebel El-Maghara, North Sinai*, Ministry of Agriculture, Cairo.

Boulos, L 1995, *Flora of Gebel El-Maghara (checklist),* Al Hadara Publishing, Cairo.

Boulos, L 1999, *Flora of Gebel El-Maghara, Vol. I (Azollaceae – Oxalidaceae)*, Al Hadara Publishing, Cairo.

Boulos, L 2000, *Flora of Gebel El-Maghara, Vol. II (Geraniaceae – Boraginaceae)*, Al Hadara Publishing, Cairo.

Boulos, L 2002, *Flora of Gebel El-Maghara, Vol. III (Verbenaceae – Compositae)*, Al Hadara Publishing, Cairo.

Boulos, L 2005, *Flora of Gebel El-Maghara, Vol. IV (Monocotyledons, Alismataceae – Orthidaceae)*, Al Hadara Publishing, Cairo.

Crawford, L 1990, 'Amax pulling out of lithium project', *Financial Times*, 8 November 1990, p. 36

Decaisene, J 1834, 'Florula Sinaica: enumeration des plantes recueilles par N Bove dans les deux arabies, la palestine, la syrie et l'egypte', *Ann. Sci. Nat. ser. 2, II and III,* p.239-270

Danin, A 1969, 'Plants of desert dunes', in JL Cloudsley-Thompson (ed.), *Adaptations of desert organisms*, Springer Verlag, Berlin.

Danin, A 1972, 'Mediterranean elements in rocks of the Negev and Sinai deserts', *Notes Roy. Bot. Gard. Edinburgh,* vol. 31, pp.437-440.

Danin, A 1973, 'Contributions to the flora of Sinai II: new records. *Israel Journal of Botany*, vol. 22, pp. 18-32.

Danin, A 1983, *Desert vegetation of Israel and Sinai*, Cana Publishing House, Jerusalem.

Delile, AR 1809-1812, *Description de l'egypte. Histoire naturelle vols. I and II*, Imprimerie Imperiale, Paris, pp. 49-85, 145-320.

El-Gazzar, A, El-Demerdash, MA, El-Kady, HF & Heneidy, SZ 1995, *Plant life in the Gulf of Aqaba (South Sinai, Egypt). Final report,* Egyptian Environmental Affairs Agency, Cairo.

El-Hadidi, MN 1969, 'Observations on the flora of the Sinai mountain range', *Bull. Soc. Geogr. Egypt*, vol. 40, pp. 123-155.

Falkenmark, M & Widstrand, C 1992, Population and water resources: a delicate balance. Population Bulletin, Population Reference Bureau, Washington DC.

Farag, MIM 1975, 'Geological studies on some subsurface bathonian section in Gebel El Maghara area, Sinai, Egypt', MSc thesis, Cairo University, Cairo.

Forsskal, P 1775, 'Flora Aegyptiaco-Arabica' (ed. C Neibuhr), Hauniae. Typ. Moller, 32, CXXV, 1, 219, pp+ 1 map

Fresnius, G 1834, *Beitrage zur Flora van Aegypten and Arabian*, Museum Senckenbergianum, Frankfurt, pp. 9-94, 165-188

Gebali, MAA 1988, 'Studies on the flora of northern Sinai', MSc thesis, Cairo University, Cairo.

Gebali, MAA 2000, 'Plant life in northern Sinai ecological and floristic studies', PhD thesis, Cairo University, Cairo.

Gleick, PH 1993, 'Basic water requirements for human activities: meeting basic needs', *Water International*, vol. 21, no. 2, pp. 83-92.

Ezcurra, E. (ed.) 2007, Global desert outlook, UNEP, New York.

Jenkins, D, Harms, JC & Oesleby, TW 1982, 'Mesozoic sediments of Gebel El Maghara, North Sinai, *6th exploration seminar, Egyptian Petroleum Corporation, Cairo*

Kumar, HD 1999, *Biodiversity and sustainable conservation science*, Science Publishers, Enfield, New Hampshire.

Morsy, AM, Mostafa, EM, Naim, GM & El Ghawaby, MA 1992, 'Geostatistical reserve estimation of the coal seams of Gebel El Maghara, North Sinai', *Proceedings of the 3rd conference of geology and Sinai development*, Ismailia, Egypt, pp. 197-208.

Muschler, R 1912, *A manual flora of Egypt*, R Friedlander & Son, Berlin. 2 volumes.

Naim, GM 1984, 'The potential of coal deposits in Egypt', *Annual Geol. Survey Egypt*, vol. 14, pp. 25-34.

Range, P 1921, 'Flora der Isthmuswueste', *Gesell. Fuer Palaestina Forschung*, vol. 7, pp. 3-44.

Redhead, RM 1866, 'Notes on the flora of the desert of Sinai', *J. Linn. Soc*., vol. 9, pp. 208-235.

Shabetai, JK 1940, 'Contribution to the flora of Egypt: plants collected from southern Sinai in April 1937', *Tech. Sci. Serv. Fouad I Univ. Agr. Museum*, no. 234, pp. 1-84

Sys, C 1991, Land evaluation part I and II lecture notes. Ghent University, Ghent, Belgium.

Walker, AS 1997, Deserts: geology and resources, United States Geological Service, viewed 19 April 2006, http://pubs.usgs.gov/gip/deserts/

Tackholm, V 1932, 'Some new plants from Sinai and Egypt', *Svensk Botanist Tidskrift*, vol. 26, no. 1-2, pp. 370-381.

Tackholm, V 1956, *Students flora of Egypt*, Anglo-Egyptian Bookshop, Cairo.

Tackholm, V 1974, *Students flora of Egypt,* 2nd edn*,* Cairo University, Cairo.

Zahran, MA 1967, 'On the ecology of the east coast of the Gulf of Suez. I – littoral salt marsh', *Bull. Inst. Desert d'Egypte*, vol. 17, pp. 225-252.

Zahran, MA & Willis, J 1992, *The vegetation of Egypt*, Chapman & Hall, London.

Zohary, M 1935, 'Die pytogeographische Gliederung der Flora der Halbinsel Sinai', *Beihefte Botanisches Zentralblatt*, vol. 52, pp. 549-621.

Zohary, M 1944, 'Vegetation transects through the desert of Sinai', *Palaestine Journ. Bot. Jerusalem*, vol. 3, pp. 57-78.

Chapter 3




Local Knowledge: a Valuable Resource

Lead Authors

Mohamed Tawfic Ahmed
Luohui Liang

Contributing Authors

Manal Hassan
Manal Hefny
Naglaa Loutfy
Kariman Mahmoud
Mayar Sabet

Main Messages

Local knowledge is a valuable element in Bedouin life in El Maghara. For hundreds of years, the Bedouin of El Maghara have accumulated a momentous body of information, knowledge and experience that delineated on all walks of life.

The role of local knowledge is quite obvious in practicing agriculture and water management in El Maghara

Sheikh Hemid, one of the main shrines of the area is a landmark of how deeply local knowledge is embedded in the Bedouin's social fabric.

Local knowledge seems to be weakening, especially among young Bedouin who are not adhering to it in the way the older generations did.

There are no institutions or schools that formally teach local knowledge. The Bedouin send their children to schools where the education system does not incorporate aspects of local knowledge and its relation with their environment. As a result, the accumulated body of experience and knowledge is increasingly severed from daily life and regular practice, depriving Bedouin society of the advantages of using such a valuable body of information.

Local knowledge is a uniquely valuable construct of information and experience that should be preserved, enriched and disseminated on a wider scale. One approach that could preserve the rapidly diminishing local knowledge would be to develop new curricula that combine formal and informal information. This would benefit science and people alike.

Formal and informal information could combine in a variety of ways that would ensure mutual benefits for people's information wealth and prosperity. It could be done in a way that allows the coarse finding of informal knowledge to be explained and substantiated by formal science.

The term "indigenous knowledge" is defined as the local knowledge held by indigenous people or local knowledge unique to a given culture or society (Warren et al. 1995). "Traditional knowledge" refers to a "cumulative body of knowledge, practice and beliefs, developed by adaptive processes and handed down through generations by cultural transmission about local ecology" (Berkes 1999). So traditional knowledge may or may not be indigenous.

The Bedouin, the inhabitants of El Maghara, have survived for hundreds of years accumulating ecological and cultural knowledge that has enabled them to continue existing until now, despite the profoundly harsh conditions of the region. Isolation and natural impediments to mobility sparked enormous diversity in socio-cultural systems adapted to local conditions. It also helped the evolution of the rich traditional knowledge on the dynamics, uses and management of resources. The knowledge they possess is unique to them, with roots firmly connected to the past, thriving and developing as a result of their continuous use of this knowledge.

3.1 Local Knowledge and Bedouin Culture

Frequent meetings with the Bedouin shed some light on how local knowledge is used as a means to manage the meagre ecosystem services of El Maghara. Several interviews and general meetings (Magless) were held between the assessment team and the Bedouin, including elders as well as young males and females. Information collected throughout the study revealed the diffusion of local knowledge in almost all walks of life. Throughout the years, it has been deeply embedded in Bedouin existence and the fabric of life. Local knowledge in the El Maghara area is an essential part of daily Bedouin activities and practices, as the following examples show.

Bedouin women in their local dress
Source: Egyptian Environmental Affairs Agency (EEAA)

3.1.1 Sheikh Hemid: The Spiritual Flavour of El Maghara

El Maghara hosts one of the main shrines in Sinai, that of Sheikh Hemid, who is buried in the area and who has a lot of followers around Sinai. The sacred status of Sheikh Hemid goes back to an old Bedouin myth: a gang of bandits attacked wealthy Sheikh Hemid on his way home. He and his small group fought them bravely, but being outnumbered, the bandits managed to kill him. Just before he died, Sheikh Hemid cursed the gang, calling upon God to turn them into trees bound to the earth underneath their feet. According to the myth, each of the large number of acacia trees in the area was once one of these bandits. Sheikh Hemid mausoleum is the small Mecca of all the Bedouin in the area who commemorate the myth once a year with a big festival. On this day, the Bedouin slaughter goats and sheep, distributing the meat to the people nearby.

This commemoration day is an excellent chance for people to meet, young men to search for brides among celebrating girls, and vendors to sell cigarettes, drinks, and other goods to those coming from far away. The big day is also a good opportunity for poor Bedouin to get their share of meat from the slaughtered sheep. With Sheikh Hemid buried in this area, the Bedouin consider it a privilege to bury their dead in the vicinity. The area around has become the graveyard of the Bedouin in the area and others who seek the blessing of the Sheikh.

3.1.2 Agricultural Practices

Local knowledge has shaped the cultural background of agricultural activities in the area. Because of the severe arid conditions in the area, the Bedouin have developed the ability to select and cultivate types of drought-resistant cultivars

Sheikh Hemid, with acacia wood in the background
Source: Mohamed Tawfic

that only exist in their regions. Agriculture is not a sustainable activity for the Bedouin in El Maghara; however, Bedouin have developed their own agricultural traditions and practices.

The Bedouin have their own unit of measurement for the area of arable land that is not used in any other part of Egypt. The special unit is called the "maanah" and it is equal to 40 x 40 metres. So one Maanah is equivalent to 1,600 square metres. A person who owns three maanah would actually own 4,800 square metres. The Bedouin do not use the same unit of measuring area as used in the rest of Egypt, i.e. a "feddan", which is equivalent to 4,200 square metres. They consider the feddan an area too large an area to manage because of the harsh conditions of water scarcity and land degradation in their region.

Sheikh Elyan showing the Sidr trees he planted years ago
Source: Mohamed Tawfic

3.2 Local Knowledge and Biodiversity in Agriculture and Nature

The Bedouin are naturally inclined towards conserving nature and maintaining biodiversity. They have a strong belief that each and every creature in their vicinity is assigned a role to play. One of their basic traits when establishing a site to live on is to keep a buffer distance to separate their homes from water sources. The buffer area would allow animals to come and drink and not to be scared by nearby houses. Examples of the many ways Bedouin in the study area value nature and biodiversity are discussed in this section.

3.2.1 Wild Plants

Old Bedouin around El Maghara believe in the wide benefits of some tree species, including El Sidr tree (Ziziphus spina-christi). Beside the remedial ability of the leaves to relieve skin diseases, the Bedouin also think that Sidr trees keep evil spirits away. Because of the scarcity of Sidr trees in the assessment area one of the Bedouin brought some seeds from South Sinai, some 600 km away. The seeds were planted in the vicinity of the main village, El Zawadin, so the inhabitants can use it. To protect rare plants in their area, the Bedouin keep a barbed wire fence around

Assessment team members with Sheikh Malah, a renowned herbalists
Source: Mohamed Tawfic

A local Bedouin identifies a rare plant species in El Maghara area
Source: Mohamed Tawfic

endangered species in order to protect them from grazing goats and other animals.

3.2.2 Medicinal Plants

Sinai is rich in natural plants with a variety of uses for humans and animals. Some of these plants do not grow in any other place except El Maghara. The Bedouin use these plants as a source of food, for animal grazing and for building their houses and fences, as well as for medicinal purposes.

They also collect the plants from the mountains to sell them for income. The Bedouin are well-versed in the value of many medicinal plants and also use them. There are a few species whose economic value is known but the utility values are not known to local people. Local knowledge could not advance beyond an understanding of the distribution and use of medicinal plants. Considerable scientific knowledge on the domestication of these species does exist but cannot be put into practice at the Bedouin community level.

Living far from cities in isolated places has helped the Bedouin become fully self-reliant, especially in treating their sick people and animals using locally available plants and other materials. This long practice has in turn built up a considerable body of experience through the years, passing the knowledge from one generation to the next. During the assessment, information about Bedouin plant use was obtained through structured and unstructured interviews and the personal knowledge of Bedouin interviewed.

The Bedouin not only depend on the plants to treat diseases, they also have special preparations from non-plant sources. Camel's urine mixed with milk is considered a treatment for some liver diseases. "Israel's Zitona," a sedimentary rock found in some places in the vicinity, is recognised by the Bedouin as an effective remedy for treating kidney stones.

3.2.3 Trees and Vegetable Crops

Information acquired over the years has built up into a valuable database of knowledge about the trees and crops that suit the rugged conditions of the area. Olive, fig, almond and peach are the most common fruit trees in the El Maghara region because of their ability to tolerate salinity and water stress. In areas where groundwater is available, the Bedouin prefer olive trees because of their high tolerance of the saline nature of groundwater. They also cultivate watermelon and sorghum (Damahlia). Watermelon is the only summer crop that suits the region.

The Bedouin practice intercropping, planting different crops with each other to maximise the use of the available water and to stop land degradation. Another advantage of intercropping is that it minimises the risk of

Artemisia plants grown with cantaloupe
Source: Mohamed Tawfic

crop failure as a result of water shortages. If one crop has not been able to withstand water shortage stress, the other crops may continue and thus provide some food. Intercropping also allows the Bedouin to grow a crop with non-crop plants that may perform some other function. For example, cantaloupe are grown with artemisia because of its ability to absorb the soil salinity that reduces cantaloupe production. The Bedouin also believe Artemisia helps fruit setting and repels insect pests. Similarly, they also intercrop barley with cantaloupe because the adjacent barley acts as a sink to collect the salinity in the soil, hence saving the cantaloupe. They also believe that barley stops insects from attacking the cantaloupe.

The Bedouin in El Maghara regularly cultivate barley, both for their own consumption and as animal feed. When growing barley, if the rain is not adequate during the winter season and the crop fails to attain full growth, then the animals eat the already emerging green foliage part of barley. If the water is adequate, growth continues, and the Bedouin harvest the grains they produced for making bread. The Bedouin know that barley is better than wheat in areas where water supply is very limited. The wisdom behind growing barley is that there is always something to gain, either foliage for animal feed or grain for themselves, depending on the availability of water. Wheat, on the other hand, fails to grow if water is not available, producing neither foliage nor grain.

3.2.4 Wood for Agriculture, Tools and Shelters

The Bedouin use local materials to make their own tools, especially those used in agriculture such as ploughs and field lining materials. They also use sheep wool to prepare ropes used for towing and pulling.

The Bedouin build their homes using materials from their surrounding environment. They use palm tree stems and leaves and bind them tightly, using ropes made from goat's wool. They also build fences around their houses using El Ader plants because they know that El Ader is a strong repellent of snakes and scorpions. They are strongly attached to their self-built houses even if the government is providing them with flats built with gravel and cement. The Bedouin use the same local materials for building the halls in which they meet and celebrate their weddings and other social activities.

3.3 Local Knowledge and the Physical Environment

The Bedouin are committed to using their local knowledge to manage their physical environment. Because water is so scarce in the area, much of

Locally made tools used in agriculture
Source: Mohamed Tawfic

Bedioun ladies with team member beside their stone built home, while keeping old home in the back
Source: Mohamed Tawfic

their local knowledge and experience is unique and has been well crafted to produce new methods of water conservation and management. This body of local knowledge includes the physical properties of soil and their effect on crop production. This section provides examples.

3.3.1 Water Harvesting Systems

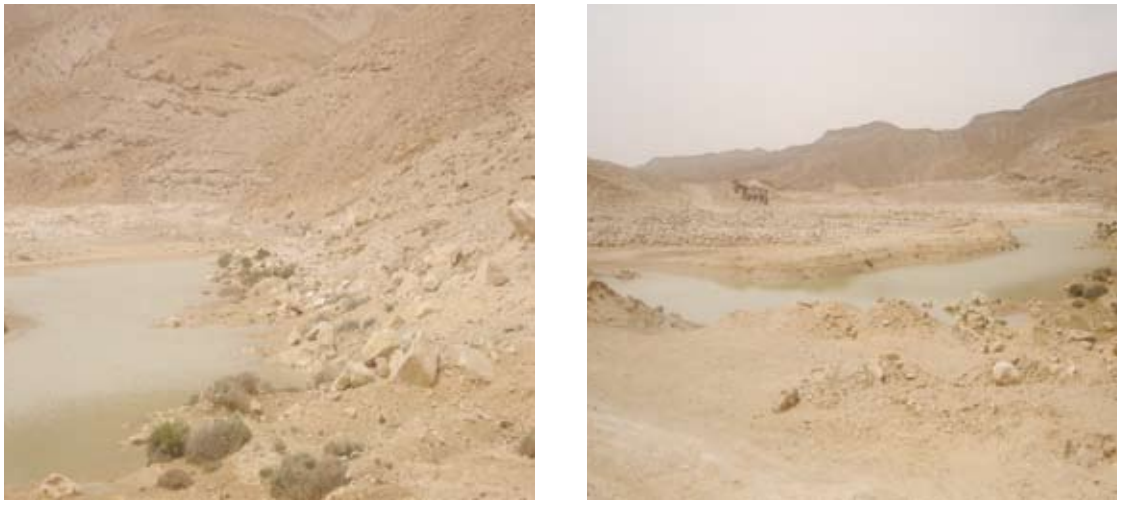
In El Maghara region, local knowledge plays a prominent part in managing water resources, trying to maximise the use of flashfloods and rain to support the community's few agricultural activities and domestic needs.

3.3.2 Sanaa (hafa'ir)

Sanaa (hafa'ir) is an earthen water reservoir that the Bedouin dig into the ground to harvest rainwater. A hafa'ir is usually built in clay soil to keep water for long periods; it is built in gently tilting areas to enable water collection. Bedouin use hafa'ir to collect water for both human and livestock consumption.

3.3.3 Concrete Tanks

Concrete tanks are the most common water harvesting technique the Bedouin use to collect and store rain water for drinking. Rectangular concrete tanks are most common around El Maghara. The



Examples of Sanaa in El Maghara area
Source: Mohamed Tawfic

Concrete tanks established by Bedouin in El Maghara area
Source: Mohamed Tawfic

Bedouin build these tanks even in places far from their homes, but near or in the way of flashfloods, so water can be available for others to use. The capacity of these tanks can be 30 cubic metres, 130 cubic metres, or more. The Bedouin know where to locate these tanks based on their long experience of the flashflood routes. The mouth of the tank, the inlet, is made of a cement opening with a metal cover, while the walls and bottom are plastered with cement to prevent water loss. Water is collected from another opening at the top, using a bucket and a rope; the opening is covered with a metal plate to stop dirt and sand from reaching the stored water. A limited area in front of the tank is smoothed by cement to minimise obstruction of runoff flowing towards the tank inlet. A small basin built in front of the tank acts as a silt trap to separate solid, sand, and other materials floating in the rainwater, and to stop such material from reaching the stored water.

Box 3.1 El Karma Dam

One of the well-known stories in the assessment area is that of El Karma dam that the governorate built a few years ago as one of the measures to manage flashfloods and make the best use of them. After a long study, government officials selected a particular spot to build the dam but the local inhabitants were not convinced about the suitability of that place and recommended a different place. The Bedouin advice was based on their long experience of managing flashfloods and their pathways through the area. The advice of the Bedouin was not heeded and the dam was built in the area selected by the government engineers. The construction of the El Karma dam was completed in 1992 and the dam has hardly received any flood water since. Such poor performance was due to the wrong placement of the dam. The story of the El Karma dam is one of the stories often told by the Bedouin to indicate the importance of local knowledge, and it makes them feel bitter that such a valuable body of information and experience is often ignored.

3.3.4 Sandy Borders (Fences)

Sandy borders are prepared by the Bedouin to harvest water from flashfloods by guiding them from one field to the next. According to Mechlia and Ouessar (2004), this system has a positive effect on soil erosion and groundwater recharge. This traditional technique also reduces surface runoff from the catchments and surface runoff peaks within the catchments, thus also reducing the hazard of erosion (Nasri et al. 2002).

3.3.5 Flashflood Prediction

The Bedouin in the assessment area have the ability to predict flashfloods a few hours in advance. Their prediction is based on observing the wild animals in the vicinity and the sounds

Fences built to keep out flashfloods
Source: Mohamed Tawfic

Flashflood Harvesting, a well-known Bedouin practice
Source: Eeaa

they produce just before the onset of the flashfloods. The Bedouin often make special arrangements in advance to make good use of the flashflood water.

3.3.6 Flashflood Logging

A common practice is to use a series of large intercepting logs to divert the water flow in order to wet a large area of land. Logs are placed in pivotal spots where they can intercept the water flow, causing it to disperse or change course and cover a wider area of land. The positioning of such logs is normally based on the local knowledge of the Bedouin and the experience gained in working out the routes of flashfloods within their territory. Flashflood logging is well known in El Maghara and the elder Bedouin still practice it.

3.3.7 Soil Type

Very often the decision to grow a particular crop is based on the water content of the soil. The Bedouin have the ability to work out crop suitability by measuring how much water the soil holds. One of the common practices for a Bedouin is to dig a hole in which he inserts his arm for a while before pulling it out. If his arm comes out smeared with sand, this indicates that the soil has enough water for growing their crops. If his arm comes out clean with no smears, it indicates that the soil is dry and the possibility of crop failure is high.

3.3.8 Planting Dates

The Bedouin use two planting dates for watermelon cultivation. In clay soil, watermelons are cultivated in late March. In sandy soils, the cultivation date is early April. The selection of dates is based on the Bedouin's long experience of the prevailing weather conditions. As the wind starts to blow in March, seedlings in clay soil are well fixed in the ground with no risk of being blown away by the wind. On the other hand, with the loose setting in sandy soil, seedlings are planted in April to avoid the chance of heavy wind uprooting them.

3.4 Gender Perspective of Local Knowledge

Local knowledge varies between males and females, and between elder and younger Bedouin.

Logging of flashfloods to divert and use water
Source: Mohamed Tawfic

Littering, reflecting changes from production to consumption
Source: Mohamed Tawfic

Community satellite receiver in the middle of the desert
Source: Mohamed Tawfic

Variation may even vary between the tribes and microhabitats of the Bedouin community.In the Bedouin community, the women, who are responsible for cooking, grazing and raising children, are most acquainted with the plants used in treating children's illnesses, for cooking and for grazing animals. Women are also familiar with harmful plants that may hurt their sheep if eaten. Men, in turn, are more familiar with the plants used to treat adult illnesses and those used for commercial and trading purposes. Elders are the main curators of the art of creating recipes and other uses of the wild plants used to address health problems. The elders are also the keepers of the secrets of using plants for such unconventional activities as producing charms for black magic etc.

3.5 Sustainability of Local Knowledge

Several interviews conducted during the assessment revealed that the Bedouin are gradually losing their interest in using natural plants for food, home building and medical purposes. There are several reasons for this growing attitude of disinterest.

3.5.1 Declining Knowledge Transfer

The study showed that young Bedouin are not interested in maintaining the traditional heritage and knowledge. They are no longer interested in learning about medicinal plants, their names and their uses and benefits, by attending family gatherings where this information can be disseminated by the elder Bedouin. Instead, the young Bedouin prefer to leave El Maghara to go to other places, looking for a better life and better employment opportunities.

Few Bedouin families are maintaining regular visits to the area where most of the medicinal plants exist as part of their main rituals. In these visits, the elder Bedouin introduce the art to young boys and girls. Coaching sessions include how to identify suitable herbs for grazing and how to avoid hazardous ones. Identifying shrubs used for fuel wood and the stage of growth at which it should be collected is also an important part of the traditional teaching processes.

There are no institutions or schools that formally teach local knowledge. The Bedouin send their children to schools where the education system does not incorporate aspects of local knowledge and its relation to their environment. This in turn contributes to the marginalisation of local knowledge. As a result, the accumulated body of experience and knowledge is increasingly severed from daily life and regular practice, depriving Bedouin society of the advantages

Using mulch, a changing pattern of agriculture in Sinai
Source: Mohamed Tawfic

of using the valuable body of information that could have a significant contribution to societal values and health.

