World Soils Book Series

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The Soils of Egypt

Springer

World Soils Book Series

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The World Soils Book Series publishes books containing details on soils of a particular country. They include sections on soil research history, climate, geology, geomorphology, major soil types, soil maps, soil properties, soil classification, soil fertility, land use and vegetation, soil management, soils and humans, soils and industry, future soil issues. The books summarize what is known about the soils in a particular country in a concise and highly reader-friendly way. The series contains both single and multi-authored books as well as edited volumes. There is additional scope for regional studies within the series, particularly when covering large land masses (for example, The Soils of Texas, The Soils of California), however, these will be assessed on an individual basis.

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This book is dedicated to our families

All photos by El-Ramady

Foreword I

This book is long overdue. Its most immediate didactic value resides in helping the reader to understand the concept and state of the art of soils from Egypt. The book thus fills an obvious need for a systematic account of concept of soil science in Middle East to facilitate the practice of science.

Specifically, the book covers extremely important chapters detailing the role of soil use and its relation to human food security, soil pollution, land use and vegetation status, soil biology, and land degradation. The concept of right use of land, cultivating the soil using nutrient lacking in animal and humans, would be a very interesting topic to improve human health.

This book is aimed at researchers and professionals, together with postgraduate students. However, I believe that the material will also stimulate advanced undergraduate students and those interested in the application of this knowledge.

I think that the authors can be confident that there will be many grateful readers who will have gained a broader perspective of the disciplines of soil science in Egypt as a result of their efforts.

São Paulo, Brazil
January 2018

Prof. André Rodrigues dos Reis Ph.D.
São Paulo State University (UNESP)

Foreword II

Our Soils: No Longer Crypto-Resources

A careful reflection on the presence and location of the living systems on our planet, including soils, leads us to observe—in compliance with the proportions—that they surround the Earth as a thin coating. A few kilometers below the Earth surface, the temperature is too high, while a few kilometers above the air is too cold and rarefied to allow survival. Between these two limits affirms animal and plant life. The latter, in particular, constitutes the basis for food chains, contributes to the water and biochemical cycles, and protects the soil's life, which is the base of the biosphere.

Soil develops where the combined actions of atmosphere, hydrosphere, and biosphere act on lithosphere and, together with air and water, completes the triad of the natural resources that are essential to the life. In a most general sense, soil is the medium that allows plants and animals to live and develop, and Man to carry out all his activities. From time to time, and in relation to his needs, Man has considered soil as a mean of agricultural and forestry production, a seat of urban and infrastructure settlements, a place of leisure and sport, a source of raw materials, and in summary, a source of goods and services useful to human life.

Soils fulfill basic functions for the human society, not only in practice because they satisfy human's material needs but also in the abstract, stimulate intellectual activity or indulging needs of spiritual well-being. There are cultural evidences regarding the role of soil throughout history and some are still found in the customs, folklore, and traditions of various populations in several countries. In ancient societies, the soil has always had a privileged position in virtue of its fundamental role of providing foodstuffs. Even today, in various parts of the world, social systems reflect the connections between the soil and the environment, and the management of soil fertility is at the heart of this connection.

Regrettably, "*homo technologicus*", descendant of "*homo sapiens*", forced to live in ever-bigger cities, to feed with ready meals, to breathe air conditioning in hyper-technological offices and impersonal lofts, rarely does he stop and reflect on how much his well-being is fundamentally connected to the soil and to the other primary resources. In the next years, maintaining the welfare and the development of the human societies will largely depend on Man's ability to ensure the sustainable use of the natural resources, in particular soils.

We live in an era and in a cultural system that pays particular attention to the human rights, but not equally indicates duties and responsibilities. We are able to fight for defending our privileges but we wimp out from our duties: our relationship with the environment is characterized by a general indifference and a widespread carelessness. Unfortunately, the awareness of the role played by the environmental resources and by the soil in particular is lacking. Soil, being a "**crypto-resource**", a hidden resource, is considered only after catastrophic events and when the failures are evident!

So far, we have shown skill in getting out from situations that the wisdom would have certainly avoided. It is time to move on by the skill to the wisdom, the same wisdom which has driven Aldo Leopold (1886–1948) to argue that "*the oldest task of man is to live on the soil without despoil it.*"

Now it is imperative a cultural leap: we all have to consider the soil as a good for a human society that is continuously changing and in which the boost toward a continuous economic growth and a rapid technological development, coupled with the progressive increase of the information, often causes considerable and unpredictable changes. The achievement of these goals is based on a sound and comprehensive knowledge of the soils of each country.

I wish to welcome the book *The Soils of Egypt* and to congratulate with the authors.

Palermo, Italy
January 2018

Prof. Dr. Carmelo Dazzi
President of the European Society
for Soil Conservation (ESSC)

Preface

It is well known that soils are the main source of our food, feed, fiber, and fuel. So, soils have a holy position in all religions including Islam, Christianity, and Judaism. Furthermore, great civilizations established depending on soils like the Egyptian civilization. Therefore, this book *The Soils of Egypt* has been written. This book includes soil and its potential from many sides in Egypt such as climate changes and water crisis, different expected scenarios of climate change in Egypt, and effects of climate change on crop productivity. Geology and geomorphology also will be presented as well as major soil types and different soil maps. Soil classification also will be among the most important subjects and will be highlighted in this book. On the other hand, different soil properties and how to sustain these land resources will be also highlighted. Due to the role of Egyptian soils in the ancient Egyptian civilization, soil fertility and its security will be presented as one of the most important issues. Pollution also as one of the most important and serious problems in Egypt will be highlighted, due to pollution already