3.5.2 Changing Lifestyle

Bedouin communities have undergone noticeable changes in their lifestyle during the last few years, probably as part of globalisation trends. Manifestations of such changes are many and include the tendency of families to spend long hours watching television programmes, either national or satellite channels. In areas where no electric power is supplied, the Bedouin buy a power generator mainly to enable them to operate their television sets. Long hours of late-night television watching have changed the pattern of life of many of the Bedouin, with many becoming later risers at the expense of the regular activities they used to perform early in the morning.

The Bedouin are becoming consumers rather than producers, which can be seen in their eating habits. Many Bedouin have settled on buying their food needs, including cereals and fruits rather than growing them around their homes as they did throughout their long history.

In recent years, some of the young Bedouin have succumbed to the temptation of the illegal activities of growing or trafficking narcotic plants. The inaccessibility of some parts of the assessment area is taken advantage of to grow and sell narcotics. Despite the rigorous control imposed by the government, the illegal cropping of narcotics has not been entirely eliminated.

3.6 Bridging Epistemologies: Integrating Local Knowledge into the Formal School Curriculum

In Egypt, local knowledge is rarely incorporated into any curricula at any level of formal education. A few amateurs have attempted to document some elements of local knowledge but their attempts have been limited to particular areas of the whole subject, especially those related to herbal medicine. The need to incorporate local knowledge in educational curricula is urgent, since this is the most viable way to maintain that wealth of information and to maximise its use.

One approach that could preserve the rapidly diminishing local knowledge would be to develop

Traditionally made Bedouin dresses
Source: Mohamed Tawfic

new curricula that combine formal and informal information. This would benefit science and people alike. Both formal and informal information could be combined in a variety of ways to ensure mutual benefits for people's information wealth and prosperity. It could be done in a way that allows the coarse finding of informal knowledge to be explained and substantiated by formal science. In other words, combining formal and informal knowledge is probably best done by starting with informal knowledge as a base that formal science can build on and provide the foundation needed.

One main reason is that many formal knowledge advocates are rather skeptical about informal knowledge, hence providing a solid scientific basis would help build bridges of confidence in the validity of informal science and the message it conveys. On the other hand, informal knowledge, drawing on the wide and old experience it has, could be used as the launching pad for ideas and concepts that formal knowledge tries to pass on, especially to laymen who have a strong tendency to cling to past experience. Because informal knowledge is mostly related to social issues, field practices, and family and children's health, attempts at combining should start with these issues. Emphasis should be laid on issues around which informal knowledge has an undisputable reputation such as folk medicine and management of the physical environment. (Box 3.2).

Box 3.2 Information Validation

Information validation is a core issue in local knowledge and is worth giving considerable time and effort to. The extensive volume of information derived from local knowledge necessitates rigorous screening in order to eliminate incorrect information. Validation in community assessment is especially difficult because references and supporting data are mostly anecdotal related to the particular community. In the case of the Sinai assessment, validation of the information and data collected was done mostly by double checking with a different clan in the same tribe if no other alternatives were available. Another way of validating information is by judging its prevalence in the area and the number of people aware of it. Invalid information receives very little publicity and is hardly known in wider Bedouin circles. Validation could also be done by finding out how the information in question works. In this respect, information in the field of farming practice and medicinal plant use can be validated through field visits, observations and personal judgment

Traditionally made Bedouin rugs
Source: Mohamed Tawfic

References

Berkes, F 1999, *Sacred ecology: traditional ecological knowledge and resource management*, Taylor & Francis, Philadelphia and London.

Mechlia, N & Ouessar, M 2004, 'Water-harvesting systems in Tunisia' in T Oweiss, A Hachum & A Bruggeman (eds.) *Indigenous water-harvesting systems in West Asia and North Africa*, ICARDA, Aleppo, Syria.

Nasri, S, Albergel, J & Berndtsson, R 2004, 'Hydrological processes in macrocatchment water harvesting in the arid regions of Tunsia: the traditional system of Tabia', *Hydro. Sci. J*., vol. 49, no. 2, pp. 261-272.

Warren, DM, Sikkerveer, LJ & Brokensha, D 1995, *The cultural dimension of development: indigenous knowledge systems*, Intermediate Technology Publications, London.

Chapter 4




El Maghara Scenarios: Alternative Images of The Future

Lead Authors

Mohamed Tawfic Ahmed
Mohamed Mostafa Saleh

Contributing Authors

Adel Abdelkader
Ahmed Abdelrehim

Main Messages

The El Maghara scenarios are an integral component of the El Maghara assessment. Scenarios provide insight on the uncertainties that may crop up, affecting the environmental setting and human well-being. They are also a viable tool that decision-makers can use to set strategies and measures and look for opportunities.

The scenario process allowed the Bedouin to express their views, hopes and misgivings. The timeframe for the scenarios is 25 years.

The method employed to develop them was a hybrid that combined both qualitative and quantitative assessments.

Scenario building entails a number of steps that include the identification of drivers of ecosystem change, direct influence between direct drivers, and the inter-dependence of these drivers.

Stakeholders had a prominent role in creating the El Maghara scenarios. Several meetings, interviews and questionnaires were used to draw a factual picture of how the Bedouin feel about their future and the possibilities of how this future may unfold.

With water shortages, poor governance and bad services as the most influential drivers in El Maghara, four storyline scenarios were built to illustrate the possible alternatives, namely water abundance, good services and governance, as the best case scenario; water abundance, bad services and inefficient governance; water scarcity, good service and governance and business as usual, in which water scarcity and bad services and bad governance would combine.

Quantitative information obtained during the study, especially that related to income, water availability, demographic trends and illiteracy, were used to build up quasi-quantitative scenarios that focused on the future trends of these attributes.

Assessment team collecting information
Source: Mohamed Tawfic

"As historians are supposed to tell us what happened and journalists tell us what is happening, futurists tell us what could happen and help us to think about what we might want to become. Futurists do not know what will happen. They do not claim prophesy. But they do claim to know more about a range of possible and desirable futures and how these futures might evolve. Methods of futures research do not produce completely accurate or complete descriptions of the future, but they do help show what is possible, illuminate policy choices, identify and evaluate alternative actions, and, at least to some degree, avoid pitfalls and grasp the opportunities of the future." (Glenn 2003)

"Future studies" is different from forecasting. Future studies involves multi-disciplinary research on changes, trends, megatrends, driving forces, emerging counter forces and uncertainties in all major areas of life to find the interacting dynamics that are creating the future. As Glenn (2003) puts it, "Perhaps the most commonly understood reason for the use of futures methods is to help identify what you don't know, but need to know, to make more intelligent decisions."

4.1 Scenarios in the Millennium Ecosystem Assessment

Scenarios can serve as useful tools in environmental assessments for evaluating future environmental problems and assessing policies to resolve them (Alcamo 2001).

One of the main objectives of the MA is to link changes in ecosystems with expected changes in ecosystem services that contribute to human welfare and prosperity. An integral part of the MA structure is to embrace a variety of assessments, beginning with locally based community assessments up to global scale assessments, with continuous feedback at all levels.

Large-scale scenarios tend to reflect longer time spans than small-scale scenarios, since changes affecting large areas take much longer than those influencing local or small areas. Scenarios that interlink the interaction between socio-economic and biophysical systems are used to translate qualitative scenario storylines into quantitative illustrations of changes in ecosystem services. The MA scenarios also reflect the uncertainties

of long-range outcomes and quantification of key variables linked to ecosystem conditions.

4.1.1 The El Maghara Scenario Process

The El Maghara scenarios are an integral component of the El Maghara assessment. The scenario process provides insight to the uncertainties that may surge up, affecting the environmental setting and human well-being. They are also a viable tool that decision-makers can use to set strategies, measures and look for opportunities. The scenario process also allowed the Bedouin to express their views, hopes and misgivings.

The timeframe for the scenarios is 25 years. The method employed to develop them was a hybrid method that integrated the Futures group Scenario method (Glenn 2003) and the prospective approach (Godet 1994), mainly the MIC-MAC and the Mactor methods. This hybrid approach combined quantitative and qualitative aspects and comprised the following steps (Figure 4.1).

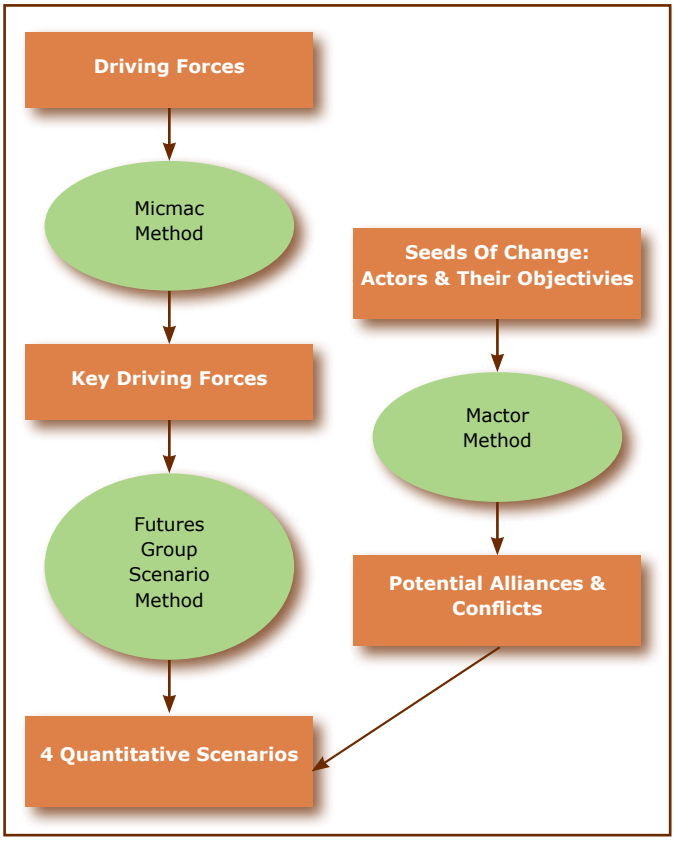


Figure 4.1. The hybrid scenario process used in the El Maghara assessment

1 Identification and Ranking of Drivers. The driving forces in the study area were identified, based on meetings and interviews with local people, and also based on the observations and records made by the assessment team. The drivers were then ranked according to their influence, independence, inter-relationship, and a limited sub-set of key drivers was selected. Much of the driver-ranking process was based on the Bedouin's views and experience. Interviews and frequent visits to the area by the study team were the main vehicle for mapping out the relative importance of the driving forces, and how the Bedouin prioritise them. The relationship between the driving forces, and how each of them may influence the others, was ascertained by using MIC-MAC methodology, based on and using the Bedouin's intuition and study team's experience.

2 Identification of Stakeholder Interest, Objectives and Influence. Ascertaining the goals and objectives that would meet people's needs and aspirations is the Mactor method an important part of the scenario process. A basic step in this respect is to identify the main actors, influential groups in the study area, their stands on these objectives, along with their influence and support. Once the various stakeholders and their concerns were identified, they were clustered into groups according to their interest and support of the objectives and goals set for the study area.

3 Scenario Matrix Construction and Development. Using the MIC-MAC method, a matrix, based on the two most important drivers, was built to produce four quadrates, each of which characterised one of four scenarios for El Maghara. Based on the four quadrants of the two-dimensional matrix, the four storyline scenarios were created describing the system along key characteristics (i.e. ecosystem services, land degradation, and others).

4 Quantitative Analysis. Using the Futures Group scenario method, a quantitative study was undertaken to determine how some of the most important drivers would unfold under

various scenarios. These quantitative scenarios were used to help build the storyline scenarios. They were also used to portray a quantitative image of how storyline scenarios may unfold.

4.2 Identification of Key Drivers: The MIC-MAC Method

The MIC-MAC (Cross-Impact Matrix – Multiplication Applied to Classification) method was created by Michel Godet (1994). The method is a way to perform structural analysis of a complex system, i.e. to represent the complex system as comprehensively as possible and then reduce its complexity to its key driving forces. More specifically, the method tries to identify the most influential driving forces, and the most dependent ones, by considering all aspects of complexity associated with the web of relations in the system.

4.2.1 The Method Used

The MIC-MAC method has three phases: a) listing all driving forces, b) describing the relationship between them, and c) identifying the key driving forces.

In phase 1, all the driving forces characterising the El Maghara area were identified. The goal was to create a comprehensive list of drivers. Several meetings were held with various stakeholders, including the Bedouin, research workers at the Desert Research Institute, people living in the vicinity, mine workers and local government officials. Questionnaires were also used to collect pertinent information. The medical team contributed to the data collection through their meetings with the Bedouin during the frequent medical check ups performed.

Phase 2 focused on describing the relationship between the drivers. Drivers have a number of relationships with each others, and very often these relationships determine the ultimate impact of a given driver. It is of paramount importance to analyse such relationships in order to understand the final web of influence in the El Maghara area. Structural analysis connected the driving forces in a two-entry table (direct relations). This entry of the

Medicinal plants in El Maghara are special assets
Source: Mohamed Tawfic

matrix is generally qualitative, with 0 value if there is no relationship between the driving forces i and j, and 1 value if there is a relationship. It is however possible to adjust the intensities of the relationships (0 = null, 1 = weak, 2 = average, 3 = strong).

Phase 3 involved using the information to determine the key drivers. Interpretation that relies solely on a direct classification of relationships between forces is not accurate because it does not take account of inherent feedback paths in the system. Many forces are indirectly related via other intermediate variables (forces). For example, illiteracy influences unemployment, which in turn influences poverty.

Thus one can conclude that illiteracy indirectly influences poverty. It is very hard to manually compute all the indirect and direct influence paths between each pair of variables. However, the MIC-MAC method automatically computes these measures. For more information, the reader may refer to Godet (1994). Using the MIC-MAC algorithm, the driving forces were sorted by order of influence and by order of dependence. This obviously gave the possibility of confirming the importance of certain forces, but also to reveal certain forces which, because of their indirect actions, play a dominating role (and which the direct classification did not reveal).

El Maghara terrain, with the coal mine, a major driver of ecosystem change, in the background
Source: Mohamed Tawfic

Drought is a major driver of ecosystem changes in El Maghara
Source: Mohamed El Shafie

4.2.2 Key Driving Forces

The process identified thirteen key driving forces.

4.2.2.1 Water Shortage

Water shortage is the main cause of the inferior quality of life in the area, with a profound effect on poverty, health, unemployment, and migration. The area has witnessed a significant drop in rainfall over the last ten years. Much of the flashflooding that used to recharge the groundwater is diverted to scattered pathways as a result of the land use change caused by gravel contractors constructing new roads and alleys to reach particular rock sites. Climate change is expected to affect precipitation even further in the coming years, giving rise to a more complicated situation.

4.2.2.2 Governance

Weak governance is a strong determinant factor that shapes the overall social and economic landscape of the area. The Bedouin accuse local government of being weak against quarries and mining contractors operating in the area illegally and inflicting considerable damage on their environment.

The massive land use change and landscape fragmentation caused by these activities hinder the Bedouin from exploiting flashfloods. They also think the type of services and utilities they get is far below their needs and less per capita than what citizens in other parts of the country get. Government efforts to improve the quality of life of the Bedouin have been inefficient. With the prevailing poverty and inferior quality of life, a mutual understanding between the Bedouin and government, at the local level, seems unachievable.

4.2.2.3 Unemployment

The remoteness of the El Maghara area and its very poor infrastructure has impeded efforts to promote economic development in the assessment area. Employment opportunities are hence very limited. Agriculture, the main activity of most Bedouin, is drastically hit by the significant drop in rainfall, making a large number of the Bedouin redundant. The high rate of unemployment recorded in the assessment area is a key factor that influences a number of attributes such as poverty, migration, education and others.

4.2.2.4 Remoteness

The assessment area is located in an isolated area in Sinai. Transportation services are limited, irregular, and unreliable, with no telecommunication service available. Sandstorms often cover the roads leading to the assessment area with sand, making travel between El Maghara and other areas of Sinai risky

and sometimes almost impossible. The area can be entirely cut off for days with no cars able to move until the sand is removed and the roads cleared.

4.2.2.5 Illiteracy

The area has a high rate of illiteracy compared to other parts of Egypt and Sinai. Some primary schools are available; however, only this year, a preparatory school was opened in the vicinity. Before that, pupils had to walk a long way to reach school. Girls are allowed to attend school for only part of primary education, if any, after which societal norms require them to stay at home. Poverty and remoteness also play a key role in the high rate of illiteracy recorded in the area.

4.2.2.6 Mining and Quarrying Activities

The assessment area has a special richness of minerals and some extractive materials, including gravel and marble. The area contains the main coal mine in Egypt, where coal was extracted for export for many years. Stone and marble quarries operating in the area have caused considerable damage to ecosystem integrity and the environmental setting. Major changes took place in the landscape and land topography as a result of the quarrying activities, with irreversible impact on flashflood quantity and quality.

4.2.2.7 Services

The area is deprived of most of the essential services such as electricity, water supply and telecommunications. The health service unit is very poorly equipped, and does not provide an adequate service. The poor service in the assessment area is a determining factor shaping many of the assessment findings.

4.2.2.8 Environmental Degradation

Environmental degradation is apparent in the El Maghara area and includes a variety of dimensions. Soil degradation, land use change, water pollution, loss of biodiversity, and landscape fragmentation are some of the manifestations of the degraded environmental setting of the study area. Environmental degradation has a strong bearing on the quality of life of the Bedouin and contributes significantly to poverty, poor health and pollution problems.

Bedouin children at Sheikh Hemid
Source: Mohamed Tawfic

4.2.2.9 Health

Medical check ups conducted during the assessment work revealed the poor health of the population, with common diseases prevalent. Contaminated water is a potential cause of many health problems recorded in the area.

The remoteness of the area from any health care facilities is an elemental factor contributing to this poor health. The disappearance of many medicinal and other plants that the Bedouin use to supplement their food has had a negative impact on their health conditions. Dietary habits could also be a cause of some of the illnesses recorded.

4.2.2.10 Migration

Prevailing hardship, unemployment, lack of proper services and isolation have forced many Bedouin families to migrate out of the area, either in Sinai or outside, looking for a better quality of life. Most of the migrants are young Bedouin, while elderly Bedouin remain behind. Many families have migrated to Sharkia Governorate in the Nile Delta, where water supply and employment opportunities are better.

4.2.2.11 Poverty

Poverty is a key factor in much of the suffering in the community. Monthly family income in the area is probably one of the lowest in the country.

Environmental degradation has an impact on many of the natural resources that the Bedouin use to support their living, hence poverty in the assessment area is partially caused by environmental degradation. Poverty has numerous effects on the environmental setting and some ecosystem services, causing severe damage and resource depletion.

4.2.2.12 Land Use Change

In Egypt land use policies are not very well enforced and Sinai is no exception. However, the impact of inefficient land use policy implementation is felt strongly in the assessment area. The growing demand for building materials such as gravel, stone and marble has turned the area into an open field for quarries and mining. With such massive extraction of building materials, the landscape has been fragmented and dissected, with serious effects on biodiversity and other environmental richness. The Bedouin put the blame for the loss of flashfloods, which used to recharge their water storage units and irrigate their fields, on these changes in the landscape.

4.2.2.13 Pollution

Soil pollution was recorded in samples collected from the study area. Water samples collected from wells in the area showed high levels of microbial and heavy metal pollution. The coal mine is the main source of soil pollution. Residues of hydrocarbons resulting from coal flushing are the main contaminants of soil in the study area. Heavy metal contamination of groundwater is also caused by the industrial activities in the area, specially mining. Pollution of both water and soil is one of the reasons for the many health problems recorded in the area.

4.2.3 Matrix of Direct Influences (MDI)

The Matrix of Direct Influences (MDI) describes the direct influences between the driving forces identified. An analytical profile that shows the influence and proximity that each driving force has to other driving forces was developed. Table 4.1 shows both the proximity and influence each driving force has to the others, at on a scale rating between 0 and 3, where 0 represents

Table 4.1. Matrix of direct influences (drivers). Influences range from 0 to 3, with 0 = no influence; 1 = weak influence; 2 = moderate influence; and 3 = strong influence.

Basin	Unemployment	Remoteness	Illiteracy	Mining	Service	Environment	Health	Migration	Poverty	Governance	Water Shortage	Land Use Change	Pollution
Unemployment	0	1	2	1	1	2	2	3	3	1	1	1	0
Remoteness	2	0	2	2	3	2	2	2	2	2	2	2	1
Illiteracy	2	0	0	1	1	2	2	0	2	1	0	1	0
Mining	2	1	0	0	2	3	2	1	2	2	2	2	2
Service	2	2	2	2	0	2	2	2	2	1	2	2	2
Environment	1	1	0	1	1	0	2	1	2	1	2	2	3
Health	1	0	1	0	0	0	0	0	2	1	0	0	0
Migration	1	0	1	0	0	0	0	0	2	0	1	0	0
Poverty	2	2	2	1	2	2	3	3	0	1	2	1	1
Governance	2	2	2	3	3	3	3	1	3	0	2	2	2
Water Shortage	3	0	2	0	3	3	3	3	3	2	0	3	3
Land Use Change	1	1	0	2	2	2	2	1	2	2	2	0	2
Pollution	0	0	0	0	2	2	3	0	2	1	2	0	0

*Lipsor-Epita-micmac

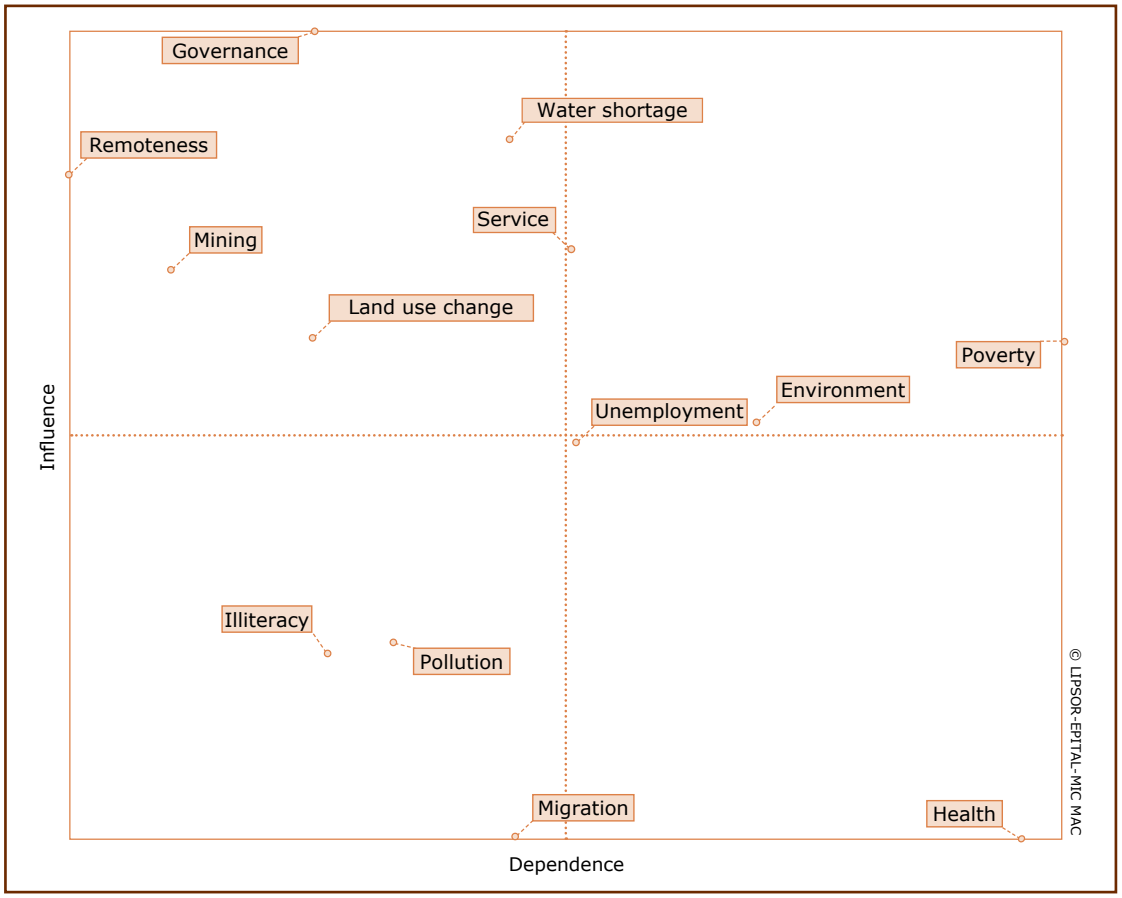


Figure 4.2. Indirect influence / dependence map

no influence and 3 represent the highest scale of influence. Examples of highly influential relationships include those between migration and unemployment, pollution and health conditions, poverty and unemployment, and environmental sustainability and gravel extraction and mining activities. On the other hand, some of the relationships shown in the matrix represent a state of no influence. The influence of pollution on illiteracy, migration on environmental sustainability and health on water scarcity are examples of such non-existing influence. Other relationships have some degree of influence between 0 and 3, for example the influence of environmental sustainability on services, illiteracy on governance and pollution on services, which all have a degree of influence of 2. Meanwhile, at a lower degree of the scale, the influence of land use change on unemployment, the influence of migration on governance and the influence of migration on illiteracy are all scaled at 1.

4.2.4 Indirect Influences and Dependence among Drivers

The indirect influence / dependence map (Figure 4.2) shows both the relative dependence and influence of drivers. The x-axis is the "dependence" measure. The x value of a certain force gives an indication of how that force is dependent on the other forces in the system. The higher the x value, the more the dependence. The y-axis is the "influence" measure. The y value of a certain force gives an indication of how that force is influencing the other forces in the system. The higher the y value, the more the influence.

The map shows that the six most dependent drivers are: health, poverty, environmental sustainability, services, unemployment, and migration, with health and poverty the most dependent. The most influential drivers - that is, those causing the most potential damage to the ecosystem - are governance, water

shortage, remoteness, mining and quarry work, and land use change.

Figure 4.2 presents the degree of influence between the drivers of ecosystem change. It is evident that governance, poor service and water shortage has a very strong influence on poverty, health, environmental sustainability and services. Considering the role of governance in providing health care facilities and other services, such a relationship is easily understandable. Poverty, one of the profoundly manifested features in the assessment area, is the product of different factors that mostly rest on the governance structure and government performance in the community. The influence of governance on sustainability is based on the weak control it has over contractors of gravel and stone extraction operating in the area.

The assessment team found, in their frequent visits to the area, that most of the contractors working in gravel and sand extraction do not confine their activities to the areas allocated to them. Instead, they tend to expand to other unauthorised areas, regardless of the impact this may have on the environment and land use pattern. Local authorities often turn a blind eye to such violations, despite repeated complaints from local people. Meanwhile, water scarcity has taken a heavy toll on the Bedouin's well-being and on environmental integrity. Many Bedouin are no longer able to grow crops that they eat and also sell. Grazing has also been highly affected, with the vegetation cover withering in the prevailing scarcity of rain, creating serious difficulty for the grazing industry, one of the main revenue sources for Bedouin trade.

4.2.5 Indirect Influence Graph

The indirect influence graph (Figure 4.3), depicts the degree of influence between the main drivers of ecosystem change in the assessment. It is rather evident that governance has a very strong influence on poverty, health, environmental sustainability and services. Considering the role

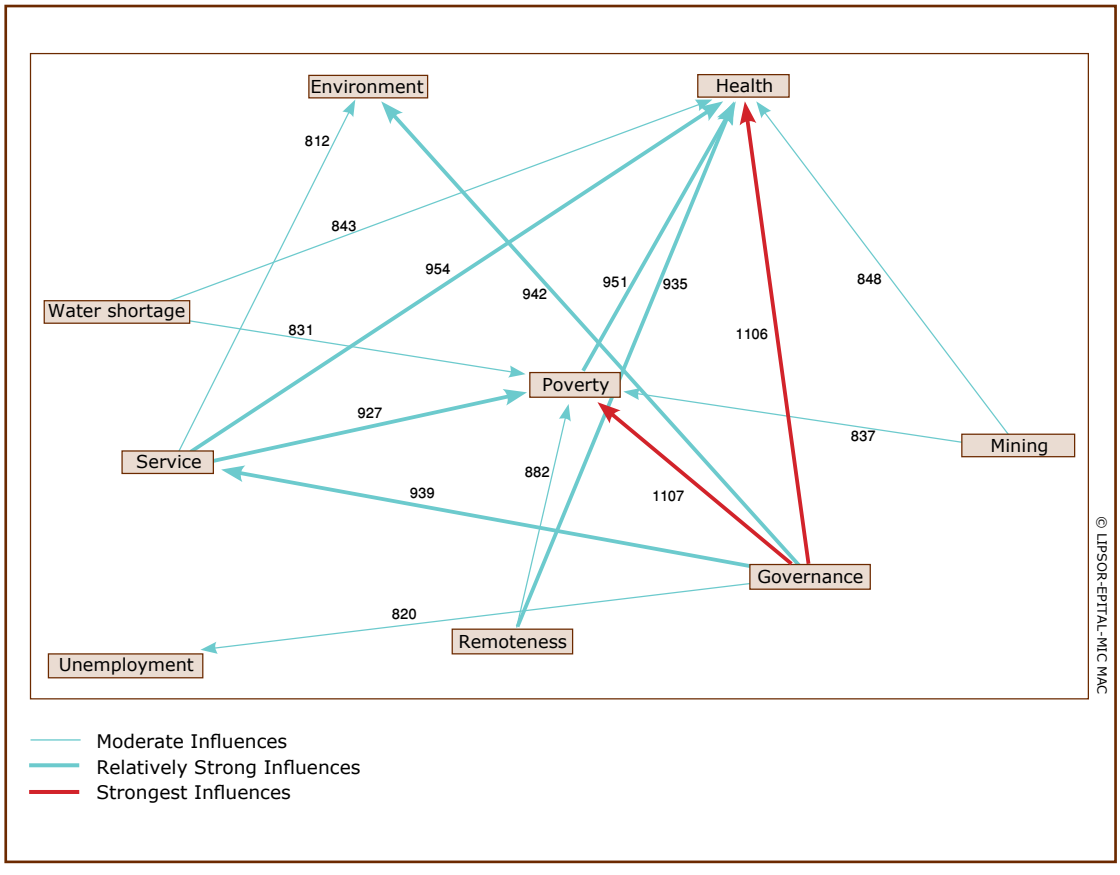


Figure 4.3. Potential indirect influence graph

of governance in securing health care facilities and utilities for other service, such a relationship is easily accommodated. Poverty, one of the profoundly manifested features in the assessment area is the product of different factors that mostly rest on governance structure and governance performance in the community.

4.3 Key Stakeholders: The Mactor Method

The Mactor method looks at each stakeholder's preference and degree of support for identified objectives. It also defines the degree of support each stakeholder potentially has for each objective and clusters groups of stakeholders according to their stance on various objectives. The method is based on inter-stakeholder influence. The assessment identified the main stakeholders (key actors) as the well as the community's main goals and objectives.

4.3.1 The Stakeholders and the Objectives

The key groups of actors in the El Maghara area are a) Governance (those responsible for the area's governance); b) Investors (defined to include gravel and marble extraction contractors); c) Bedouin; and d) Environmentalists.

An objective is an issue whose outcome may affect the future evolution of the system under study, especially those upon which the actors have sensibly diverging positions and the means to influence their outcomes. In the El Maghara assessment, the most important objectives identified were:

- governance and service improvement
- promotion of sustainable development
- poverty alleviation
- employment
- return on investment
- water availability
- land use pattern control

4.3.2 Matrix of Direct Influences

Table 4.2 shows the influence the key stakeholder groups have on one another, with the actors listed on the left being the ones to influence the actors listed across the top. The number signifies the degree of influence. For example, governance has a strong influence on the Bedouin and a moderate influence on investors. The matrix in Table 4.3 shows the key actors' stances on various objectives (whether as a group they are for, against, neutral, or indifferent). The position of an actor over an

Extraction of gravel and its impact on landsape fragmentation in Sheikh Hemid
Source: Mohamed Tawfic

Table 4.2. Matrix of direct influences (actors). Influences range from 0 to 3, with 0 = no influence; 1 = weak influence; 2 = moderate influence; and 3 = strong influence.

MDI	Governance	Investors	Bedouin	Environment
Governance	0	2	3	1
Investors	2	0	1	0
Bedouin	1	0	0	1
Environmentalists	1	0	1	0

A young Bedouin, El Maghara
Source: Mohamed Tawfic

issue represents the actor's preferred outcome for an issue, i.e. the outcome which, if realised, would best suit their objectives. The position indicates the direction towards which an actor is willing to exert influence over an issue.

4.3.3 Influences and Dependence among Actors

Using the Mactor software, the actors' positions with respect to influences and dependence in relation to one another was mapped out. The positions, calculated automatically by the software, Figure 4.3, show that investors (including gravel and marble extraction contractors) and governance are the most influential actors in El Maghara, while environmentalists and the Bedouin are the least. It also shows that the Bedouin are the most dependent and least influential actors. Environmentalists are also among the least influential actors but with a high degree of independence.

Investors are well situated in the social hierarchy. With their financial resources and good connections in influential circles that extend from local governance to the upper tier of national governance, they are heavily committed to lobbying for their demands and interests. Investors strive to ensure a good return on their investment in the shortest possible time, without much regard for the ethics of sustainability or environmental codes.

Local governance has the greatest influence as well as the upper hand in running, supervising and managing administrative issues in the assessment area. Their mandate includes legislative issues such as authorising and supervising gravel and stone extraction activities, the distribution of water tanks and maintaining land use patterns. The isolation and remoteness of El Maghara, coupled with the Bedouin's lack of awareness, has many reprecussions. The commitment and efficiency of local officials in El Maghara is rarely monitored or audited by higher governance circles, which allows local officials an authoritarian and independent role.

Relatively few in number, environmentalists are always outsiders who come and go just for short spells of time with no strong or permanent presence in the area. Their ideas and thoughts may only be expressed in research papers and technical articles that are not widely read and have a very limited impact.

Bedouin are the most vulnerable and weak actor in El Maghara. Their social fabric that keeps them living in small cut-off communities, in addition to their nomadic tendency, has weakened their sense of togetherness and their rights to demand. On the other hand, poverty, high rates of illiteracy, and lack of public awareness and public participation have stifled Bedouins' initiatives for independence and ability to communicate with Governance

Table 4.3. Valued position matrix

2MAO	Services	Sus. Dev.	Poverty	Employment	ROI	Water	Land Use
Governance	2	1	1	1	0	1	0
Investors	1	-1	0	0	3	1	-2
Bedouin	3	2	3	3	0	3	2
Environmentalists	2	3	2	2	0	3	3

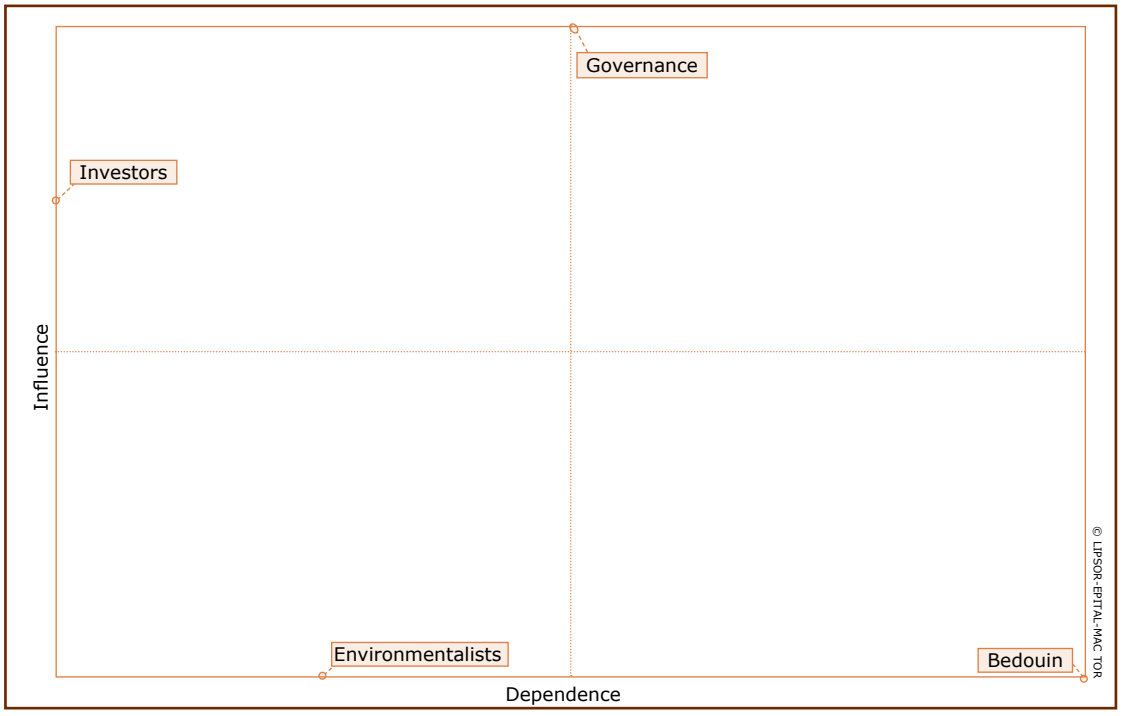


Figure 4.4. Map of influence and dependence between actors

representatives on an equal footing. This situation is well presented using the Sustainable Development Scale. In this scale, the Mactor method would weigh the interest of each and every stakeholder in promoting sustainable development in El Maghara. The relevant position of each stakeholder, multiplied by the stakeholder's influence, would decide its given weight in a hypothetical balance shape, indicating whether this group of stakeholders supports sustainability or is against it. Mactor analysis of sustainable development competitiveness (Figure 4.5), has clearly indicated that, with the

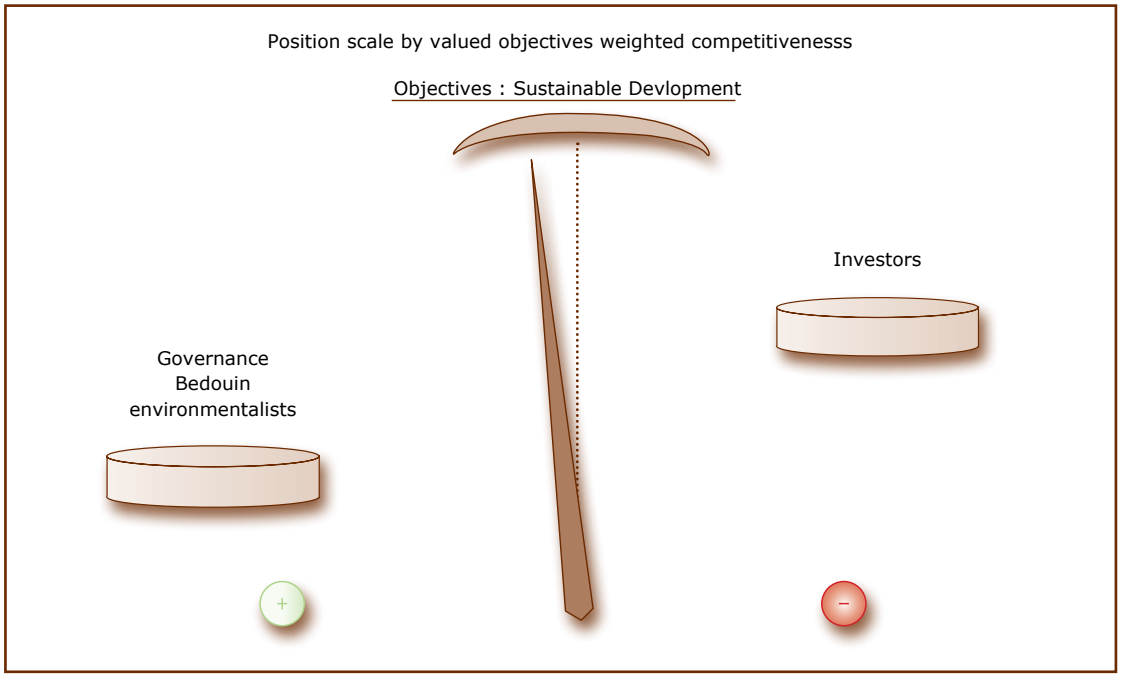


Figure 4.5. Sustainable development competitive scale

Local market at one of the nearby villages
Source: Mohamed Tawfic

exception of Investors, all stakeholders, including Bedouin, Governance, and Environmentalists, are inclined to support sustainable trends in the area.

4.4 Storyline Scenarios

Scenarios are either quantitative or qualitative. Qualitative scenarios are made of storylines, a narrative description of each scenario that highlights how the future may unfold and the role of various driving forces.

Storylines impart people's wishes, hopes, and ideas and merge them into a holistic, well-woven pattern that reflects how people feel about their future, possible uncertainties and surprises, and any other factors that are likely to shape future trends. Storylines are a core constituent of a scenario and much of the quality of a scenario rests on the authenticity and transparency of its storyline component. The driving forces that influence and cause changes, along with the flickering uncertainties that people feel, are the backbone of good storylines. (Box 4.1) In the El Maghara assessment, storyline synthesis was an integral part of creating the El Maghara scenarios.

Stakeholders at all levels provide the fabric of a scenario and their participation is a basic requirement in the construction of a viable scenario. In building the El Maghara scenarios, several meetings and interviews with individuals and groups were held in and outside the assessment site, seeking information and exploring uncertainties and views.

Bedouin, mine workers, civil servants, gravel contractors, truck and taxi drivers, children and others, were all part of the scenario construction process. Parts of the several questionnaires and medical surveys were designed to collect baseline information. The assessment team, having been closely involved with the Bedouin for years, also contributed in the building process as each team member was asked to delineate on some of the critical issues that touched upon the future of the area and how it may unfold.

The El Maghara storyline scenarios were constructed using a blend of two factors - the highest ranking drivers and information obtained from ongoing meetings with the local population. The drivers that ranked as the most influential driving forces in El Maghara (as shown in Figure 4.2) - inefficient governance and water scarcity - were used to build two axes for draft scenarios (Figure 4.6). The vertical axis shows good local governance at the top; this includes a commitment to the environment and community, the provision of good services, and enlightened governance with a prime concern for enforcing laws and sustainable conduct as well as for keeping Bedouin interests as its prime responsibility and objective.

At the bottom of the axis is inefficient local governance that provides inferior services and turns a blind eye to environmental perturbation committed by industries and gravel contractors. The horizontal axis shows the spectrum from water scarcity to water abundance. Under good water availability, water would be made available through a branch of El Salam Canal, passing Nile freshwater to Sinai, making a regular supply of irrigation water available to the Bedouin for the first time ever. At the other extreme, a branch of El Salam Canal to cover the area and supply it with water would not be approved and the area would have continued water scarcity.

Locks of El Salam Canal
Source: Mohamed Tawfic

El Salam Canal, changing the prospects of Sinai
Source: Mohamed Tawfic

Frequent meetings and interviews with stakeholders streamlined into a dialogue that centred on a number of questions and answers between the assessment team and the Bedouin. Questions posed in the dialogue aimed to bring up issues not previously expressed explicitly before, with an emphasis on:

- what are the major threats to the area that may affect you?
- how could the problems of the area be alleviated and the quality of life improved?
- what is the governance mechanism needed to bridge the growing gap that alienates them?

The questions were formulated and put forward to help the Bedouin express their worries and spell out their current and future concern, including fears, threats and even misgivings. The dialogue also explored the uncertainties looming in the Bedouins' minds. The issues addressed related to the changes needed and changes expected (and the possibility of each) and whether environmental degradation and its impact on people would continue even further and how conditions could be improved.

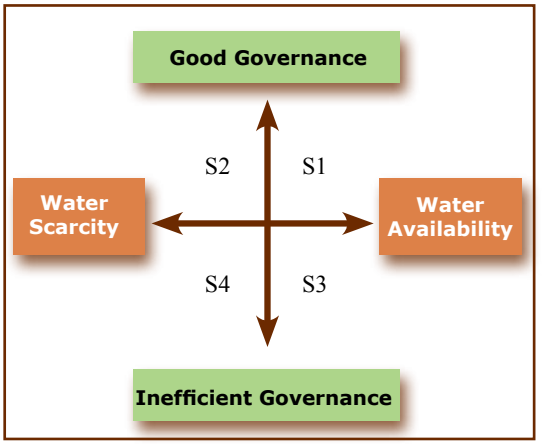


Figure 4.6. Quadrate of key drivers shaping the scenarios

The scenario building process took place in stages, continually reviewing the emerging scenarios, refining them and incorporating any new themes. In this process, efforts were made to highlight contrasts between the scenarios while eliminating duplicated themes. In the final stage, a decision was made about four scenarios, as determined by the four quadrants of the axis made earlier. The decision was made after the assessment team and the Bedouin determined that focal questions and concerns fitted equally well into the four possible scenarios portrayed by the quadrant.

The four scenarios are shown in Figure 4.6 as S1 (also called the Gazelle Scenario), S2 (the Butterfly Scenario), S3 (the Tortoise Scenario), and S4 (the Dead Horse Scenario).

S1: THE GAZELLE SCENARIO: Good Governance and Water Availability- Also the Best Case Scenario

Scenario Background

The Gazelle scenario is an illustration of how big hopes may come true in El Maghara. In this scenario, efficient governance, good services and water availability combine to strike an ideal synergy, stimulating economic growth

while maintaining environmental sustainability. The central theme of this synergy is to have all the stakeholders of El Maghara striving to de-couple economic growth from environmental degradation with a focus on environmental integrity. In this scenario, the Bedouin, government, environmentalists and industry all have the same influence on such critical issues as land use pattern, water, poverty alleviation and good services.

The Gazelle scenario is the product of long battling by representatives of the Bedouin in parliament, coinciding with a newly formed government that puts special emphasis on the marginalised communities of Egypt and how to improve their quality of life. The cabinet has included a state minister for marginalised communities and poverty alleviation for the first time in Egypt's history. One essential driver of the newly introduced ministry is to learn and study success stories from other countries in order to avoid pitfalls and to "leapfrog" toward achieving sustainability and prosperity.

El Salam Canal Branch to Central Sinai: An Old Dream Comes True

The provision of freshwater to Sinai through El Salam Canal was one of the main accomplishments of Egypt's vision for Sinai development. The canal delivers Nile water for the first time into Sinai through a number of reservoirs underneath the Suez Canal. In its first stages, the canal covered areas in North Sinai,

Box 4.1 The power of a well-told story

The narrative approach allows the scenario designer to provide holistic views of the future. By using concrete stories to supplement abstract descriptions, it is possible to be user driven rather than discipline driven. Scenarios are for people with legitimate interests in the development of a socio-technical system. They are a mean of imagining what the stakeholders want as well as how systems may be developed to fulfil these wants. Even the simplest but a well - told story contains the power to create in our minds an image of a possible future, so it is almost like we are there (Alexander 2004; Carroll 1995).

One of the tourist attrations sites in El Maghara
Source: Mohamed Tawfic

Lush Green Sinai, an image of possible scenario
Source: Mohamed Tawfic

but not Middle North Sinai where El Maghara is located. The Bedouin of Central Sinai felt deeply left out, but never lost hope of having a tributary forking from the main canal to their area. The repeated demands and strong pleas of the Bedouin representatives put forward to the government finally produced a positive response and a decision was taken to extend a small branch of the canal to the area. The provision of water was a momentous addition to El Maghara that changed many of the Bedouins' deeply rooted norms and life practices and laid down a robust foundation for a settled rural society.

Business-oriented Community

The provision of water for agriculture offered an excellent platform for a number of initiatives in various domains with agriculture and tourism industries as the propeller for a better economy. An action plan, based on a package of economic reform measures, is developed to revitalise El Maghara. The ten-year economic reform plan has the ultimate objective of doubling per capita income, creating employment opportunities and adopting sound mechanisms to market the environmental services and assets of El Maghara. A basic tier in the programme is to allow banks to operate in the area with new credit schemes that would encourage the Bedouin to establish their own businesses. In parallel, a national campaign is created to market the area to national and international tourist organisations and environmental associations.

The action plan has a number of cornerstones that include:

- banks and financial institutions are allowed to have outlets in the area, promoting small businesses and allowing the Bedouin to take out loans to establish private businesses in the area.
- new, diverse projects are established in the area, including ecotourism projects, medicinal plant processing and olive oil industries. Industries based on gravel and sand extraction that have sound environmental practices are allowed to operate. Government encourages companies to adopt sound environmental practices and to use cleaner production technologies. Companies with an ISO certificate are given special incentives and business priorities, while companies failing to implement a sound environmental management system have their operating licenses suspended.
- government helps to provide newly established companies with a package of logistical advantages such as a grace period for taxation. In return, these companies are asked to employ and train local people. With

the support of good governance, industries contribute to providing infrastructure and other services in the area and help build schools, roads and hospitals.

The ten-year action plan consists of well-defined stages, each with a specified time limit.

- in the first five-year stage the concepts of good agricultural practice and entrepreneurship are introduced to the Bedouin.
- during the second three-year stage, the El Maghara coal mine operates under a new set of rules and business conditions.
- the third and most important stage is to alleviate poverty in El Maghara by the end of the whole action plan, i.e. after ten years.

Small and Medium-size Enterprises and Entrepreneurial Activities

Good governance and adequate water supply to support agriculture, coupled with raising awareness and improving literacy rates, provide the right environment for the creation of a new class of entrepreneurial Bedouin. A number of small and medium-size enterprises are established and run by young Bedouin. Entrepreneurial activities capitalise on the ecological speciality of the region and new types of services activities emerge.

Good education and good schools are essential for sustainable development
Source: Mohamed Tawfic

Environmental Sustainability

An emphasis on environmental sustainability is a key component of the Gazelle scenario.

Good Agricultural Practices

With an active role played by the extension unit of the Department of Agriculture, a rigorous integrated pest control programme is enforced to minimise the risk of environmental impact on people and the environment. Officials launch a well-planned programme to address the risks associated with expanding agricultural activities and from waterborne contaminants and their impacts on humans and the environment. The concepts of good agricultural practices were introduced to the Bedouin, including the rational use of pesticides and fertilisers. The extension service has established extension fields for a number of medicinal crops that the Bedouin can learn from. Advanced methods of irrigation, including drip irrigation, are introduced to the Bedouin in order to minimise leaching of waterborne contaminants into the groundwater. The prevailing good governance and services maintain traditional land use patterns, ensuring a sound flow of flashfloods, with proper rain harvesting. This also allows the restoration of landscape integrity and stops land degradation and water pollution.

Protected Areas and Buffer Zones

A sound programme of sustainable development and an action plan are implemented to restore floral and faunal diversity of the area. The programme aims to enhance the productivity of El Maghara ecosystems and improve the social and economic welfare of the Bedouin. International environmental bodies, including the World Wide Fund for Nature (WWF) and the United Nations Environment Programme (UNEP), along with international donors, are invited to participate in the regional programme to salvage the El Maghara environment. A training programme, consultation and expert views are provided on aspects of environmental damage and the restoration process.

Protected areas (PAs) have been established worldwide as a tool for conservation and

Bedouin women play an important role in their community
Source: Mohamed Tawfic

maintaining environmental assets, especially floral and faunal biodiversity. One of the sound approaches adopted in the Gazelle scenario is the establishment of a number of protected areas, with special reference to Sheikh Hemid Wood and Gebel El Maghara juniper trees, one of the main highlights of El Maghara.

Bedouin, who use the surrounding environment as a potential source of services, are likely to develop a hostile attitude to these protected areas. Experience has shown that buffer zones are a conciliatory approach to overcoming such hostility. The International Union of the Conservation of Nature (IUCN) defines buffer zones as areas adjacent to protected areas, adding to their protection and providing valued benefits to the neighbouring local communities. Buffer zones address two principal issues:

- they provide extension buffering by which habitats contained in the PAs are extended for the core species.
- they also act as a buffer by absorbing the resource pressures on the socio-economic needs of the surrounding Bedouin communities.

In the Gazelle scenario, buffer zones respond to the strong calls for conservation and maintaining environmental integrity while also accommodating the Bedouin's needs for utilising the environmental assets necessary for their livelihood.

Protection of Rare and Endangered Species

The environmental harassment encountered in the El Maghara area has rendered a number of species as rare and endangered. A valuable approach is to protect species in their natural habitats. Medicinal plants are a major asset for the economy of the Bedouin of El Maghara and for Egypt as a whole. The Gazelle scenario includes the propagation and domestication of these plants so that in due course they can be properly conserved, under sound scientific conditions. Cultivation of these plants would meet the growing market demand at a lower price while easing the pressure on the natural population in the wild.

El Maghara Coal Mine

The coal mine is one of the pressing factors affecting the environment of El Maghara, with direct responsibility for soil degradation, water contamination and loss of biodiversity. In this scenario, efforts are made to ensure restoration of the mine's production, while observing a sound programme to maintain environmental quality and integrity, with active representation of the local

Bedouin on the mine board. The Bedouin members of the board also have the chance to express the community's views on relevant issues.

A three-year plan (2008–11) to restore the sustainable operation of El Maghara Coal Mine offers a number of possibilities based on economic viability and ecological measures, with an emphasis on how to maximise the Bedouin's benefits and share of responsibilities. Under the plan, part of the mine's production is used to fuel a power plant to supply the area with electricity and other sources of energy. Part of the mine's revenues are dedicated to the development of the area, funding some community service projects such as schools and hospitals. The Bedouin should have a priority to join the mine for jobs and they should be also treated equally with others coming from outside the El Maghara area with regards to health care and social welfare.

Under the new management of El Maghara coal mine, a top priority is how to restore ecosystem viability and repair the environmental damage caused by the mine. A group of national experts considers various approaches to deal with land degradation, water pollution, biodiversity losses and other symptoms. The eco-restoration process entails good funds, expertise and time. The mine owner, along with other national and international donors, provides the necessary funds, and the panel of experts provides an action plan with different repair strategies. An ongoing monitoring scheme to gauge water, soil and biodiversity quality is enforced and run alongside the mine operation.

Socioeconomic Issues

Agricultural expansion would have a strong impact on economic performance and help elevate family income to a significant extent. It would also provide a good source of nutrition for the Bedouin, with direct bearing on their health and well-being. The grazing industry would develop, making good use of the extension programme of the Ministry of Agriculture and the good quality sheep it brought in. The export of sheep to national and international markets would ensure an additional flow of cash to the Bedouin and would contribute significantly to family income in addition to creating jobs for young Bedouin. Improving the economic conditions of the Bedouin would increase their demand for meat and milk. This in turn would encourage the Bedouin to invest in grazing.

Industrial Development and Societal Impacts

The economic growth brought about by good governance and adequate services under the Gazelle scenario allows many non-Bedouin to

Sustainability is a crucial need for future Bedouin generations
Source: Mohamed Tawfic

come and settle in the area. Newcomers bring their traditions and patterns of life to the area and tend to live in separate quarters. One of the main objectives of the city council is to make sure that local knowledge and the social structure of the local Bedouin are not affected by the newcomers and the new practices they bring. A centre for the conservation of traditional knowledge and practices is established with the help of industries in the area and under the supervision of relevant government bodies.

Services

Good services are the backbone of any progress that a community can make. In the Gazelle scenario, the introduction of irrigation water and the substantial shift the community is making toward a new sustainable and prosperous future have also ushered in a new efficient service system. The local council was reformulated, with new members representing all stakeholders. The council has adopted policies and strategies meant to improve the infrastructure and to secure the needs of newly emerging companies and activities. Industry representatives have donated seed money to start the service upgrading scheme. Improvement of services includes the provision of clean water, electricity, schools and communications facilities such as telephones. Houses have access to clean tap water for the first time. Meanwhile, sewage water is collected and treated through a biological system and wastewater may be re-used.

The impact of utility service improvement on health and welfare is significant and easily seen in the decreasing number of child deaths, good control over the spread of communicable diseases, awareness raising, illiteracy eradication and many other factors. A big virtue of the provision of good services is ridding the area of the problems caused by isolation and remoteness. The provision of telecommunication facilities and of an efficient network of bus services connecting El Maghara with other parts of Egypt benefits almost all social, economic and civic activities.

Good bureaucracy is a fundamental requisite for people's welfare and is strongly felt in a number of spheres, such as good teaching, sound extension services, health and vaccination programmes. Follow-up programmes and regular visits by key officials to the area ensure the adequate bureaucratic performance of civil servants and government employees, with reasonable efficiency and proficiency.

El Salam Canal Water and Bedouin Health

A large proportion of the water provided by the new canal is wastewater that contains some biological and chemical waste. Stringent efforts were made by officials to forestall any impacts of wastewater on Bedouin health. An awareness campaign, orchestrated by specialists, held numerous meetings to explain how to use the water without being exposed to the high risks of contracting waterborne diseases. Bedouin women were briefed on best practices for protecting their children from any risks and a series of vaccinations were administered, free of charge, to almost all the population of the area, with close follow up. In some cases, canal water was treated through filtering systems that officials recommended for the removal of many of the waterborne pollutants. With the help of academics, simple and cost-effective treatment facilities were devised and approved. The Bedouin are encouraged to establish their own

New houses built by the government for Bedouin in El Hassana
Source: Mohamed Tawfic

Clean and well maintained roads are basic requirements for communities to develop
Source: Mohamed Tawfic

water treatment facilities, with officials providing logistical and technical support.

Remoteness

The city council has embarked on a people-driven initiative to furnish the necessary infrastructure to meet the demands of the newly established companies and to tempt more companies to operate in the area. Telecommunication networks were installed to cover the area. The council has also convinced major gravel contractors to provide seed money to purchase new buses to run between El Maghara and the main cities in Sinai and Cairo. Both the growing influx of people traveling to and from El Maghara, and the demand to transport goods, have motivated the establishment of private transportation companies in the area.

Education and Literacy

The big shift accomplished in the field of economics and community affluence is also manifested in growing demand for education. New schools have been built, with major contributions from government bodies; newly established companies have also helped fund some of these new schools. As the number of workers coming from Cairo and other places has increased, a demand has arisen for some private schools. A number of small private schools have been established to which some of the wealthy Bedouin now send their children. A higher technology institute has also been founded that provides training to local students in tourism and medicinal plant technology and processing. The literacy rate has improved noticeably, with more girls enrolled in schools. Financial incentives are provided to families allowing their girls to continue their education to the secondary-school level. The literacy rate is expected to double by 2025, reaching more than 50 percent, as the number of schools increases and proper control on education is enforced.

S2: THE BUTTERFLY SCENARIO: Good Governance and Water Scarcity

Scenario Background

In this scenario, efforts to have a branch of El Salam Canal serve the El Maghara area were not successful. The people's request for a small extension canal was turned down on economic grounds. The decision not to support an extension of the canal was conveyed to senior officials of the district's city council, who in turn conferred with representatives of the local council, to explain the reasons for the refusal. Both officials and the Bedouin were utterly disappointed. However, a strong zealous spirit of determination was sparked to turn the disappointment into a big challenge.

The governing body gave an outstanding example of how to go forward, ridding El Maghara of the precarious conditions it suffered, with sincere efforts to help the Bedouin attain a reasonable standard of living, while strengthening environmental sustainability ethics and practices. By mobilising the available natural and human resources, the community was able to navigate out of the existing impasse. A key factor in this process was ensuring the participation of all sectors of the community based on equity and sharing responsibilities. One of the biggest challenges faced by the city council was to encourage the Bedouin to play their participatory role at the local level. Several

meetings were held with Bedouin chiefs, senior sheikhs, and others to persuade them to pledge the needed support for the city council through participation and communication. Bedouin members of the council took advantage of any celebration such as weddings, moulids, such as that of Sheikh Hemid, to talk to Bedouin, urging them to speak up about their views and participate in city council meetings.

An Action Plan to Promote Sustainability and Prosperity

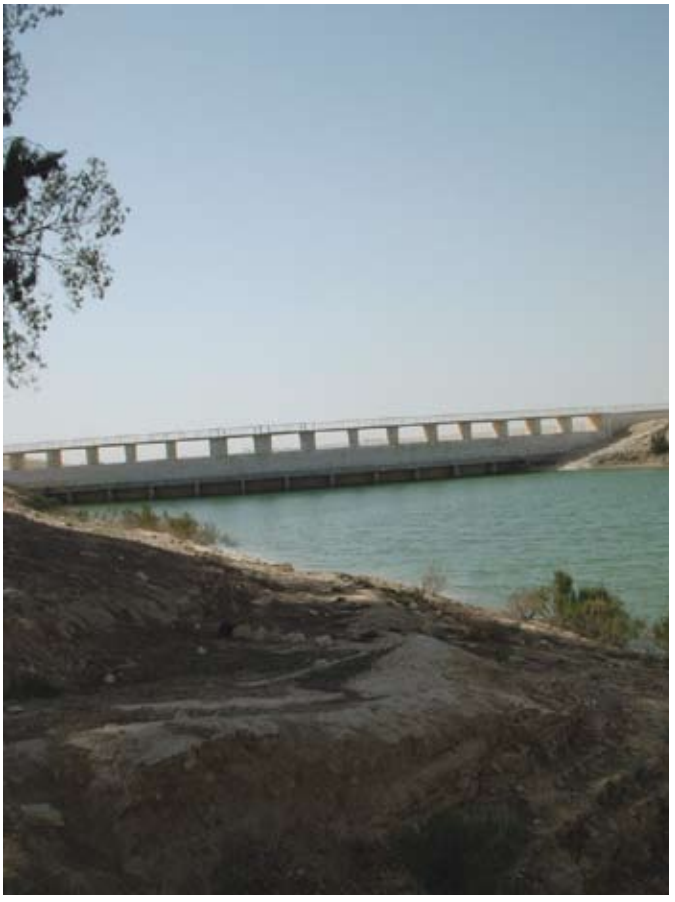
The city council drafted a package of measures to restore the environmental setting of the area. A central focus of the plan is to capitalise on the area's highly valued environmental assets as a basic precursor for a sound economy, business activities and prosperity. A ten-year rehabilitation plan is designed to accomplish this target.

Poverty Alleviation and Bank of the Poor

In El Maghara, poverty is a natural product of ailing economic conditions, scarce employment opportunities, and the unsustainable exploitation of natural stocks and environmental assets. A prime concern of the city council is to halve poverty in El Maghara by 2017. An initiative in that direction is the creation of a new banking system through the Bank of the Poor, which provides long-term loans and loans that charge almost no interest and have long grace periods to poor Bedouin willing to start small businesses, once they prove their ability and capabilities to establish and run a profitable and environmentally friendly business.

Social Fund Agreement, Social and Economic Improvement

The city council has entered into an agreement with the Social Fund for Development to provide loans to young Bedouin who want to establish small businesses based on medicinal plants and olive oil production. The city council, in turn, has forged a number of contracts with big supermarkets in Cairo and the main cities to supply them with quality, organic olive oil and medicinal plants produced at these units. Part of the fund is dedicated to supplying the Bedouin with small trucks to transport their products to the several marketing venues in Cairo and other cities. The new economic reforms introduced in El Maghara have an impact on poverty alleviation and the economic improvement of the area, as seen by changes in population density and population dynamics trends. Migration of local Bedouin to other parts of Sinai and Egypt has stopped as a result of the societal and economic improvement. In addition, the movement of people to the area is observed, as Bedouin from other parts of Sinai, along with non-Bedouins are moving to El Maghara, attracted by the industrial regeneration.



Harvesting flashfloods through one of the government built dams in the area
Source: Mohamed Tawfic

El Maghara Rehabilitation Initiative

The continuous efforts of the city council to draw public attention to the deteriorated conditions of El Maghara's environment has captured the interest of one of the most influential non-

Streets of El Hassana, village centre
Source: Mohamed Tawfic

governmental organisation in Egypt, which has launched a strong appeal to save and restore the environment of El Maghara. The goal of the El Maghara Rehabilitation Initiative is to reconcile economic development with environmental sustainability for the benefit of the people and the environment. Basic elements of the initiative include: conservation of medicinal plants, restoration of degraded woods, establishment of protected areas, enforcement of the 'polluter pays' principle and other relevant codes.

The initiative has made a big change in the attitude of industries towards the environment and has helped them adopt sustainable production programmes. Extractive industries are limited to their licensed area with no violation of land use pattern. Observing sustainable land use patterns brings several advantages to the local Bedouin, including:

A senior staff meeting in El Arish, capital of North Sinai
Source: Mohamed Tawfic

- good harvesting of flashfloods and the elimination of pollution sources that used to affect the quality of flashflood water, such as heaps of coal in the pathway of flashfloods
- the ability to provide sound ecosystem services as a result of eliminating the factors that led to landscape fragmentation
- possible restoration of damaged ecological landmarks in the El Maghara area such as Sheikh Hemid Wood
- sustainable use of minerals and other extractive materials as long as extraction is performed under strict control especially at designated sites. Such sustainable exploitation is bound to maximise the area's reserve, adding more potential and longer exploitation.

Monitoring Sustainability

New departments have been established to monitor environmental conditions in the area. Newly appointed rangers and inspectors were trained for conservation and monitoring. Patrol groups cover the area on a regular basis to make sure that industrial activities are operating with no violation of environmental codes.

Sheikh Hemid Wood Conservatory

Because of the importance of the floral diversity of the El Maghara area, and Egypt as a whole, a United Nations-sponsored project was launched for the conservation of these plants. Special importance was given to Sheikh Hemid

Natural beauty could be the base for ecotourism in El Maghara
Source: Mohamed El Shafie

Wood, an icon that combines unique biological biodiversity, local knowledge and anecdotal history. One of the main recommendations of the project was to turn the wood into a national heritage conservatory. The city council accepted the recommendation and turned it into an international plea to secure funds. The fundraising campaign, orchestrated by the ministries of environment and tourism and the governorate of North Sinai, proved very successful. Donations, coming from local and international bodies, have enabled the establishment of Sheikh Hemid Wood Conservatory, which was inaugurated in a public ceremony attended by a number of ministers and some foreign ambassadors.

Sheikh Hemid Wood Conservatory was a turning point in El Maghara's history, ushering in a new era of improved services, good roads, and more business opportunities, taking advantage of the increasing number of visitors and holiday makers. National and international touring groups come regularly to visit the conservatory, whose sound and light show attracts a great number of visitors enjoying the narrative part of the show amid the desert sceneries and special sound effects. With the help of a renowned land development firm, the city council has announced a national tender for exploitation contracts for areas around the Conservatory to be used as shops, motels, safari excursions, and other similar activities.

Education and Illiteracy

Revenues are used to rejuvenate services in the area, with special reference to education and health. An action plan has been drafted. A number of temporary schools and health care units have been established, using pre-fabricated buildings hauled from Cairo until permanent buildings can be built. Bedouin reluctant to send their young boys or girls to far away schools will now feel comfortable to send them to nearby schools. The increased number of schools and pupils raises public awareness in El Maghara. Schools are used after hours as illiteracy eradication centres, in which separate classes are run for male and female Bedouin. Literacy rates are expected to double, reaching a level similar to that achieved in the best case scenario. Afternoon classes also introduce relevant subjects to the Bedouin such as environmental awareness, health and safety issues, and local handicraft skills. A gradual increase in the proportion of female pupils will improve gender issues and gender participation in daily life will give them

greater power in family issues, especially those related to health.The conduct of the city council, and the governing bodies, toward employees working in official offices is most inspiring. Civil servants working in the area, especially those coming from outside, are provided with special incentives and financial benefits to come and settle in El Maghara.

Services

Restriction on land use enforced by the city council was a key factor in maintaining land topography, helping the Bedouin collect flashfloods and make good use of them for agricultural and domestic use. Meanwhile, water storage facilities were further improved and supervised by medical staff to ensure a reasonable quality of drinking water. The city council, through its good office has convinced some of the major gravel extraction companies working in the area to sponsor the installation of water desalination units attached to some of the major wells of the area. Desalinated water was distributed equally to Bedouin in the vicinity. However, with the growing population of El Maghara, and almost no migration outside the area water was always a critical issue, with occasional shortages and spills.

Agriculture

The population increase in El Maghara has had its impact on water consumption, affecting the availability of water for agriculture. The Bedouin had to augment the available water resources by overusing the groundwater. A series of problems was observed including salinity, invasive species and others, caused by groundwater overuse.

Central Sinai is endowed with natural beauty that could support a flourishing tourism industry
Source: EEAA

Remoteness

One of the main projects of the Bank of the Poor was to offer loans for the purchase of transportation vehicles. A number of young Bedouin took advantage of the scheme to establish their own small transportation businesses. A number of small buses were operating between El Maghara and major nearby urban and commercial centres. The availability of this small fleet of transportation buses has also encouraged Bedouin and non-Bedouin from nearby centres to come to El Maghara, especially on Fridays where the Bedouin could perform Friday prayers in the vicinity of Sheikh Hemid, a respected holy figure for all the Bedouin of Sinai.

S3: THE TORTOISE SCENARIO: Inefficient Governance and Water Availability

Scenario Background

In any community, governance occurs at multiple tiers, each with its own duties and responsibilities. At higher tiers, governance focuses on deciding centrally controlled issues, such as budget allocations and national utility planning, including electricity and water supply, medical insurance, pensions and education. At lower levels, governance is entrusted to supervise and observe the implementation of policies and strategies created by higher tiers, as well as providing logistical support. In addition, local governance is responsible for managing issues of a local nature, such as issuing licenses and applying the law to those who violate codes and laws established at the central level. Lower governance tiers are also responsible for suggesting action plans and budget requirements, as well as for reporting the state and conditions of their localities to allow regular bottom-up feedback between the local community and central government. With inefficient governance, uncertainties and unaccounted risks pose potential threats to people, their properties and their environment. Weak governance also gives rise to strong feeling of alienation, discontent and a sour feeling of injustice and inequality.

An eminent factor in such a paradigm is the level of influence that localities and their stakeholders

Changing land use pattern is a major challenge to El Maghara sustainability
Source: Mohamed Tawfic

can line up to pressure government and push for their needs and aspirations. Parliamentarians, celebrities and local people are the driving force for generating the support needed to call attention to their people's needs. The role of this driving force is crucial and communities that lack that leverage may not be able to progress very far with their demands and needs.

In Egypt, inefficient governance, especially in remote and marginalised areas is a product of well-defined, common features in the community, including inequity, illiteracy, feelings of alienation, a lack of democracy, corruption and poverty. Good governance can only thrive in communities where all people are aware of their rights and duties and enjoy a considerable degree of freedom to express their views, which is not the case in El Maghara.

El Maghara city council has several members whose main objective is to follow up on government performance and convey people's wishes and views to the administrative officers. Ideally, the council is selected from citizens with recognised experience in public work and community service. But in the Tortoise scenario, members of the council are mostly pro gravel and stone extraction contractors. During the selection campaign, contractors pressed very hard, offering gifts and using unlawful means to support those loyal to them. With its members so industry-oriented, the council is not always effective in its role of controlling and maintaining environmental sustainability, a situation aggravated by the community's passive participation and inferior representation.

El Salam Canal Branch

A decision has been taken to extend a branch of El Salam Canal to Middle Sinai, including El Maghara area. The decision was made on strategic grounds with the ultimate goal of attracting people from the 'old land' in the Delta and Nile valley to come and settle in Sinai, particularly young people and fresh graduates. The decision is part of Egypt's strategy to reduce the vulnerability of Sinai demonstrated in previous conflicts with Israel.

When the new branch of the canal was extended, the local council and local government employees were supposed to provide the necessary logistical and administrative support by upgrading and improving the technical and administrative skills of key officials.

Unfortunately, the El Maghara governing body failed to accommodate the necessary changes and failed to live up to the expectations that both the Bedouin and higher-level senior officials had.

Land Acquisition Problems

A lack of transparency and definitive, fair policies governing land acquisition has created a series of potential problems, involving Bedouin families and tribes and also the newly established companies. On several occasions, the regulatory bodies have turned a blind eye to the unlawful acquisition of land, either by families, tribes or companies. This, in turn, has created friction between the tribes and the enterprises over sovereignty and land rights. Land ownership was subject to the approval of tribal and local Orfi laws (customary laws), with little interference from the government except on security-related issues. The growing demand for land after the provision of water and several requests from companies to establish new, large farms in the area has created a tense atmosphere over land rights. Serious repercussions, including spells of violence, dominate the area.

Economy and Services

The different stages of construction of the canal provided excellent opportunities for many Bedouin. In the construction stages, many Bedouin started small businesses to provide construction workers with food and beverages and they flourished around the construction sites. With the completion of the canal and provision of water, expansion in agriculture and related activities began. Each Bedouin family was granted a fixed land allotment in the vicinity of each village. The Bedouin were offered a good package of incentives to help them start new businesses, especially in the field of medicinal plantation, with loans for purchasing seeds and fertilisers. The growing agricultural activities and crop production have ensured unprecedented income levels for Bedouin families, with a direct bearing on their well-being and quality of life.

Impact on biodiversity
Source: Egyptian Environmental Affairs Agency (EEAA)

In the Tortoise scenario, the provision of water and the subsequent improvement of business opportunities was not paralleled by a sound economic package of logistical and other support measures. The local council is not able to decide many of the economic issues because of limited experience and the tendency to exclude members from outside the community. Economic planning and implementation strategies are short-sighted and mostly based on individual visions, with no thorough studies or consultations. However, a number of banks have been established in the area, along with other financial organisations that hope to foster good business. In particular, companies want to develop the area as an ecotourism magnet, investing heavily in the region.

It was not too long before organisations and investors new to the region recognised that the gross lack of service facilities and basic infrastructure, especially telecommunications, hospitals and sanitation, is a major barrier to the cost-effective operation; some have even tried to have their own utility facilities, such as power generating units and private clinics. The deterioration of environmental assets, caused by gravel and stone contractors, is also hindering plans to promote an ecological tourism industry.

Transportation between El Maghara and other parts of Sinai and Egypt has improved, to some extent, but not enough to meet the growing demands. A number of private companies have been formed, taking advantage of the growing

Acacia trees are major service providers in El Maghara
Source: Yasser Hanafy

demand and lack of good public service. Private companies provide much better service and have a good share of the market, but because of weak governance, most of the companies do not abide by the official tariffs set by the city council.

Environment and Sustainability

Unsustainable Agriculture and Business Opportunities

A major opportunity to boost the economic vitality of the area and improve the quality of people's lives is through promoting the export of medicinal and aromatic plants. Growing demand for medicinal plants, coupled with the long experience of the Bedouin and the suitability of the environmental conditions have favoured business opportunities in this field. With the help of some NGOs and businesses, a number of cooperatives have been established to produce medicinal and aromatic plants for export. With the irrational use of pesticides and the high residue levels of heavy metals and other pollutants in the irrigation water, however, many products are not suitable for international markets. On several occasions, exports have been rejected and sent back because of high residual levels of pesticides and other pollutants. The rejection of several shipments of medicinal plants has caused considerable loss and some cooperative have gone bankrupt, making a large number of workers redundant.

Heavy reliance on pesticides and fertilisers has caused elevated levels of groundwater pollution. A number of invasive weeds have increased in density in the medicinal plants plantations, causing economic damage in addition to affecting the biodiversity of the area. Likewise, new insect pests are emerging in the area, most likely transmitted by irrigation water. In the absence of any natural enemies, these insect pests become abundant and problematic.

The irrational use of pesticides has caused serious effects on wild life in the area. Frequent incidents of dead animals have been reported, presumably after being exposed to highly toxic pesticides or to their residues in their prey or food. With wastewater as a main component of the canal water, growers regularly encounter problems that inefficient governance and lack of extension services failed

to meet. Flood irrigation is the most widely used system in the El Maghara area, allowing leaching of heavy metals and other pollutants to concentrate in the soil and to penetrate down to groundwater level. Problems of soil contamination are apparent in some of the crops produced in the area that failed to meet health regulations.

Gravel Industry and Canal Water

The new presence of canal water was unlawfully exploited by a number of the gravel companies operating in the area in some of their industrial processes, such as cooling and the washing of hardware. A number of cases have been reported of gravel companies dumping solid waste generated from the gravel industry in the canal. The excessive use of canal water by the gravel industry, especially in summer, has led to conflicts between gravel contractors and agricultural companies that have suffered serious losses as a result of water shortages.

Poor Governance and Industries

The presence of water has brought about ideal opportunities to change the emphasis on industrial development in the El Maghara area and limit the growing trend of unsustainable activities such as mining and gravel and marble extraction. However, in this scenario, with weak governance, mining barons have continued to exert pressure and have a strong hold on the area. Extensive gravel, sand and stone extraction continues to cover new areas, including those of ecological significance, with massive impacts on the environment.

With lack of governance, highly polluting industries that cannot be accommodated in other parts of Egypt, such as chemical, cement and other similar industries, are easily established. The establishment of such industries is further deteriorating the environmental setting and massively depleting the already exhausted natural resources. Housing facilities for the employees of the new industries are being built with no consideration for land use patterns and the environmental. Municipal problems, such as solid waste and sewage are surfacing, causing many environmental impacts.

The uncontrolled increase in quarries and mining activities is taking its toll, resulting in:

- landscape fragmentation, with losses of habitats, floral and faunal biodiversity
- soil compaction as a result of heavy trucks moving and transporting stones and sand

Poor road service is one major reason for remoteness
Source: Mohamed Tawfic

Bedouin using innovative methods to cope with water scarcity
Source: Mohamed Tawfic

Box 4.2 Bedouin Protest against Government

Frequent clashes between police forces and militant Bedouin groups were reported in 2007, and a number of senior police officers, soldiers and Bedouin were reported killed. The Bedouin protested their mistreatment at the hands of the government and their inferior living conditions. They demanded the economic development of the Sinai Peninsula, which they say has been historically neglected by the government, as well as more employment opportunities for the local population. "Central Sinai is among the poorest areas in the world, with rampant unemployment and few basic services available." http://ipsnews.net/news.asp?idnews=38209.

- air pollution from dust and other particulate matter caused by gravel extraction is deposited on plants and all other sorts of life
- contamination of groundwater with leachates from heaps of stones, coal and other extracted materials
- losses of flashfloods, with negative consequences for agriculture and other rangelands.

People's Health and Welfare

People's health and welfare are basic commitments that government should strive to achieve through the provision of adequate facilities and services. Having lived in Sinai, outside Egypt's mainland, the Bedouin have always been immune to some waterborne diseases, particularly schistosomiasis, which is transmitted through canals and drains. The regular exposure of the Bedouin to a wide variety of waterborne pathogens during irrigation is now causing a high incidence of these diseases. Bedouin children are even more vulnerable as a result of bathing in the canal. On top of this, many children bathing in the canal have drowned, especially in the early days.

Much of the blame for the deteriorating health conditions in the Tortoise scenario is directed at the governing body. The provision of water through the canal should have been preceded by a stringent campaign to raise Bedouin awareness about the drawbacks of using wastewater and the expected risks. The inferior services at local hospitals, and the chronic shortage of staff, have deepened health problems.

Education and Illiteracy

In the Tortoise scenario, schools remain far from meeting the growing number of pupils who still have to travel a long way to neighbouring villages. This, in turn, reduces the number of pupils completing their primary school education and stifles chances for girls to complete primary school education, if they have a chance of attending school at all. Thus school attendance is likely to remain low. The provision of a regular supply of water, and the presence of regular agriculture, causes many Bedouin to seek the help of their children in their fields rather than allowing them to go to school. In Egypt, the law requires children to attend primary school; failure to send the children to primary school can result in fines for the parents, but in El Maghara the law is regularly not enforced.

S4: THE DEAD HORSE SCENARIO: Inefficient Governance and Water Scarcity—Business as Usual

Scenario Background

Inefficient governance at the local level, with almost no public participation to support community demands, has failed to prepare a strong and convincing case for a branch of the canal, and their demand was turned down. The refusal to support the branch of the canal has resulted in a deep sense of dismay and disappointment that has driven the area even further into a vicious circle of despair and isolation, with the gap between various stakeholders growing.

In the El Maghara area, most key officials are not local Bedouin but come from outside Sinai. The rugged quality of life in the area has not encouraged them to settle and bring their families. Instead, their presence is considered temporary until they are

A Bedouin clears the solid waste
Source: Mohamed Tawfic

moved out again. Thus most officials do not develop a sense of belonging to the area. The different culture and traditions prevailing in El Maghara and Sinai in comparison to those in all other parts of Egypt has even deepened the feeling of alienation and allowed a barrier to form between these officials and the local Bedouin. A key factor in the relationship between Bedouin and their governance is built around this gap, making communication difficult.

With their lack of faith in governance, the Bedouin lost interest in participating in their city council and several attempts to form the council have failed. The Bedouin, with their deeply rooted misgivings, have developed an indifferent stand toward representation and participation, making the involvement of the Bedouin in local councils marginal and ineffective. This passive attitude has stunted all efforts at communication with decision-makers at the central level, who in turn have become unaware of the deteriorating conditions in the area.

Environmental Setting

Efficient governance and good public participation are essential for a community to have good prospects. Flaws in either of these result in a community's inability to meet emerging challenges or to control conduct. In the Dead Horse scenario, inefficient governance and lack of follow up and control by regulatory bodies have allowed gravel and sand contractors to expand their activities even in the most ecologically sensitive areas.

More works were established, without respect to land use patterns. The environmental setting is deeply affected, with a number of alarming manifestations such as:

- landscape fragmentation and loss of biodiversity and genetic continuity
- land degradation
- disappearance of species, with some becoming endangered or extinct
- loss of plant land cover.

The deterioration of environmental stocks has many impacts, particularly economic and welfare. Problems such as the loss of flashfloods, loss of plant cover and abandoned agriculture constitute daunting challenges for the Bedouin, with a direct bearing on their economy and subsistence.

One of the main environmental attractions of the area, the acacia wood located at Sheikh Hemid, has been badly affected, with many trees uprooted and used for fuel. Overharvesting of the groundwater is turning it saline and is increasing seawater intrusion, causing soil degradation and the introduction of some invasive species that flourish on saline groundwater. In addition, some rare medicinal plant species may disappear as a result of the severe drought and over-collection. Loss of plant cover will cause major losses for grazing activities and the grazing products that nourish the Bedouin and help improve their economic conditions.

Inferior Services

Under the Dead Horse scenario, services in El Maghara are profoundly affected by the gross

Sand mining and land use changes
Source: Mohamed Tawfic

negligence brought about by inefficient governance and inferior public participation. With no plans for maintenance and follow-up, the remaining schools and hospitals are failing to address the increasing demand for health care and education.

Health, a central issue for the Bedouin's quality of life, is badly affected. Water pollution, caused by unhealthy storage facilities, is a detrimental factor in people's health and well-being. The incidence of communicable diseases is increasing, especially in the summer. Child mortality figures are increasing as well. Considering the inadequate hospital facilities and the lack of preparedness to meet emergencies, the outbreak of a communicable disease is a real possibility. Meanwhile, air pollution, caused by the massive cutting and polishing of stones in the area, is resulting in widespread pulmonary diseases among the local people.

The deterioration of services has strong repercussions on social, cultural, security and especially gender issues. Women bear the heavy burden of managing the family's affairs under such hardships. Fetching water, plants for food and fuel wood and managing grazing activities, are all harder under these circumstances.

Education and Literacy

With not enough schools in the vicinity, the Bedouin have stopped sending their children to distant schools, especially girls, who are now being denied even a basic education. Illiteracy is increasing, as is the number of school dropouts.

With the lack of nearby schools and good educational opportunities for girls, the number of illiterate women will increase. Illiterate mothers, in turn, fail to provide an enlightened and healthy childhood to their children. El Hassana District, where El Maghara is located, already has the highest level of illiteracy in the governorate of North Sinai. In this scenario, a growing and alarming level of illiteracy stifles all efforts to improve the quality of life and to enhance people's economic profile.

Social Impact and the Eruption of Violence

Lack of basic services, in addition to inefficient governance, has contributed greatly to the break down of societal harmony and communications at the tribal level. It has also influenced the relationships between tribes and between the whole tribal community and the local authorities. (Box 4.2).

The relationship between the individuals in each tribe is strained because of the prevailing hardship and the harsh competition for food, water and other resources. A tense atmosphere is growing among tribes over the right to grazing, vegetation and water, instigated by resource scarcity, inferior services and lack of governance supervision and control. Unrest between tribes may develop to pan-community unrest, in which tribes confront governance, represented by the police. A long episode of sectarian and communal unrest can lead to instability, with the possible eruption of violence.

Growing feelings of hardship and discontent among the Bedouin cause some of them to get involved in growing and trafficking narcotic plants. The police forces carry out regular raids and several arrests have added a new dimension to the confrontations with the local people. Growing and trafficking narcotic plants bring extra money to the area, much of which is used to buy arms for use against the police forces, pushing the area to the verge of open conflict. The spread of illegal activities has led to an influx of drug dealers from other parts of the country, adding more instability and challenges to the future of the area. The area is turning into an enclave in which strict police patrols and security forces are heavily involved.

Poverty and its Effects

As in the other scenarios, poverty is not only about low income but goes far beyond that to include lack of clean water, clean air, safe shelter and, above all, freedom of choice.

Environmental damage and resource depletion have prevented the Bedouin from getting their supplementary needs from their surrounding environment. The inferior quality and quantity of water and the vast area of land becoming infertile are additional causes of poverty, on top of lack of access to quality education, the spread of diseases and the high rate of child mortality. Inferior services and inferior infrastructure, including transportation and telecommunication facilities, have left little room for economic development in the area and the average income is only about LE 350 per family per month.

The repercussions of poverty in all its dimensions are significant. While a majority of the Bedouin

Bedouin talking to gravel contractors, trying to stop constructing new illegal roads
Source: Mohamed Tawfic

has succumbed to their fate, with their grudges and pain growing day after day, a minority group of young Bedouin has developed a religion-based cult that allows the use of violence to address the poverty and injustice they feel.

The incidence of violent eruptions, in which extremist Bedouin are showing a hostile attitude to government forces stationed in the area, is becoming more frequent. As a result, the government is increasing the number of anti-terrorist groups in the area, with the imposition of new controls on people's movements. The emergence of young fundamentalists is a turning point in El Maghara's history. Having been known as tolerant and peaceful, some Bedouin are now adopting a revolutionary attitude that fragments the community, and a number of young Bedouin are involved in attempted terrorist attacks and political unrest. Growing fanaticism in El Maghara is driven by poverty and fed on negligence, corruption and ignorance, some of the consequences of inefficient and uncommitted governance.

1.5 Comparative Analysis of the Four Scenarios

Using the Futures Group scenario method, a quantitative study was undertaken to determine how some of the most important variables would unfold under different scenarios. These quantitative scenarios have provided valuable benchmarks that contributed significantly to building the storyline scenarios. They also show the timelines for the most important indicators in each of the four scenarios that were built.

Futures Group International developed the scenario method known as the 'Futures Group scenario method', which was used in our study. The first step is to define the axes of the scenario space, where each axis is associated with a key driving force. The usual practice is to define two axes, in order to construct a two-dimensional scenario space that is divided into four alternative worlds. Then key variables from each alternative world (scenario) are projected onto the axes. In this study, we used the Enhanced Trend Impact Analysis method to make such projections (Nedaa et al, 2008).

The Enhanced Trend Impact Analysis method is generally used to estimate the possible impacts of probable occurrences of some events—with different degrees of severity —on the future values of the variables under study. This method takes as inputs the probabilities and impacts of events and the historical data for each variable. In our study, the probabilities of events differ in each alternative world, and this is the reason that we got different projections for the same variables in the various worlds.

In the best case scenario (S1), by the year 2025, average income is well above LE 650 per month per family. While in the worst case scenario (S4), by the year 2025, average income is around LE 300 per month per family. Thus in the best case, average income is twice as much as the percent increase in the worst case. This is a significant difference. Note also that, with respect to income, S3 is better than S2. (Figure 4.7).

With respect to literacy, in the best case scenario, by the year 2025, the literacy rate is around 60 percent, while in the worst case scenario it is about 35 percent. The literacy rate is thus more than a third higher in the best case than the worst. This is a significant difference. Moreover, in this aspect, the second scenario is slightly better than the third one. (Figure 4.8).

With respect to the employment rate, by the year 2025, there are also significant differences, with the best case scenario showing an employment rate of more than 70 percent, and the worst case scenario showing just over 35 percent. In the best case, the employment rate is thus 100 percent more than in the worst case. The third scenario is better with respect to employment than the second one. (Figure 4.9).

In terms of population, there are also differences between the scenarios. In the best case scenario, population is expected to be around 1,700 persons by year 2025; in the worst case scenario, 1,400 persons (Figure 4.10). The reasons behind this

trend is probably the migration of many young Bedouin, in the worst case scenario, to other places where employment is available.

In the best case scenario, water share per capita is more than 650 litres per person per year by 2025, whereas it is less than 300 litres per person per year in the worst case scenario, i.e. in the best case, water share per capita is 20 percent more than in the worst case. The third scenario is far better than the second scenario, as a result of the branch of the canal serving the area (Figure 4.11).

Comparison of Drivers in Each of the Four Scenarios

Scenario	Employment	literacy	Health	Pollution Control	Water	Biodiversity	Affluence
Scenario 1							
Scenario 2							
Scenario 3							
Scenario 4							

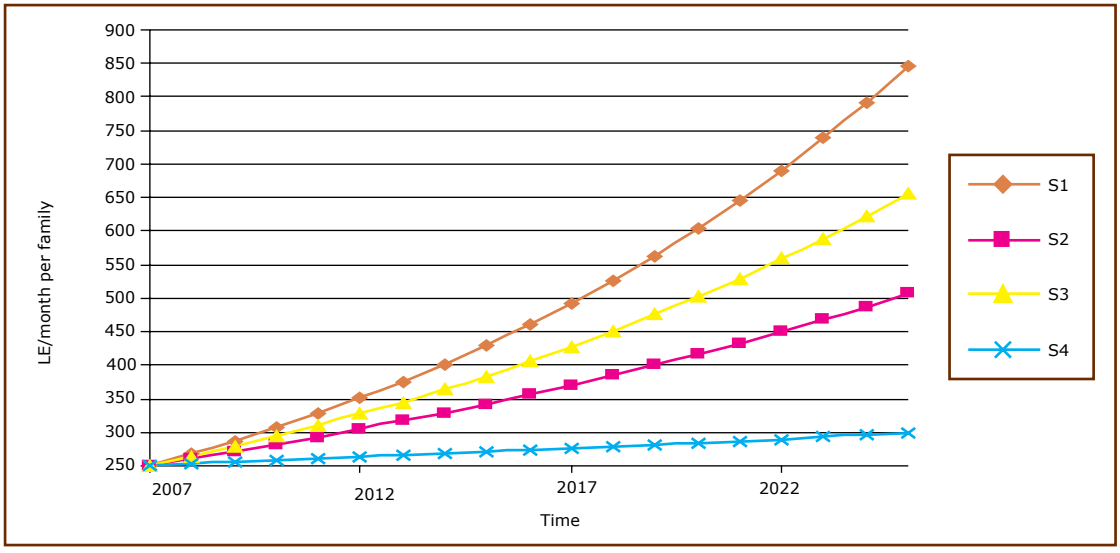


Figure 4.7. Average monthly family income in each scenario

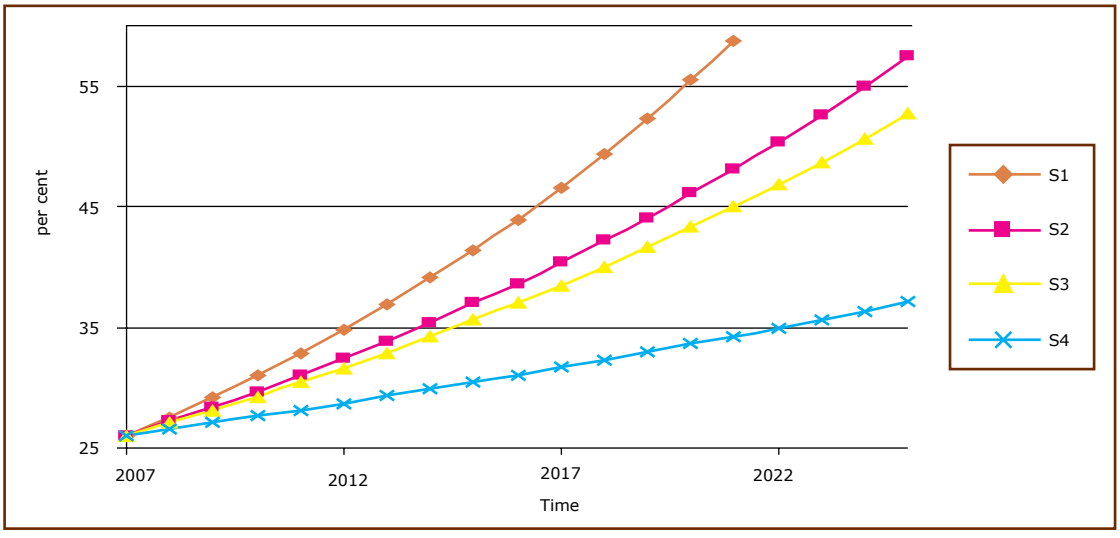


Figure 4.8. Literacy rate in each scenario

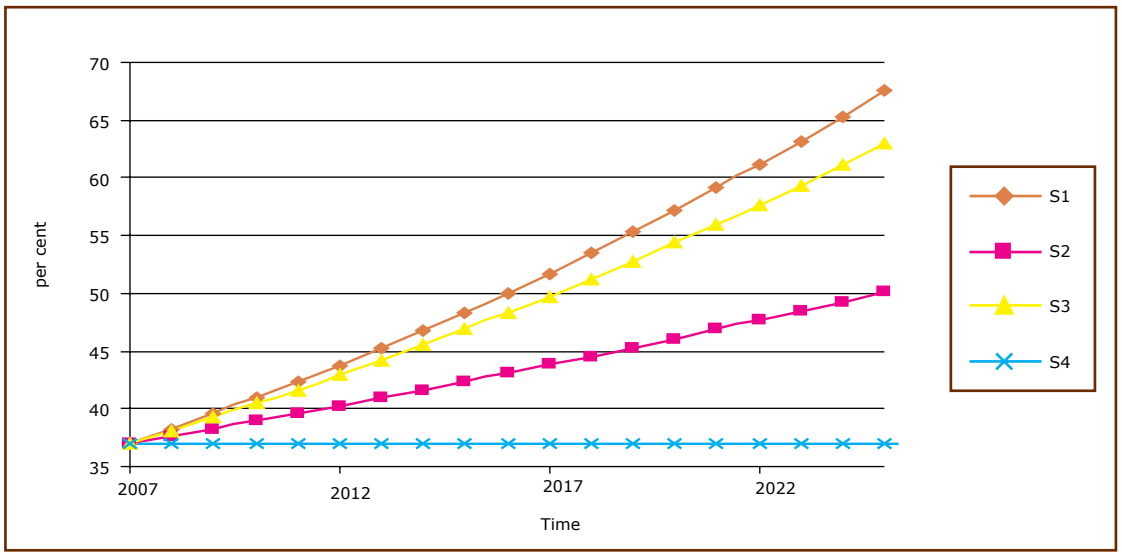


Figure 4.9. Employment rate in each scenario

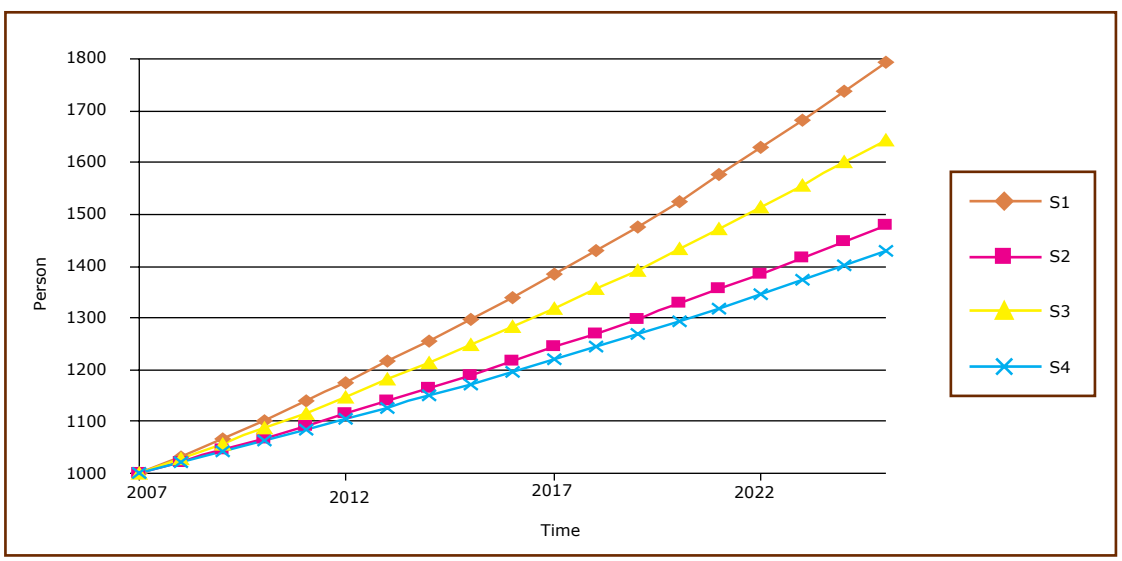


Figure 4.10. Population levels in each scenario

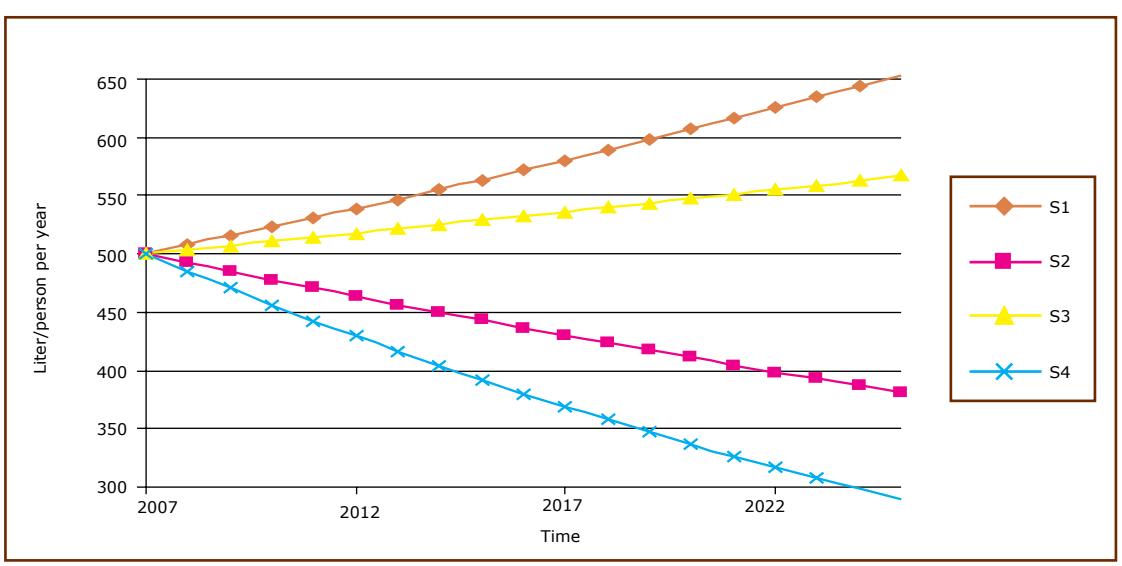


Figure 4.11. Water share per capita in each scenario

References

Agami, NME, Omran, AMA, Saleh, MM & El-Shishiny, HE 2008, 'An enhanced approach for trend impact analysis', *Technological Forecasting and Social Change*, vol. 75, no. 9, pp. 1439-1450.

Alcamo, J 2001, Scenarios as tools for international environmental assessment, (Experts Corner report. Prospects and scenarios no. 5), European Environmental Agency, Copenhagen, Denmark

Alexander, IF 2004, 'Introduction: scenarios in system development', in IF Alexander & N Maiden (eds.) *Scenarios, stories, use cases: through the system development life-cycle*, John Wiley & Sons, Chichester, UK.

Carroll, J 1995, *Scenario-based design, envisioning, work and technology in system development*, John Wiley & Sons, Chichester, UK.

Glenn, J 2003, 'Introduction of the Future Research Methods series', in *Future Research Methodology, version 2.0* (CD ROM), American Council for the United Nations University, Washington DC.

Godet, M 1994, *From anticipation to action: a handbook of strategic prospective*, UNESCO Publishing, Paris.

Chapter 5




Policy Responses: Moving Toward Sustainability

Lead Author

Ahmed El Kholy

Contributing Authors

Adel Abdelkader
Ahmed Abdelrehim
Mohamed Tawfic Ahmed

Main Messages

A web of poverty, despair and negligence surrounds the local population of El Maghara. These miserable conditions are associated with the degraded ecosystem as presented earlier in the report.
Lack of good governance in this remote area is the root cause of this condition.

To improve the general conditions of El Maghara, an intervention package is put forward. The proposed programme comes in several domains of intervention:

a) regenerating and protecting the ecosystem;
b) development of human resources;
c) achieving sustainable economic growth; amd
d) transforming the institutional framework

Cutting across these three areas of intervention is a set of programmes to transform the current institutional set up into one that prevents the degradation and depletion of the natural resource base in El Maghara.

Regenerating and protecting the environment would entail a number of steps that include:
Programme for environmentally-friendly management of water resources
Programme for environmentally sound management of land resources
Programme for drought management and combating desertification
Programme for improving air quality
Programme for protecting biodiversity
Programme for providing physical infrastructure

Meanwhile, development of human resources is made of the following components:
Poverty alleviation - Extending social structure

Promoting economic growth without sacrificing sustainability is the third pillar of the intervention campaign to improve the quality of life in El Maghara. This initiative is made up of the following steps:

Changing production and consumption patterns
The use of economic instruments

Transforming the Institutional Framework
The transformation process should be performed in the context of:
- making decisions for sustainable development
- information for decision making
- applying prinicpales of good governance

A thorough scheme for monitoring and evaluating the implementation of the intervention is also put forward, with the possibility of using indicators to signal changes in parameters compared to baseline conditions

Introduction

Lack of good governance is the cause of the current situation in El Maghara (Figure 5.1). Without proper physical infrastructure, the local population and the local ecosystem are subject to threats that negatively affect the health of both the people and the environment. Lack of social infrastructure complicates the matter, and the natural result is inferior quality of human resources and obvious human deprivation. These all result in serious challenges to the possibility of achieving sustainable development in the El Maghara area. The effects of these problems are numerous. The degraded ecosystem as a result of uncontrolled use and dumping of waste is the first effect. Second is the inability to alleviate poverty in the area, which is associated with economic losses of many kinds, including, but not limited to, premature mortality, high morbidity rates, the loss of working days, the inability to attract foreign direct investment to the area and failure to diversify the local economic base. This has resulted in resentment, and manifested in terrorist attacks against police forces and innocent tourists and civilians.

5.1 The Role of Governance

Government, whether central or local, is one of the actors in governance. Other actors involved in governance vary depending on the level of government that is under discussion. In rural areas, for example, other actors may include influential landlords, associations of peasant farmers, cooperatives, NGOs, research institutes, religious leaders, financial institutions, political parties and the military. The situation in urban areas is much more complex. At the national level, in addition to the above actors, the media, lobbyists, international donors and multinational corporations may play a role in decision-making or in influencing the decision-making process. All actors other than government and the military together constitute the "civil society". Formal government structures are one mean for formulating and implementing decisions. At the national level, informal decision-making structures, such as "kitchen cabinets" or informal advisors may exist. In urban areas, organised crime syndicates such as the "land mafia" may influence decision-making. In some

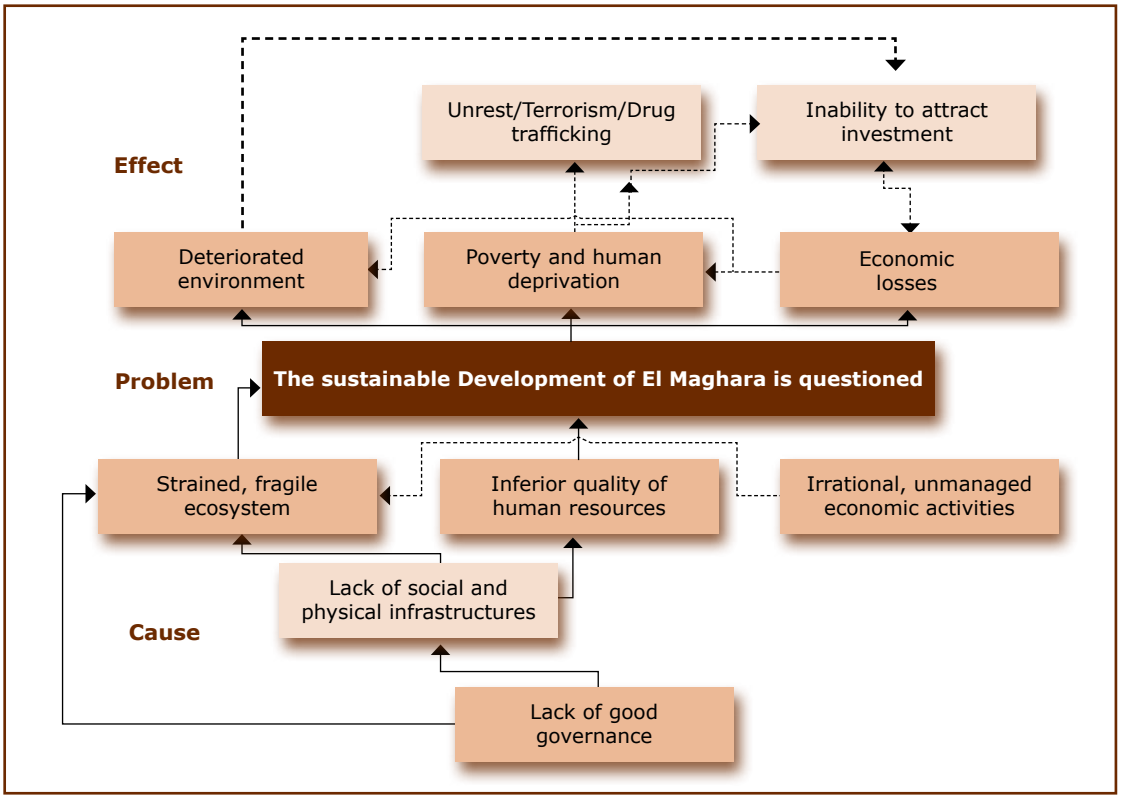


Figure 5.1. Problem tree: implications of poor governance

Signs of poverty and poor health, Bedouin girls in El Maghara
Source: Mohamed Tawfic

rural areas, locally powerful families may make or influence decision-making. Such informal decision-making is often the result of corrupt practices or leads to corrupt practices.

Good governance has eight major elements. It is participatory, consensus oriented, accountable, transparent, responsive, effective and efficient, equitable and inclusive, and follows the rule of law. It minimises corruption, takes the views of minorities into account, and hears the voices of the most vulnerable in society when making decisions. It is also responsive to both the present and future needs of society.

Good governance is at the crux of sustainable development. This requires institutional transformations to ensure that problems that threaten the sustainable development of El Maghara area, and Egypt at large, do not continue after interventions to reform markets and regenerate the natural resources. Good governance requires networking and capacity development to establish an environment conducive to sustainable development. In this respect, good governance means changes in attitudes, customs and beliefs.

5.2 Past and Current Integrated Responses

There are no clear records of past and ongoing attempts to protect El Maghara. Fortunately however, Egypt recently amended 34 articles of the Constitution. The constitutional reforms aim to restructure the relationship between the legislative and executive powers, delegating some of the president's authorities to the Cabinet of Ministers; protect the environment; and give greater support and autonomy to local administrations. The goal of these amendments is to set conditions for a proper, efficient, competitively functioning market economy and to promote social equity (State Information Services, 2007).

Figure 5.2 provides a schematic presentation summarising the outputs and outcomes of a comprehensive set of interventions to achieve sustainable development in El Maghara.

The objective is to adopt and apply the eight elements of good governance in order to develop social and physical infrastructures and initiate economic growth that does not negatively affect social equity and the natural resource base.

The proposed programmes are in three areas of intervention: a) regenerating and protecting the ecosystem; b) development of human resources; and c) achieving sustainable economic growth. Cutting across these three areas of intervention is a set of programmes to transform the current institutional set up into one that prevents the degradation and depletion of the natural resource base in El Maghara.

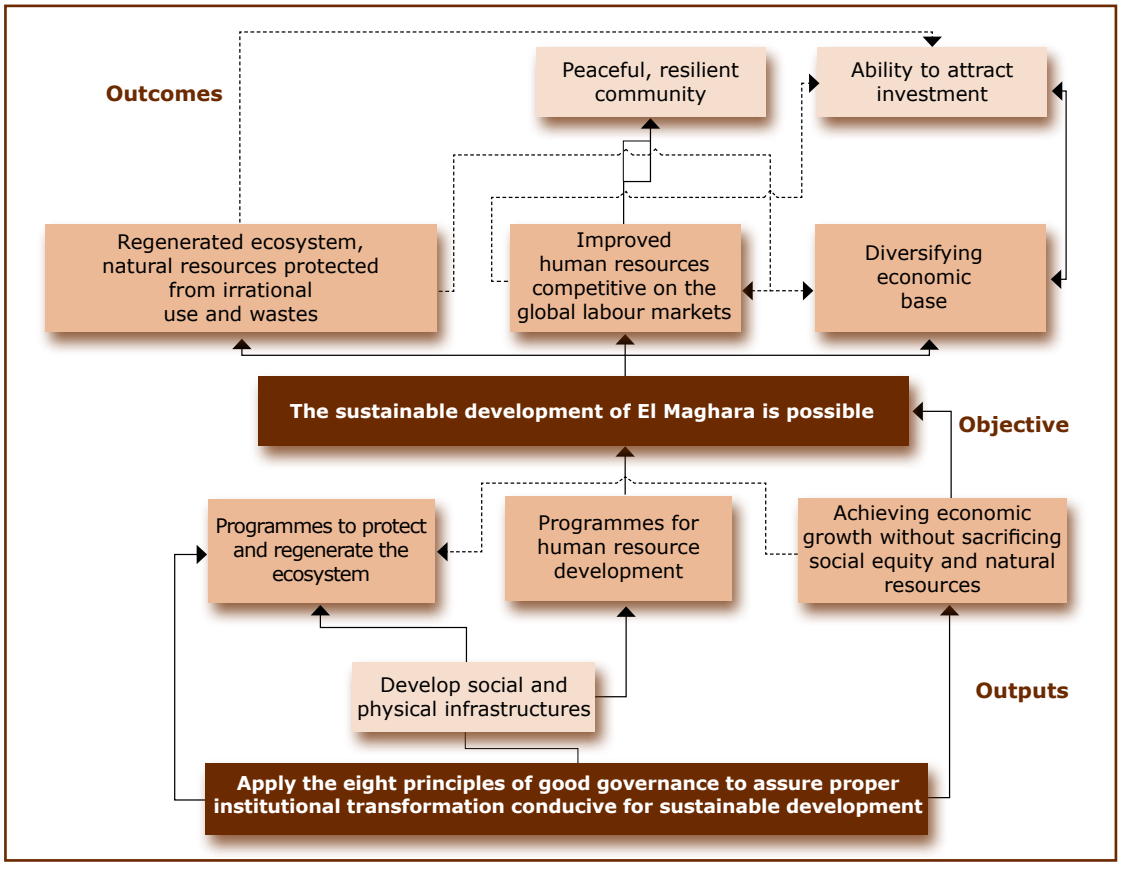


Figure 5.2. Objectives tree: implications of good governance

The expected outcomes of the proposed intervention are: first, to regenerate the ecosystem and manage the natural resources rationally; second, to engage both the local population and the private sector in the management of the community and its affairs as a step towards real ownership and equitable access to both resources and decision-making, which will end the bitter feelings of negligence; and third, to diversify the economic base of the community, thus protecting it from drastic market changes and ultimately to have a self-reliant, resilient and developed community able to face and deal with challenges.

The primary aim of the interventions is to mitigate for the imperfect markets in the area, which in turn will price natural resources and ultimately result in actions to regenerate and conserve them. The second aim of the interventions is to achieve equity and social justice. The third aim is to provide members of the community and their clients with public goods that the private sector companies cannot provide, such as clean air. The fourth reason for the proposed interventions is to protect the economic activities of individuals in the area from the negative impacts of the economic activities of external agents in the study area. Last but not least, the interventions will seek to transform the current institutional set up into a progressive framework conducive to localising sustainable development in El Maghara, Sinai.

These interventions are ambitious, and will require enormous efforts to execute and implement. At the moment it is extremely difficult to cost these interventions and meticulously design a work plan of implementation augmented by a system for monitoring, evaluation and verification.

Egypt has a strategy and action plan for protecting biodiversity. The country also has an action plan for combating desertification and managing drought. However, a rapid review of these documents does not specifically mention

the El Maghara area. This assessment of the area's ecosystem will attract the attention of international and national agencies to protect and regenerate the ecosystem of El Maghara, and the proposed policy responses are offered with that in mind.

5.3 Proposed Policy Responses

The proposed interventions come in three spheres of action: a) regenerating the ecosystem; b) human resource development; and c) institutional reforms. Under each sphere a number of interventions are proposed in three different, but complementary, components: a) information and monitoring measures; b) corrective and preventive actions; and c) supportive procedures to assure the successful attainment of the sub-goals of each component.

5.3.1 Regenerating the Ecosystem

Actions to regenerate the ecosystem are grouped into six programme areas.

5.3.1.1 Programme for Environmentally-Friendly Management of Water Resources

Water quality and quantity are direct drivers of environmental change in Sinai. Lack of a clean, fresh and regular water supply is the main reason for a variety of diseases that affect the community at all life stages. It is also the main reason for the successive waves of out-migration of young men. Water scarcity is the most important and serious driver in the study area. Water shortage has had impact on a wide variety of issues, including agriculture, health, education and out-migration of youth. Agriculture is mostly sporadic because of the water shortage and the failure of many crops to grow.

Recording information from local Bedouin

Source: Mohamed Tawfic

Egypt has a strategy for developing and using groundwater in a controlled way. The groundwater policy aims to encourage agricultural development of desert areas, which will encourage the development of new communities to attract people from the densely populated Nile Valley and Delta. The expected increase in future demand for groundwater requires continuous monitoring and evaluation of the groundwater aquifers to avoid any possible deterioration in these aquifers as a result of misuse or overuse.

The groundwater in parts of Sinai is very deep and needs huge investment to make it usable. Therefore, future strategies for the best use of groundwater in Sinai include:

- use of modern technologies for determining the main characteristics of each aquifer, its maximum capacity and safe yield. These data should provide the basic criteria for selecting the most suitable projects that could use such aquifers as a sustainable source of water
- use of non-conventional sources of energy such as solar and wind energy to minimise the costs of pumping
- use of new technologies for farm irrigation in desert areas to minimise field losses, especially deep percolation due, in part, to the high porosity of such soils.

The aims of the proposed water resource management programme is to a) increase water resources to meet growing demands and needs; b) make efficient use of available water resources; c) protect water resources from pollution and waste; and d) contribute to the equitable distribution of water among the various users both socially and spatially.

Restoring the ecosystem in El Maghara is a basic need
Source: Yasser Hanafy

Information and Monitoring. It is evident that El Maghara area needs to strengthen its water resource information base through a water resource assessment; starting with an inventory of all basins and wells and eventually leading to a water census. It also needs to monitor the implementation of plans for providing this remote area of Egypt with fresh water.

Preventive and Corrective Actions. The optimum use of all available water resources is possible through an integrated plan that translates the overall policy targets into long-term programmes. The main actions proposed to minimise water loss include, but are not limited to, the use of pipelines to transfer water, especially at the locations of high porosity soils; replacement of the level-based water distribution system to the flow-based water distribution system through calibration of control structures; and new technologies for irrigation system maintenance and operation.

Irrigation improvements entail enhancements to the efficiency of water use at farm level. They also initiate user participation in the operation and maintenance of the irrigation system. The framework for irrigation improvement includes the rehabilitation and renewal of water structures, the use of pipelines, the use of one- point collective pumping, and land leveling using modern techniques. Other actions include the redesign of the field irrigation systems. It is crucial in this regard to consider formulating water user associations that reflect the new vision for the water distribution management process.

Drainage water reuse is an option to meet part of the irrigation water demands. The reuse of drainage water increases the overall efficiency of the water system, but it requires strict regulation to prevent negative environmental impacts.

To achieve better water quality, protecting water resources from pollution is a must, and pollution abatement programmes have to be put in place. The proposed preventive measures include enforcing Law 48/1982 for the protection of water resources and other legislation and regular assessment of the water quality status and suitability for various uses.

Supportive Measures. Raising environmental awareness through organised campaigns, media (particularly TV and radio), festivals, etc., is the first supportive measure for any action to conserve and rehabilitate an ecosystem. Central bodies and local administrations have to consider the use of economic incentives in addition to command and control regimes.

Some possible economic instruments include:

- encouraging private sector participation in environmental management through financial packages that promote compliance
- adopting the 'polluter pays' principle
- introducing incentives (tax exemption) promoting the adoption of clean technologies
- encouraging recycling efforts through deposit recycling schemes, tax incentives for recycled material, and grants and soft loans for recycling industries
- reducing fresh water pollution resulting from industrial effluents through effluent charges, soft loans, and grants to finance the purchase of wastewater treatment equipment.

5.3.1.2 Programme for Environmentally-Sound Management of Land Resources

A growing population and an expanding economy create competition for land use and tensions among various users. The sustainable use of land means finding a balance that attains the greatest benefits for social and economic development whilst still protecting and enhancing the environment. Proper land management is necessary to protect biological diversity and to utilise the land in a sustainable way. Securing property rights, accounting for protected areas and habitats and the rights of local communities, including local indigenous groups such as nomads, is necessary to achieve the sustainable use of land.

Around El Maghara, a number of factors, such as aridity, weather events, sand encroachment and water scarcity cause land degradation. Development activities, such as mining for coal and quarrying for building materials, have accelerated the deterioration of natural vegetation in general, and grazing plants in particular, leading to an accelerated rate of land degradation (desertification). The proposed programme aims to a) prevent and/or reduce land degradation; b) rehabilitate partly degraded land; c) reclaim desert land; and d) elaborate and execute environmentally-sound management of agricultural and rural development.

Information, Monitoring, and Assessment. Establishing a database of traditional systems in agriculture is a must. This will facilitate the assessment of land affected by salinity in terms of area, locations, and types of salinity. It will also ease the process of measuring the level and magnitude of degradation on rangelands, thus making the assessment of rural-urban migration possible.

Preventive and Corrective Actions. A master plan should be prepared to protect cultivated and

Lack of community services is a main feature in the assessment area

Source: Mohamed Tawfic

Bedouin Majlis in El Maghara area

Source: Mohamed Tawfic

Local market in a nearby village where Bedouin sell their products

Source: Mohamed Tawfic

range areas and to formulate integrated measures for the conservation and sustainable use of land and water resources in fragile agricultural areas.

Supportive Measures. Supportive measures include a) capacity building and training on improving traditional seed selection; b) outreach and extension on the proper use of available resources; and c) institutional transformations, including a system of information generation and dissemination and financial incentives.

5.3.1.3 Programme for Drought Management and Combating Desertification

El Maghara is endowed with a wealth of diverse natural plants adapted to the variable ecosystems and varied terrain. Many of these natural species are of high economic value, aside from their value as genetic resources. Unfortunately, many also face serious ecological threats. Despite the relative scarcity of appropriate developmental activities and appropriate investigations, the area needs major efforts to combat desertification and introduce suitable sustainable development of the available resources. The plan to combat desertification and manage drought has two main objectives: a) to avoid damaging flashfloods and use them as a source of development through appropriate water spreading and water conservation techniques; and b) to conserve, manage, and utilise the highly valued and diverse natural flora and fauna resources in the area. Actions proposed include:

- review the National Action Plan for Drought Management and Combating Desertification to find investments and projects in the pipeline to be implemented in the study area
- elaborate a project for the study area in case the National Action Plan lacks actions designed for this specific area. The project has to address the specific agro-ecological attributes of the study area
- address and focus on the varied natural attributes, specific desertification processes, and action priorities
- facilitate the identification of suitable indicators of development and appropriate techniques for monitoring ongoing and future desertification processes in this agro-ecological zone
- improve the identification of projects, research needs, and public awareness campaigns tailored to the needs of this agro-ecological zone.

5.3.1.4 Programme for Improving Air Quality

Huge amounts of mining and quarrying tailings, accumulated as loose sediment, cover vast open surface areas in El Maghara. Heavy trucks loaded with building stones and blocks dislodge large volumes of particulate matter and dust into the atmosphere. High speed windstorms accelerate these emissions of suspended materials. All these factors affect the air quality in the area being studied. Indirectly, this particulate matter could have an adverse effect on the health of human, faunal and floral diversity and soil.

The overall objective of this programme is to reduce the amount of gases emitted and suspended particulate matter in and around El Maghara. Achieving general air improvement will have a positive impact on improving the quality of indoor air. The actions to achieve this objective include:

In the area of Information, Monitoring, and Assessment:

- elaborate an inventory of "pollution sources" for human settlements.

Preventive and Corrective Actions include the following:

- formulate and enact a strategy for air pollution abatement
- establish and operate a network for monitoring air quality to collect information pertaining to proper decision-making. If this is not possible, at least use a mobile laboratory for assessing air quality
- formulate a contingency plan for controlling pollution
- impose self-monitoring programmes for air quality around large sources of pollution by applying the law, such as having an environmental registry, for example, at the coal mines and quarries.

Supportive Measures include:

- use available funds, such as those from the Global Environment Facility (GEF), to encourage the use of control technologies
- implement public awareness and education modules.

5.3.1.5 Programme for Protecting Biodiversity

As mentioned earlier, Egypt has a strategy and action plan for biodiversity. The aim of biodiversity conservation in Egypt is to set the baseline for the rational use and sustainable development of the national natural biological resources. The purpose is to keep these resources fit for use and capable of production in ways that provide for the legitimate requirements of the present and for the basic needs of future generations.

The programme aims to fulfill four integrated objectives: a) conservation of natural resources; b) sustainable use of natural resources; c) integration of biodiversity issues in El Maghara into sectoral development plans at both national and local levels; and d) creation of a framework conducive to implement activities that ultimately protect biodiversity in the study area. A number of suggested activities are designed to attain these goals.

In the area of Information, Monitoring, and Assessment, this requires establishing a biodiversity baseline and an information system for the El Maghara area through the following measures:

- conduct surveys and assessments of the region, natural ecosystems, and productive (managed) ecosystem within El Maghara
- conduct surveys and assessments of species (particularly those which have a restricted range and are globally threatened)
- search for gene resources and associated medicinal, pharmacological, and chemical potential resources (particularly the secrets and knowledge of women using medicinal plants in the area to heal wounds and treat various types of illnesses and diseases)
- develop a complete reference of collections and taxonomic research related to species native to El Maghara

Installing water desalination unit at El Maghara, one of the community services the assessment project is providing

Source: Hamdy El Sharabsi

Serabit El Khadem temple ruins, one of the attractions that could be used in promoting tourism industry in the area

Source, Http://Egyptsites.Wordpress.Com/2009/03/15/Serabit-El-Khadim/

- initiate a project to establish monitoring stations and schemes
- put together an inventory of indigenous knowledge related to living species in El Maghara.

Corrective and Preventive Measures include the following:

- conserve and rehabilitate key endangered species through law enforcement, information gathering, and implementation of community-based in-situ[1] conservation programmes for key endangered flora and fauna
- establish an effective control and monitoring system supported by an information system and legislative framework for the trade, use and control of alien invasive species
- engage in ex-situ conservation[2] of rare and endangered native taxonomic groups of plants species by improving knowledge and understanding of species and ecosystems, and by establishing and strengthening gene banks, seed banks, green belts, botanical gardens and public gardens
- conserve biological resources through adopting ecologically sustainable agricultural and pastoral management practices, including control of fertiliser and pesticides, terrace management, traditional land use and water management systems and introducing modern irrigation systems
- reduce adverse impacts on habitats and ecosystems infrastructure and industry through eco-tech introduction, EIA enforcement, and effective regulating policy
- reduce adverse waste impact on ecosystems through the adoption of ecological policy and through the introduction of new techniques such as recycling, treatment and green technology
- mitigate the impacts of greenhouse gas emissions and the subsequent climate change on biodiversity and desertification through the energy mitigation strategy included in the national Intergovernmental Panel on Climate Change (IPCC). Source: Egyptian Environmental Affairs Agency (EEAA)

Bedouin discussing their issues with officials
Source: Mohamed Tawfic

Supportive Measures include:

- raise the environmental awareness of the local society by integrating environmental themes into university and school curricula, promoting green media and supporting youth clubs and eco-industry
- revive traditional biological knowledge, innovations, and techniques in conserving biological resources
- strengthening the productive capacities of individuals, agencies, and communities in the planning, implementation, monitoring, and evaluation of biodiversity conservation programmes
- enable communities and individuals to conserve and use sustainable biological resources by facilitating their participation in planning and managing natural resources and providing the local population with secure access to biological resources and sufficient financial and technical funding for community-based environmental programmes

1 Adjective, being in the original position; not having been moved. Source: in – situ. Dictionary, com.WordNet® 3.0. Princeton University. http://dicionary.reference.com/browse/in-situ (accessed:May 20, 2007).

2 Ex-situ conservation means literally, "off – site conservation". It is the process of protecting an endangered species of plant or animal by removing part of the population from a threatened habitat and placing it in a new location, which may be a wild area or within the care of humans. While ex-situ conservation is comprised of some of the oldest and best known conservation methods, it also involves newer, sometimes controversial laboratory methods. Source; Ex-situ conservation. Reference.com.wikipedia, the free encyclopedia. http://www.reference.com/browse/wiki/Ex-situ_conservation (accessed; May 11, 2007).

Bedouin talking to gravel contractors constructing new roads to reach distant gravel without regard for land use patterns
Source: Mohamed Tawfic

One of the main industrial facilities established in the industrial zone in the assessment area
Source: Mohamed Tawfic

- maintain and strengthen Egypt's relations and cooperation with international and regional partners in the field of biodiversity and attract attention to this remote area of the country.

5.3.1.6 Programmes for Providing Physical Infrastructure

Action is needed to improve drinking water, wastewater management, solid waste management and transportation infrastructure.

Safe, Clean Drinking Water. Despite rapid population growth in Egypt, the percentage of the population with access to the municipal water supply has increased over the past two decades due, in part, to large investment in the water sector. Even though development of the overall water supply coverage has been rapid and impressive, service coverage varies widely throughout the country. The parts of the population that have no access to piped water, such as El Maghara, obtain their water from public standpipes (often connected to groundwater wells) and street vendors.

Poor quality drinking water is a concern in many parts of Egypt. This is due, in part, to the fact that sources of raw water in many areas have become increasingly polluted, and therefore require more sophisticated treatment to produce drinking water of adequate quality. Furthermore, water treatment units do not always function properly as a result of lack of maintenance and proper operation. Even when water treatment is satisfactory, drinking water is sometimes contaminated by leaks in the distribution network, which may be infiltrated by sewage, for example. Another source of bacterial contamination of drinking water is rooftop water storage tanks.

The proposed action is to develop a water treatment plant and a distribution network of piped water to residential, commercial and other productive facilities in El Maghara. The capacity of the production plant and pumping stations should be suitable to provide safe drinking water to the population today and into the future. Establishing a system for monitoring the quality of the water produced is central to this proposal. The local administration can offer this proposal as an investment package or opportunity to the private sector, as in the case of the internationally acknowledged resort Sharm El-Sheikh in the southern part of the Sinai Peninsula.

Wastewater Management. At present, the nationwide coverage for household sewerage connections for urban areas ranges between 10 and 60 percent. Although rural population densities are often high, coverage rates are very low. In areas without sewerage networks, wastewater is often collected in septic tanks

or in other on-site disposal systems. These installations frequently leak due, in part, to poor construction and maintenance, and they are a major source of water pollution and unhygienic living conditions. The activities of the wastewater management programme include:

- developing and implementing low-cost technologies for domestic wastewater treatment, such as small bore holes, taking into account traditional and indigenous practices
- devising an equitable system to finance the cost of extending sanitary services to unserved areas to close the gap between rural and urban areas.

The output of this programme serves areas such as El Maghara that lack sanitation, improving the quality of life of the local residents and attracting investment. This will have its own economic and financial gains, once a system that deals with sanitation as a revenue generating activity is in gear. The supportive measures for this programme include addressing the existing institutional and financial constraints to enhance the inspection authority of the specialised public body to ensure the effective implementation of the law.

Solid Waste Management. Solid wastes include all domestic refuse and non-hazardous wastes such as commercial and institutional wastes, street sweepings and construction debris. Unsustainable consumption is increasing the amount and variety of waste produced, which will increase the cost of waste disposal. Waste management charges should require those who generate waste to pay the full cost of environmentally safe disposal. This will make waste recycling and resource recovery cost effective. The best way to cope with waste problems is via a waste-prevention approach, focused on changes in lifestyles and in production and consumption patterns. The first step is to prepare an inventory of sources of waste generation in both qualitative and quantitative terms, and then establish guidelines for the safe re-use of waste.

Environmental pollution is a major constraint for development in El Maghara

Source: Mohamed Tawfic

Financial and economic measures include establishing incentives for the proper management of solid wastes, including recycling, re-use, and recovery; encouraging markets for recycled and reused products; funding pilot programmes such as small-scale and cottage recycling industries; and lastly, composting production and the recovery of energy from wastes. Industrial solid waste, is another major problem in the area emanating from the coal and other extractive industries. Serious problems are being caused as a result of the magnitude of industrial solid waste in El Maghara. Policies of clean production should be introduced to facilities operating in the area to minimise the generation of such waste.

Transportation. One reason for the underdevelopment of El Maghara is its remoteness. The study area needs a network of roads to properly connect it to the rest of the country. A network of roads and bridges is the main artery for development and progress and the smooth flow of the national economy. Regional highways and internal routes support the development of new human settlements, thus attracting additional population outside the narrow Nile valley. Furthermore, roads contribute to agricultural and industrial development everywhere in the country.

Lavendula Sp.
Source: Yasser Hanafy

Blepharis Ciliaris (L.) Plants with wide medicinal and aromatic use medicinal plants can be used as a good source of income for poverty alleviation
Source: Yasser Hanafy

5.3.2 Developing Human Resources

The UNDP Human Development Report ranks Egypt (2005), a poor middle-income country, among the third quintile of the Human Development Index. This reflects the fact that Egypt is not found in the rich districts of Cairo and Alexandria, but in its 1,200 informal settlements and four thousand villages and their satellites. Egypt cannot afford to let these settlements perish. It will no longer be Egypt. Countries, such as Egypt, with a limited natural resource base depend on human resources for sustained development. The Asian "tigers" (Hong Kong, Singapore, South Korea, and Taiwan) and Japan do not have a rich base of natural resources. The secret to their development miracle is export-led growth based on excellent use of the available human capital. This excellent use of human resources is good management.

Traditional economists tend to emphasise gross national product or aggregate wealth as indicators of national well-being; however, a more sentient measure of the usefulness and value of development is whether it expands real freedoms that people enjoy. If a country achieves economic growth without sacrificing human dignity and self-esteem, then human development will follow, and the development will be sustainable.

In 2003, the Human Development Index (HDI) of the Governorate of North Sinai increased to 0.723 compared to 0.692 in 2002. Life expectancy at birth was 68.7 years[3] and literate adults (15 years and over) represented 84.2 percent of the population. However, with respect to education, indicators show gaps between males and females. The per capita share of the Gross Domestic Product (GDP) in 2003 was about LE 6,908.2[4] per annum. The work force represented 33.7 percent of the population aged 15 years and over that year, of which females represented only 19.1 percent (UNDP 2005).

Achieving sustainable development is political. It requires major institutional transformations and cannot be done without political acceptability. The paradigm shift to sustainable development is sustainable human development, which rests on expanding people's choices and capabilities by

3 Life expectancy at birth for females was 79.7, while the life expectancy at birth for females in rural areas was only 70.3, indicating serious shortages in maternal health care services and a general gap between urban and rural Sinai.

4 This includes revenues from the Suez Canal and from exports of natural gas and petroleum.

forming social capital[5]. Sustainable development, therefore, starts with people and will occur only when people are in charge of their destiny. Achieving sustainable human development in El Maghara will require good governance, which will result in institutional transformation (discussed in section 5.3.4) but also requires specific steps with respect to the development of human resources. These steps involve poverty alleviation, extending the social infrastructure and achieving economic growth that is sustainable.

Flashflood water behind one of the small dams around El Maghara
Source: Mohamed Tawfic

5.3.2.1 Poverty Alleviation

Poverty is the result of a set of natural and human factors, domestic policies and external factors that come together to create an environment conducive to the occurrence and spread of poverty and its increase in severity. Reasons for poverty include the lack of skills to be competitive in the labour market, inefficient management of natural resources, and an unfriendly business environment that is overloaded with regulations and complicated procedures. Poverty in Egypt is also a result of the lack of social justice and an inefficient economic system and not the result of a lack of natural resources (El-Naggar, 2005). Adopting and implementing programmes for Economic Reform and Structural Adjustment (ERSA) probably improved the macro indicators of the economy, such as closing the budget deficit, but did not contribute to eradicating poverty.

The relationship between poverty and the environment is complicated, due, in part, to the fact that the poor are essentially reliant on the environment for their livelihood. At the same time, they are affected by the methods by which natural resources are exploited. Since most natural resources are limited and susceptible to deterioration, the improvement of environmental management and regulation of the management of natural resources leads to benefits for the population at large and for the poor in particular. Although population growth may initially lead to environmental deterioration, what happens at long term is more subject to policies.One of the ways to alleviate poverty is to give more responsibilities and resources to the local population, particularly to the youth and women. NGOs, grassroots organisations and women's groups are important sources of innovation and action at the micro-level. In many cases, they have proven ability to promote sustainable livelihoods.

The people of El Maghara need to participate in protecting and sustainably managing their natural resources. They need access to land, natural resources, and funds to be productive. They also need to share in the benefits of the natural resources of their area. They need education, health services and training to be more productive. Community-based organisations can be the means toward localising sustainable development in El Maghara. Finally, they need to network their experiences with similar communities in Egypt and abroad to share lessons learnt and best practices.

Another means of poverty alleviation and development is the urgent need for family planning and relief from debt. Adopting such programmes has positive impacts on the health of women and better care for children. Equally important is to relieve the national economy from foreign and domestic debts.

5 Social capital is defined as voluntary forms of regulations whereby individuals purposefully invest their time and efforts into the defined or natural rules of society.

5.3.2.2 Extending the Social Infrastructure

Human health depends on a healthy environment including clean water, sanitary waste disposal and an adequate food supply. Good health depends on social, economic and spiritual development and a healthy environment. The people of El Maghara need health care facilities properly equipped and staffed with qualified physicians, dentists, nurses, and other health care professionals to provide them with proper attention and concern.

Many children in the El Maghara area are still not enrolled in primary school; the majority of those not enrolled are girls, for numerous reasons. Primary school education costs, such as uniforms, books, copybooks and tutoring are a major barrier to access, and the opportunity cost of child labour is still higher compared to educating a child. In severe poverty, a family will be reluctant to send children to school rather than send them to the fields, the rangeland or the workshop to earn a living and help support the family. Furthermore, many primary school teachers lack adequate qualifications. Many people aged fifteen and older live without basic literacy skills.

The government and aid agencies currently give insufficient priority and financing to youth and adult literacy programmes in the El Maghara area.

Egypt can meet the literacy challenge only if leaders at the highest level in El Maghara and Sinai commit themselves to action and the government adopts some specific polices, including:

- expanding quality primary and lower-secondary education;
- scaling up youth and adult literacy programmes;
- active government responsibility for adult literacy policy and financing as part of planning the education sector
- clear frameworks to coordinate public, private and civil society provision of literacy programmes;
- increased budgetary and aid allocations
- programmes based on an understanding of learners' demands, especially their language preferences and their motivations for attending class, determined in consultation with local communities

Bedouin girls exhibiting their local handicrafts, special venues could be created for proper marketing

Source: www.Ecotoursonline.Ca/Egy_photos_t07_eng_01.Htm

- curricula that build on these demands, with clearly stated learning objectives and the provision of adequate learning materials
- adequate pay, professional status and training opportunities for literacy educators.

Literacy is associated with a wide spectrum of benefits. Human benefits closely relate to an individual's self-esteem, confidence and personal empowerment. Participation in literacy programmes brings a wide range of benefits, including increased civic participation (whether in labour unions, community activities or politics) and enhanced cultural diversity (because it improves people's ability to engage with their own culture). Research shows that women who participate in literacy programmes have better knowledge of health and family planning, and are more likely to adopt preventive health measures like immunisation or seek medical help for themselves and their children. The correlation between education and lower birth rates is well established. Educated parents, especially mothers (whether they receive their education through formal schooling or adult programmes) are more likely to send their children to school and to help them with their studies. The economic returns of education include increased individual income and economic growth.

5.3.2.3 Promoting Economic Growth without Sacrificing Sustainability

Changing Production and Consumption Patterns. One of the major cause of environmental deterioration in the El Maghara area is the unsustainable pattern of consumption. Poor families are unable to meet their food, health care, shelter and educational needs. They have to "dig" their environment and exploit the ecosystem. This pattern aggravates poverty in the area. There is a need to seek ways of using natural resources that minimise depletion and reduce pollution. These new concepts underline the importance of following economic objectives that account for the full value of natural resources. Achieving sustainable development in the El Maghara area requires efficient production processes and changes in consumption patterns. This entails changing the production and consumption patterns that have developed in the past.

Sheikh Elyan, a main figure in El Maghara talks to team members

Source: Mohamed Tawfic

Using Economic Instruments to Bring about Change. A market-based approach to environmental management uses incentives to encourage producers and consumers to make better use of resources. Economic instruments together with regulations and voluntary agreements can all be part of this strategy. There is a need for the cooperation of private sector companies in El Maghara as well

Brackish water desalination unit at El Hassana

Source: Mohamed Tawfic

Poor quality water storage facilities add to the prevalent poverty of the area

Source: Mohamed Tawfic

as both the central and local bodies responsible for environmental management and economic growth. Significant changes in consumption and production patterns will occur once the prices of materials and goods reflect the cost of environmental degradation.

Economic instruments fall into seven broad categories: a) property rights; b) market establishments; c) fiscal instruments; d) charge systems; e) financial instruments; f) liability instruments; and g) performance bonds and deposit refund systems (Panayotou 1994). The lower per capita incomes of the people of El Maghara imply higher marginal utility of income and lower willingness to pay for environmental improvements and amenities. Whenever a development opportunity and environmental protection are in conflict, existing levels of income, as well as other factors such as preferences and environmental awareness influence the choice between the two.

Thus, economic instruments to be developed for improving the ecosystem of El Maghara have to be set according to estimates of marginal damages or marginal benefits and hence of people's willingness to pay for a benefit (or accept compensation for damage). This is particularly important at low levels of income, such as in the case of El Maghara, where a small change in prices or a reduction in income can threaten the survival of native households.

5.3.3 Transforming the Institutional Framework

The evolution of policies to protect the environment of Egypt began in the 1960s. During the 1960s and 1970s the need to achieve economic growth, while closing the gap between social classes and meeting the basic needs of a rapidly growing population exerted great pressure on the natural resource base and led to environmental deterioration. With the government as the major player in the development process, civil society organisations including the private sector remained largely weak, with little capacity to participate in the development process. Accordingly, the institutional framework for effective compliance and enforcement remained largely undeveloped (EEAA and UNDP 2001).

The 1990s marked a turning point towards more effective environmental management as Egypt started its Economic Reform and Structural Adjustment Programme (ERSAP), and expressed its commitment to pursing the goal of sustainable development. Currently, the principles of sustainable development and UN conventions such as Agenda 21 and the WSSD (World Summit for Sustainable Development) Johannesburg Action Plan are the basis of environmental policymaking in Egypt (EEAA and UNDP 2001).

The strategic objective of environmental activities in Egypt is to mainstream, introduce and integrate environmental concerns relevant to protecting human health and managing natural resources into all national policies, plans, programmes and projects. The medium-term objective is to preserve natural resources and biodiversity and national heritage within the context of sustainable development. The short-term objective is to reduce current pollution levels and minimise health hazards to improve the quality of life in Egypt (EEAA and UNDP 2001). Policymaking in Egypt to date has largely been based on the sectoral approach. This has resulted in fragmented economic, social and environmental policies. Issues such as poverty, unemployment, health and environment,

have been addressed independently with little consideration for the inter-relationships between these issues and their causes and solutions.

The development of environmental regulation in Egypt has followed the traditional regulatory approach, which focuses on end-of-pipe controls implemented through command-and-control regulations. Legislation in Egypt is, to a large extent, reactive to emerging environmental problems and enforcement-oriented, i.e. emphasis is on output rather than outcome. The substance of Egyptian environmental regulations appears to be single-based emission limits, with little consideration for variations among point sources, or to ambient carrying capacity and with weak links to any land use planning regulations. Law 4/1994 concentrates on informing the polluter of a violation. However, the law has few provisions for phasing in compliance measures after the violation has been announced. This most likely results from the fact that the law is being implemented in gradual steps and is probably why industries have been given an extended grace period (EEAA and UNDP 2001).

The Egyptian Environmental Affairs Agency (EEAA) sets environmental policy after consultation with legislative, political and public representatives. The EEAA Board of Directors includes representatives from the private sector, the research community and environmental NGOs. Compliance with Law 4/1994 is weak because enforcement is still not efficient enough. There is a need to strengthen the institutional mechanisms necessary for effective environmental management (EEAA and UNDP 2001).

At least seventeen ministries are involved in administrating about 80 laws and numerous decrees with environmental components. The main ministries involved in implementing environmental policy are the Ministry of Health and Population (MOHP), Ministry of Water Resources and Irrigation (MWRI), Ministry of Housing, Utilities, and Urban Communities (MHUUC) and the Ministry of Agriculture and Land Reclamation (MALR) among others. Many

Children and poverty
Source: Http://Farm4.Static.Flickr.Com/3001/2581088378_19122050a5.Jpg

ministries undertake work that has very strong environmental implications like new crop varieties, chemicals, land zoning, tourism development, water issues and infrastructure projects.

The EEAA was first established in 1982 as the highest authority in Egypt responsible for promoting and protecting the environment and coordinating adequate responses to these issues. The agency was re-established in 1994 in accordance with Law 4/1994 for environmental protection. The EEAA has to prepare general policy and plans for protecting the environment, monitor the state of the environment, set procedures for licensing, monitor and inspect establishments, enforce the law and follow up on plans. In addition, the EEAA has to prepare and implement campaigns for education, public awareness and information dissemination.

5.3.3.1 Making Decisions for Sustainable Development

Moving decision-making from the narrow, sectoral approach towards mainstreaming the environmental dimension in the decision-making process requires the adoption of a participatory, bottom-up approach that will help develop partnerships and enable stakeholders to be in charge of their destiny. Prices, markets and governmental fiscal and economic policies also shape attitudes and behaviour toward the environment. The local administration and central bodies responsible for licensing economic activities in El Maghara have to consider actions

that encourage protecting and regenerating the degraded ecosystem.

Assuming that economic 'trickle-down' will happen, after encouraging economic growth at the expense of social equity and the environment, is wrong. Discontinuities are not just temporal, but also, in many cases such as El Maghara, are also spatial, e.g. where El Maghara is exploited for the development of another locality, probably where the headquarters of the coal mining and quarrying companies are.

5.3.3.2 Developing Information for Decision-making

The most significant constraint on effective environmental policy making and implementation in Egypt is the lack of reliable and timely information. Another constraint is that the existing data and information are not adequately managed for a lot of reasons, including the lack of financial resources, trained workforce, awareness and availability of information and/or institutional structure. Other constraints relating to the processes of environmental information collection, production and dissemination are evident in Egypt. Furthermore, the monitoring organisations do not feed their results into a common information system and there is no comprehensive methodology for data collection (EEAA and UNDP 2001).

Policymakers need environmental information in order to prioritise problems and take the necessary action. Most environmental problems are complex and decisions are often made with great uncertainty. Effective planning and decision-making cannot be achieved and implemented without solid and dynamic information that is based on monitoring. The design of environmental monitoring systems should be systematic and compatible with the planning and decision-making process. It should be based on a unified methodological framework that facilitates the development of environmental quality objectives and targets the various media

An acacia tree badly affected by polluted soil

Source: Raffat Abdelwahab

and sectors of the economy and the development of both regulatory and non-regulatory policy instruments (EEAA and UNDP 2001).

There are substantial inventories of statistics in Egypt but they are not shared and they are not comparable. It is also the case that additional data of different types need to be collected at the local, regional, national and international levels to elucidate a more detailed, accurate story of Egypt's environmental and development issues. Furthermore, there is a need to standardise data collection and storage and make it accessible at technical and managerial levels. Reports and related information tend to be located in different bodies between which there is little or no coordination, cooperation, or exchange, resulting in gaps, duplication, incompatibility and limited utilisation of data.

This hinders the development of policy, planning, implementation and follow up. It is imperative, for improved decision-making, that enhancements are made in data collection and analysis. The ministries of Finance, Planning, Higher Education and Environmental Affairs and the Central Agency for Public Mobilization and Statistics (CAPMAS), the Information and Decision Support Center (IDSC), academia and the private sector all have some responsibility for promoting environmental statistics and information.

The proposal to establish a programme of environmental information management systems has two main objectives: a) to strengthen local, regional and national capacity to collect, analyse and use multi-sectoral information for decision-making by better identification of users, both public and private, and of their information needs; and b) to improve overall quality, i.e. validity and reliability, coverage and timeliness and access to environmental information. The required activities include:

- produce inventories of environmental, resource and development data to determine gaps and organise activities to fill those gaps
- develop a coordinated, standardised data collection and assessment framework
- establish systems to verify the quality of data gathered, i.e. a source check
- establish procedures for measurement and evaluation
- organise continuous and accurate data collection systems, making use of GIS, databases, expert systems and models
- co-operate with the private sector and international bodies to facilitate transfer of technology and technical know-how.

Soil pollution is a significant cause of poverty in the study area
Source: Mohamed Tawfic

Improving the quality of environmental data and statistics requires the strengthening of institutional capacity, promoting ongoing education, awareness raising and training while ensuring financial commitment as well. There are many sources of statistical information, including government archives, academic institutions, UN documents and the World Bank as well as other international bodies. Efforts should be made to gather information from various sources to form a more complete profile of Egypt and be the base for a better decision-making process.

5.3.3.3 Applying Principles of Good Governance

Good governance will provide a strong foundation for transforming the government in ways that can make it effective at achieving

Very inferior Bedouin homes at the assessment site
Source: Mohamed Tawfic

sustainable development. The basis for such good governance is:

1 *Participation*. Participation by both men and women is a cornerstone of good governance. Participation can be either direct or through legitimate intermediate institutions or representatives. Participation needs to be informed and organised. This means freedom of association and expression on the one hand and an organised civil society on the other hand. In El Maghara, the Governor of North Sinai has to elaborate a framework within current legislation and establish for each facility, such as schools, health care centres, a Board of Trustees whose members are prominent figures of the local community. The Governor has to empower and authorise these Boards to take control of the finances and management of the facility to deliver services that meet the needs of the local population. These Boards of Trustees will serve as forums for participation and decision-making.

2 *Rule of Law*. Good governance requires fair legal frameworks that are enforced impartially. Accordingly, the norm in El Maghara has been to make no exceptions whatsoever. The local administration has to penalise any violator and collect fines and deposit them in special funds to improve the environment. There is always a grace period during which the local administration provides other options, then the law and regulations are imposed.

3 *Transparency*. Transparency means that decisions are taken and enforced in a manner that follows rules and regulations. It also means that information is freely available and directly accessible to those who will be affected by such decisions and their enforcement. It also means that the information is provided in easily understandable forms and media. Moreover, before making a decision, local and central administrators have to meet with the people and present their idea. Then a round of consultations has to start. Based on the inputs of the public and their legitimate representatives and natural leaders, the authorities can make a decision. This process is flexible and should include a loop for monitoring, evaluation, and verification.

4 *Accountability*. Accountability is a key requirement of good governance. Not only governmental institutions, but also the private sector and civil society organisations, must be accountable to the public and to their institutional stakeholders. Who is accountable to whom is an issue that varies depending on whether decisions or actions taken are internal or external to an organisation or institution. In general an organisation or institution is accountable to those who will be affected by its decisions or actions. Accountability cannot be enforced without transparency and the rule of law.

5 *Responsiveness*. Good governance requires that institutions and processes try to serve all stakeholders within a reasonable timeframe. In Sinai, the governor periodically holds an open session that members of the Executive Council are required to attend as members of the public present their case. Decisions have to be made on the spot.

6 *Consensus-oriented*. All decisions are the output of a participatory process for

decision-making. Participation generates the information necessary to clearly define the situation, the reasons for the status quo, and the means to transform it into the desirable future situation. Consensus building is at the crux of the development process. There are several actors and as many viewpoints in any given society. Good governance requires mediation of the different interests in society to reach a broad consensus on what is in the best interest of the whole community and how this can be achieved. It also requires a broad and long-term perspective on what is needed for sustainable human development and how to achieve the goals of such development. This can only result from an understanding of the historical, cultural, and social contexts of a given society or community.

7 *Effectiveness and Efficiency*. Good governance means that processes and institutions produce results that meet the needs of society while making the best use of resources at their disposal. The concept of efficiency in the context of good governance also covers the sustainable use of natural resources and the protection of the environment. Today all projects and new developments are obliged by law to perform an environmental impact assessment (EIA) and adopting an environmental management system (EMS) is central for economic establishments operating in El Maghara. The role government and local authorities can play in this respect is one of the means of achieving effectiveness and efficiency in El Maghara.

8 *Equity and Inclusiveness*. In El Maghara, all decisions have to be made with equity and there is room for all sub-population groups to present their concerns and defend their interests. A society's well-being depends on ensuring that all its members feel they have a stake in it and do not feel excluded from the mainstream of society. This requires all groups, but particularly the most vulnerable, to have opportunities to improve or maintain their well-being in El Maghara.

Water pipes bringing drinking water to the coal mine while local Bedouin nearby suffer lack of water
Source: Mohamed Tawfic

5.4 Implications

Implementing the proposed actions is expected to have a number of implications.

1 Good governance promotes information sharing. The reform process will stimulate local players representing different interests to share information. Participation, building partnerships and increasing the capacity of the Bedouin to enable them to participate in running their own affairs is a process that will emerge as a mechanism that is essential for attaining effective developmental progress

2 Environmental concerns can be part of the local development agenda. Adopting a participatory mechanism will bring environmental concerns to the development agenda and sharpen the focus on managing natural resources. The proposed process for decision-making will clearly show the success of, and the need to continue, cross-sectoral coordination and the participation of interested parties.

3 Participation, partnership and empowerment will cause institutional transformation. Inviting the representatives of different interest groups in El Maghara to participate in decision-making and implementation will

Massive land use change caused by mine activities
Source: Mohamed Tawfic

persuade the masses to adopt this avant-garde modality as a process for urban planning and management and take decision-making outside the rigid governmental institutions into more spacious popular institutions that are grounded in the realities of both the governorate and the community.

5.5 Trade-offs

To implement the prescribed actions, we have to bear several trade-offs in mind.

First, there is no way to stop economic activities in the area and return the ecosystem to its original status. The only way to regenerate the ecosystem is to encourage sensible economic growth and expansion without sacrificing the quality of life of the Bedouin. This is possible by weighing economic growth against both social equity and conserving the ecosystem.

Second, private and public sector companies operating in El Maghara want government intervention to extend physical infrastructure, such as roads, and social services, such as health care facilities, but do not want strict regulations. This contradiction is inherent in the market system. Governing bodies need to reach win-win solutions, in which they focus on the interests of both the production establishments and the community. The use of economic instruments will be of great importance in reaching such agreements, but this can only be done if natural resources are properly priced to reflect the cost of current development to present and future generations.

Third, the terrain, land and other natural resources are subject to property contradiction. In other words, the dilemma that will be faced in the execution of the proposed programmes is the contradiction between the market value and the use value of land. The owners of the land see only its market value, i.e. its exchange value on the market; while society sees in it the use value, i.e. what the land means to the local population. Once more, the solution involves applying command-and-control regulation and using proper economic instruments that enable a win-win agreement - economic growth and expansion without damaging the environment and/or threatening the stability of the local community - to be reached.

5.6 Monitoring and Evaluating

Monitoring, evaluation (M&E) and other feedback-generating activities play important roles in assessing programme performance, achievements and shortcomings.[6] Monitoring begins during, not after, the implementation phase as regular documentation of both implementation activities and effects, allowing for the comparison and evaluation of action strategies, approaches and impacts on local conditions for use in future performance evaluation. Certain programmes, such as biodiversity protection, depend heavily upon diligent monitoring activities to gauge and maintain the health of the system.

Generally, monitoring is required for internal management purposes, whereas evaluation and feedback activities have both external and internal applications and are important for guiding planning and resource allocation, maintaining accountability to stakeholders, informing the public and signaling when a project must change.

6 This part is drawn from GEF/UNDP manuals on M&E that are applicable to El Maghara projects.

Flashfloods are potential risk to north sinai, that needs effective warning system
Source: Sayed Aly

The logical framework (log frame) approach is now being widely adopted. Its purpose is to provide a clear, rational framework for planning the envisioned activities and determining how to measure a project's success, while taking external factors into account. The strength of the log frame is in the analysis. Under the log frame approach to project management, objectively verifiable indicators are an important element of project design, implementation and evaluation.

Therefore, one of the most important aspects of monitoring and evaluation (M&E) is the choice of suitable and meaningful indicators. An indicator is a qualified/quantified parameter that details the extent to which a project objective has been achieved within a given timeframe and in a specified location. For instance, an indicator measuring conservation of biodiversity might look at the change in the area (km^2) of habitat protected.

Above all, indicators must be practical and realistic and should, whenever possible, be meaningful and consistent with the main objectives of the project. In discussing indicators, a useful acronym to remember is: SMART (Specific, Measurable, Attainable, Relevant and Trackable). An indicator can also be a signal that shows the change in a parameter compared to a baseline or a future target. Due to the empirical nature of indicators, a project proponent and an external observer should both reach the same conclusion about the project's progress. By specifying project objectives in more concrete and verifiable terms, indicators allow an impartial and indisputable assessment of whether a particular objective has been achieved. The project team should go one step further and interpret what the indicator means in the context of the project.

M&E methodologies are dependent on well-developed sets of indicators. Indicators provide the basis for before-and-after analysis and describe the effects of project interventions, positive and negative, anticipated and

unanticipated, intentional and unintentional. They can be grouped into two categories:

- indicators of implementation progress, that is, the delivery of technical services, capital inputs with related disbursements, and the resulting outputs generated (facilities created, activities and participatory processes organised, people trained etc)
- indicators of environmental impact in local and global terms that demonstrate the environmental accomplishments.

The choice of indicators and their source of verification are governed, among other things, by considerations of the costs involved in collecting the relevant data. Excessively complex or numerous indicators lead to high costs, which could be a reason to seek other, more indirect indicators, for which the data are easier to obtain, so requiring less research and entailing less expense. For example, instead of conducting a survey on income, the number of bicycles sold in the village might be counted.

When in doubt, a "common sense" approach should be used. The choice of indicators should never take up so much time that project managers lose sight of why they are establishing the indicators in the first place. It is far more important to direct resources toward project implementation than to come up with scientifically precise, detailed indicators. In other words, the project should not be driven by the indicators but rather by its objectives.

While it is not possible to establish one set of indicators for all projects, it is possible to provide general guidelines on how to formulate indicators during the planning stage of a project. In particular, the following questions should be answered as part of the process of establishing indicators:

- are the objectives and outputs clearly stated?
- what changes are anticipated as a result of achieving the project objectives and outputs?
- what are the criteria for judging the success of the project?
- anticipating the end of the project, how would one know if the objectives have been achieved?
- are the key stakeholders participating in the establishment of indicators?
- are the data, which are necessary to measure change against a baseline or target, available at reasonable costs?

An ideal set of indicators would include indicators of implementation progress and impact. One must make sure that changes in an indicator are attributable to project activities and not to an external factor. The monitoring and evaluation section of a project brief or project document should include the following:

- brief descriptions of standard M&E procedures such as APR (annual percentage rate), PIR (project implementation review), mid-term and final evaluation, inception report, financial reports, updating and revising work plan and budget, terminal report and terminal reviews
- brief descriptions of specific M&E procedures, such as substantive review or steering committee meetings, submission of progress reports and technical reports
- an M&E plan outlining in detail the following:
  - Timetable: When are the crucial M&E activities supposed to take place during the lifetime of the project (APR, PIR, audit, evaluations)?
  - Reporting requirements: What are the formats and frequency of reporting?
  - Data collection: What kind of data will be collected, when, by whom and where?
  - Responsibilities: Who will be responsible for the M&E tasks?
  - Budget: What are the costs for each of the M&E tasks?

Compliance with the tasks specified in the M&E plan should be monitored and adjustments should be made as appropriate. For each of the standard and specific procedures, the following issues should be addressed:

- what mechanisms and tools will be used?
- what is the schedule and who has what responsibility (who is preparing reports and

Impact of Recent Flashflood on Bedouin Houses
Source: Mohamed Tawfic

convening meetings, composition of the steering committee, identification of target groups)?

- what resources are allocated for each M&E task?

The M&E section should also refer to the indicators and benchmarks documented in the log frame matrix and specifically address the question of provisions, costs and methodologies for baseline data collection, data collection at regular intervals during implementation, and post-implementation data collection and monitoring. Last but not least, some insights should be given on how lessons that have been learnt elsewhere are incorporated into the project design and how the project is going to extract, document and disseminate its own lessons learnt. Learning and feeding back lessons are crucial to "closing the loop" of the project cycle. In turn, these lessons will be applied to the next project.

References

El-Naggar, AE 2005, 'The geography of economic resources and its relationship to poverty in Arab countries: comparative indicators with developed and developing countries', in A El-Naggar (ed.) *Poverty in the Arab world*, (I can't find this book in any catalogue or bibliography it's needs a publisher and place of publication)

Egyptian Environmental Affairs Agency 2001, *National Environmental Action Plan* 2002-2017, viewed 4 April 2007 www.eeaa.gov.eg/english/main/policies3.asp

Panayotou, T 1994, *Economic instruments for environmental management and sustainable development*, Environment and Economics Unit, UNEP, New York, viewed 13 May 2007 http://www.conservationfinance.org/Documents/CF_related_papers/panyouto_econ_instru.pdf

State Information Service, *Modernising the constitution of Egypt: the vision of the National Democratic Party on constitutional reforms*, viewed 29 March 2007, www.sis.gov.eg/VR/conts/5aa.htm

United Nations Development Program 2005, *Egypt human development report*. UNDP &Ministry of Planning and Local Development, Cairo.

Glossary

Index

Glossary

Aquifer: An underground geological formation or group of formations, containing usable amounts of groundwater that can supply wells and springs.

Arable land: Land under temporary crops (double-cropped areas are counted only once), temporary meadows for mowing or pasture, land under market and kitchen gardens, and land temporarily fallow (less than five years). The abandoned land resulting from shifting cultivation is not included in this category.

Baseline: A set of reference data sets or analyses used for comparative purposes; it can be based on a reference year or a reference set of (standard) conditions.

Biodiversity: The variability among living organisms from all sources including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within and among species and diversity within and among ecosystems.

Capability: The combinations of doings and beings from which people can choose to lead the kind of life they value. Basic capability is the capability to meet a basic need.

Clean technology: Manufacturing process or product technology that reduces pollution or waste, energy use or material use in comparison to the technology that it replaces. In clean as opposed to "end-of-pipe" technology, the environmental equipment is integrated into the production process.

Climate change: Any change in climate over time, whether due to natural variability or as a result of human activity. (The UN Framework Convention on Climate Change defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.")

Cultural services: The nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experience, including, for example, knowledge systems, social relations, and aesthetic values.

Decision-maker: A person whose decisions and actions can influence a condition, process, or issue under consideration.

Driver: Any natural or human-induced factor that directly or indirectly causes a change in an ecosystem.

Desertification: This is land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities. It involves crossing thresholds beyond which the underpinning ecosystem cannot restore itself, but requires ever-greater external resources for recovery.

Drainage basin: Land area where precipitation runs off into streams, rivers, lakes and reservoirs. It is a land feature that can be identified by tracing a line along the highest elevations between two areas on a map, often a ridge.

Drylands: Areas characterized by lack of water, which constrain two major, interlinked ecosystem services: Primary production and nutrient cycling. Four dryland sub-types are widely recognized: Dry sub-humid, semi-arid, arid and hyper-arid, showing an increasing level of aridity or moisture deficit. Formally, this definition includes all land where the aridity index value is less than 0.65. See also Aridity index.

Driver, direct: A driver that unequivocally influences ecosystem processes and can therefore be identified and measured to differing degrees of accuracy.

Ecosystem: A dynamic complex of plant, animal, and microorganism communities and their nonliving environment interacting as a functional unit.

Ecosystem assessment: A social process through which the findings of science concerning the causes of ecosystem change, their consequences for human well-being, and management and policy options are brought to bear on the needs of decision-makers.

Ecosystem function: An intrinsic ecosystem characteristic related to the set of conditions and processes whereby an ecosystem maintains its integrity (such as primary productivity, food chain, biogeochemical cycles). Ecosystem functions include such processes as decomposition, production, nutrient cycling, and fluxes of nutrients and energy.

Ecosystem health: A measure of the stability and sustainability of ecosystem functioning or ecosystem services that depends on an ecosystem being active and maintaining its organization, autonomy, and resilience over time. Ecosystem health contributes to human wellbeing through sustainable ecosystem services and conditions for human health.

Ecosystem interactions: Exchanges of materials and energy among ecosystems.

Ecosystem properties: The size, biodiversity, stability, degree of organization, internal exchangesof materials and energy among different pools, and other properties that characterize an ecosystem.

Ecosystem services: The benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services such as nutrient cycling that maintain the conditions for life on Earth. The concept "ecosystem goods and services" is synonymous with ecosystem services.

Geographic information system (GIS): A computerized system organizing data sets through a geographical referencing of all data included in its collections. A GIS allows the spatial display and analysis of information.

Endemic species: Species native to, and restricted to, a particular geographical region.

Environmental impact assessment: An environmental impact assessment (EIA) is an analytical process or procedure that systematically examines the possible environmental consequences of the implementation of a given activity (project). The aim is to ensure that the environmental implications of decisions related to a given activity are taken into account before the decisions are made.

Environmental policy: A policy initiative aimed at addressing environmental problems and challenges.

Genetic diversity: The variety of genes within a particular species, variety or breed.

Global scale: The geographical realm encompassing all of Earth.

Globalization: The increasing integration of economies and societies around the world, particularly through trade and financial flows, and the transfer of culture and technology.

Governance: The manner in which society exercises control over resources. It denotes the mechanisms through which control over resources is defined and access is regulated. For example, there is governance through the state, the market, or through civil society groups and local organizations. Governance is exercised through institutions: laws, property rights systems and forms of social organization.

Groundwater: Water that flows or seeps downward and saturates soil or rock, supplying springs and wells. The upper surface of the saturate zone is called the water table.

Habitat: Area occupied by and supporting living organisms. Also used to mean the environmental attributes required by a particular species or its ecological niche.

Hazardous waste: Products of society that can pose a substantial or potential hazard to human health or the environment when improperly managed.

Substances classified as hazardous wastes possess at least one of four characteristics: Ignitability, corrosivity, reactivity or toxicity, or appear on special lists.

Health: Strength, feeling well, and having a good functional capacity. Health, in popular idiom, also connotes an absence of disease. The health of a whole community or population is reflected in measurements of disease incidence and prevalence, age-specific death rates, and life expectancy.

Heavy metals: A group name for metals and semimetals (metalloids), such as arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc, that have been associated with contamination and potential toxicity.

Institutions: The rules that guide how people within societies live, work, and interact with each other. Formal institutions are written or codified rules. Examples of formal institutions would be the constitution, the judiciary laws, the organized market, and property rights. Informal institutions are rules governed by social and behavioral norms of the society, family, or community.

Irreversibility: The quality of being impossible or difficult to return to, or to restore to, aformer condition. See also *option value, precautionary principle, resilience*, and *threshold*.

Land cover: The physical coverage of land, usually expressed in terms of vegetation cover or lack of it. Influenced by but not synonymous with *land use*.

Land degradation: The loss of biological or economic productivity and complexity in croplands, pastures and woodlands. It is due mainly to climate variability and unsustainable human activity.

Land use: The human utilization of a piece of land for a certain purpose (such as irrigated agriculture or recreation). Influenced by but not synonymous with land cover.

Landscape: An area of land that contains a mosaic of ecosystems, including human-dominated ecosystems. The term cultural landscape is often used when referring to landscapes containing significant human populations.

Level: The discrete levels of social organization, such as individuals, households, communities, and nations. See also *scale*.

Mainstreaming: Mainstreaming the environment into development policy making means that environmental considerations are considered in the design of policies for development.

Mitigation: Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards.

Participatory approach: Securing an adequate and equal opportunity for people to place questions on the agenda and to express their preferences about the final outcome during decision making to all group members. Participation can occur directly or through legitimate representatives. Participation may range from consultation to the obligation of achieving a consensus.

Policy: Any form of intervention or societal response. This includes not only statements of intent, such as a water policy or forest policy, but also other forms of intervention, such as the use of economic instruments, market creation, subsidies, institutional reform, legal reform, decentralization and institutional development. Policy can be seen as a tool for the exercise of governance. When such an intervention is enforced by the state, it is called public policy.

Pollutant: Any substance that causes harm to the environment when it mixes with soil, water or air.

Pollution: The presence of minerals, chemicals or physical properties at levels that exceed the values deemed to define a boundary between "good or acceptable" and "poor or unacceptable" quality, which is a function of the specific pollutant.

Poverty: The pronounced deprivation of well-being.

Projection: A potential future evolution of a quantity or set of quantities, often computed with the aid of a model. Projections are distinguished from "predictions" in order to emphasize that projections involve assumptions concerning, for example, future socioeconomic and technological developments that may or may not be realized; they are therefore subject to substantial uncertainty.

Provisioning services: The products obtained from ecosystems, including, for example, genetic resources, food and fiber, and fresh water.

Rangeland: An area where the main land use is related to the support of grazing or browsing mammals, such as cattle, sheep, goats, camels, or antelope.

Regulating services: The benefits obtained from the regulation of ecosystem processes, including, for example, the regulation of climate, water, and some human diseases.

Resilience: The capacity of a system to tolerate impacts of drivers without irreversible change in its outputs or structure.

Responses: Human actions, including policies, strategies, and interventions, to address specific issues, needs, opportunities, or problems. In the context of ecosystem management, responses may be of legal, technical, institutional, economic, and behavioral nature and may operate at local or micro, regional, national, or international level and at various time scales.

Risk: The probability or probability distribution of an event or the product of the magnitude of an event and the probability of its occurrence.

Run off: A portion of rainfall, melted snow or irrigation water that flows across the ground's surface and is eventually returned to streams. Run-off can pick up pollutants from air or land and carry them to receiving waters.

Salinization: The buildup of salts in soils.

Scale: The physical dimensions, in either space or time, of phenomena or observations.. See also *level*.

Scenario: A plausible and often simplified description of how the future may develop, based on a coherent and internally consistent set of assumptions about key driving forces (e.g., rate of technology change, prices) and relationships. Scenarios are neither predictions nor projections and sometimes may be based on a "narrative storyline." Scenarios may be derived from projections but are often based on additional information from other sources.

Security: Access to resources, safety, and the ability to live in a predictable and controllable environment.

Sedement: Solid material that originates mostly from disintegrated rocks and is transported by, suspended in or deposited from water.

Species: An interbreeding group of organisms that is reproductively isolated from all other organisms, although there are many partial exceptions to this rule in particular taxa. Operationally, the term species is a generally agreed fundamental taxonomic unit, based on morphological or genetic similarity that once described and accepted is associated with a unique scientific name.

Species diversity: Biodiversity at the species level, often combining aspects of species richness, their relative abundance and their dissimilarity.

Stakeholder: An actor having a stake or interest in a physical resource, ecosystem service, institution, or social system, or someone who is or may be affected by a public policy.

Supporting services: Ecosystem services that are necessary for the production of all other ecosystem services. Some examples include biomass production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat.

Surface water: All water naturally open to the atmosphere, including rivers, lakes, reservoirs, streams, impoundments, seas and estuaries. The term also covers springs, wells or other collectors of water that are directly influenced by surface waters.

Sustainability: A characteristic or state whereby the needs of the present and local population can be met without compromising the ability of future generations or populations in other locations to meet their needs.

Threshold: A point or level at which new properties emerge in an ecological, economic, or other system, invalidating predictions based on mathematical relationships that apply at lower levels. For example, species diversity of a landscape may decline steadily with increasing habitat degradation to a certain point, then fall sharply after a critical threshold of degradation is reached. Human behavior, especially at group levels, sometimes exhibits threshold effects. Thresholds at which irreversible changes occur are especially of concern to decision-makers.

Uncertainty: An expression of the degree to which a future condition (e.g., of an ecosystem) is unknown. Uncertainty can result from lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from quantifiable errors in the data to ambiguously defined terminology or uncertain projections of human behavior.

Urbanization: An increase in the proportion of the population living in urban areas.

Vulnerability: An intrinsic feature of people at risk. It is a function of exposure, sensitivity to impacts of the specific unit exposed (such as a watershed, island, household, village, city or country), and the ability or inability to cope or adapt. It is multi-dimensional, multidisciplinary, multisectoral and dynamic. The exposure is to hazards such as drought, conflict or extreme price fluctuations, and also to underlying socio-economic, institutional and environmental conditions.

Water treatment: Any of the mechanical, biological or chemical processes used to modify the quality of wastewater in order to reduce pollution levels.

Water quality: The chemical, physical and biological characteristics of water, usually in respect to its suitability for a particular purpose. Occurs when annual water supplies drop below 1 000 m per person, or when more than 40 per cent of available water is used.

Water scarcity: Occurs when low water supplies limit food production and economic development, and affect human health.

Water stress: An area is experiencing water stress when annual water supplies drop below 1,700 m per person.

Water table: The top of the water surface in the saturated part of an aquifer.

Well-being: A context- and situation-dependent state, comprising basic material for a good life, freedom and choice, health, good social relations, and security.

Index

A

Agriculture 16, 22, 26, 29, 33, 35, 37, 39, 40, 46, 53, 55, 58, 60, 61, 62, 64, 66

Agro-diversity 16, 18, 61

Air 4, 60, 118, 120, 121, 129, 132, 136, 137

Aquifer 48, 50, 51, 53, 54, 55, 56, 57, 133

Aridity 42, 153

Assessment 3, 4, 5, 6, 11, 12, 14, 15, 16, 17, 19, 20, 21, 22, 23, 26, 28, 29, 33, 41, 42, 47, 53, 60, 76, 77, 78, 81, 83, 84, 85, 89, 90, 91, 93, 94, 95, 97, 98, 99, 101, 102, 125, 133, 134, 135, 137, 139, 148,149, 150, 152

B

Bedouin 7, 11, 12, 14, 15, 16, 17, 18, 20, 21, 22, 23, 24, 25, 26, 28, 29, 33, 34, 35, 37, 39, 40, 41, 42, 46, 47, 49, 55, 57, 58, 59, 60, 61, 66, 67, 73, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 89, 91, 92, 93, 94, 95, 97, 98, 99, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 115, 118, 119, 120, 121, 122, 123, 150, 151

Biodiversity 12, 17, 22, 33, 40, 42, 77, 94, 95, 106,107, 112, 116, 117, 119, 129, 132, 137, 138, 139, 145, 151, 152

C

Capacity building 136

Climate change 3, 59, 93, 138

Conceptual framework 4, 19

Conflicts 20, 21, 24, 114, 117

Contamination 12, 19, 33, 50, 60, 64, 65, 95, 106, 117, 118, 139

Convention on biological diversity 4

D

Degradation 3, 4, 11, 12, 17, 19, 22, 23, 33, 35, 39, 60, 61, 66, 77, 78, 91, 94, 95, 102, 103, 105, 106, 107, 119, 129, 131, 135, 145

Demographic 23, 89

Desertification 4, 129, 132, 135, 136, 138

Diseases 4, 21, 27, 28, 29, 39, 41, 48, 50, 65, 77, 78, 94, 108, 118, 120, 121, 133, 137

Drivers of ecosystem change 5, 18, 19, 89, 97, 133

Drought 28, 24, 39, 40, 55, 76, 119, 129, 133, 136

E

Economy 104, 106, 110, 115, 119, 131, 135, 140, 142, 148

Ecosystem services 4, 5, 14, 18, 19, 22, 33, 34, 47, 76, 90, 91, 95, 111

Encroachment 40, 62, 135

Endangered species 78, 106, 138

Environment 4, 5, 6, 11, 12, 15, 19, 33, 47, 75, 79, 83, 85, 93, 97, 101, 105, 106, 110, 111, 112, 113, 116, 117, 121, 129, 130, 1321, 135, 137, 142, 143, 144, 145, 146, 147, 149, 150, 151

Erosion 4, 39, 40, 61, 62, 67, 81

F

Flashfloods 16, 26, 34, 49, 56, 59, 81, 82, 93, 95, 105, 111, 113, 118, 119, 136

Flora 12, 17, 40, 41, 44, 65, 136, 138

Fertility 35, 61, 62, 65, 68

Fuel wood 29, 35

G

Governance 15, 22, 89, 93, 96, 97, 98, 99, 101, 102, 105, 107, 109, 113, 114, 116, 117, 118, 119, 120, 121, 122, 129, 130, 131, 142, 148, 149, 150

Grazing 21, 22, 26, 28, 33, 34, 49, 40, 47, 60, 66, 67, 78, 83, 97, 107, 119, 120, 121, 135

H

Health 3, 4, 26, 28, 29, 39, 40, 83, 84, 85, 93, 94, 95, 96, 97, 98, 107, 108, 112, 113, 117, 118, 120, 130, 133, 136, 142, 143, 144, 145, 146, 149, 151

Heavy metals 19, 26, 37, 46, 59, 60, 116, 117

Human development 141, 142, 150

Human well-being 3, 4, 5, 6, 11, 18, 22, 89, 91

I

Illiteracy 22, 23, 26, 89, 92, 94, 96, 99, 108, 112, 114, 118, 120

Income 5, 24, 25, 39, 78, 89, 94,104, 107, 115, 121, 122, 141, 144, 145, 153

Indicators 11, 19, 122, 129, 136, 141, 142, 152, 153, 154

Institutions 75, 83, 104, 130, 148, 149, 150, 151

L

Land 3, 4, 7, 12, 14, 19, 20, 22, 28, 33, 34, 35, 46, 47, 56, 59, 64, 66, 77, 78, 91, 93, 94, 95, 95, 97, 99, 103, 105, 107, 111, 112, 113, 115, 117, 119, 121, 129, 134, 135, 136, 138, 146, 151

Law 15, 22, 25, 113, 118, 134, 138, 146, 149, 150

Local knowledge 7, 16, 18, 21, 24, 75, 81, 85, 76, 77, 78, 79, 80, 82, 83, 84, 108, 112

M

Medicinal plants 12, 21, 24, 33, 34, 41, 42, 43, 78, 83, 106, 110, 111, 116, 137

Migration 3, 12, 22, 23, 39, 93, 94, 96, 110, 111, 123, 133, 135

Millennium Development Goals (MDG) 5

Millennium Ecosystem Assessment (MA) 3,4,

Mineral 19, 33, 50, 67, 68, 94

Mining 26, 28, 35, 37, 46, 55, 59, 65, 67, 70, 93, 94, 95, 96, 97, 117, 135, 136, 147

P

Policy responses 133

Pollution 12, 33, 35, 37, 59, 60, 65, 94, 95, 96, 105, 107, 111, 116, 118, 120, 133, 134, 135, 137, 140, 144, 145

Population 4, 5, 16, 21, 22, 23, 24, 28, 55, 59, 66, 68, 94, 101, 106, 108, 110, 113, 116, 122, 129, 130, 132, 135, 138, 139, 140, 141, 142, 145, 146, 149, 150, 151

Poverty 5, 11, 12, 18, 20, 22, 23, 33, 92, 93, 94, 95, 96, 97, 98, 99, 103, 105, 110, 114, 121, 122, 129, 130, 132, 133, 134, 135

Protected areas 105, 106, 11, 35

Q

Quarries 59, 93, 94, 95, 117, 137

R

Rainfall 14, 35, 46, 48, 49, 53, 56, 59, 93

Ramsar convention on wetlands 4

S

Salinity 46, 50, 53, 61, 62, 66, 78, 79, 113, 135

Sanitation 28, 58, 115, 140

Scenarios 19, 87, 90, 91, 92, 101, 102, 103, 121, 122

Sinai 6, 7, 8, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 28, 29, 37, 40, 41, 42, 44, 45, 46 ,47, 48, 49, 51, 60, 66, 67, 76, 77, 78, 85, 93, 94, 95, 101, 103, 104, 109, 110, 112, 113, 114, 115, 118, 119, 120, 132, 133, 139, 141, 143, 149

Spiritual 4, 143

Sustainable development 6, 11, 18, 20, 40, 98, 100, 105, 129, 130, 131, 132, 136, 137, 141, 142, 144, 145, 146, 149

T

Trade offs 151

Transport 59, 67, 93, 109, 110, 113

Tribe 12, 22, 83, 85, 115, 120, 121

U

Uncertainties 87, 90, 91, 101, 102, 113

Urbanization 12, 22

V

Vulnerability 22, 114

W

Wadi 13, 15, 37, 42, 46, 47, 49, 50, 51, 53, 57, 58, 59

Women 21, 26, 27, 29, 47, 66, 67, 83, 108, 120, 137, 142, 144, 149

Waste 4, 12, 26, 33, 34, 35, 37, 46, 64, 108, 117, 130, 133, 138, 139, 140, 143

Water 4, 12, 14, 16, 17, 19, 21, 22, 24, 26, 27, 28, 29, 30, 33, 34, 35, 39, 40, 47, 48, 49, 50, 51, 53, 55, 56, 57, 58, 59, 60, 61, 62, 64, 67, 68, 75, 77, 78, 79, 80, 81, 82, 89, 93, 94, 95, 96, 97, 98, 99, 101, 102, 103, 104, 105, 106, 107, 108, 109, 111, 113, 115, 116, 117, 118, 120, 121, 123, 129, 133, 134, 135, 136, 138, 139, 140, 143, 146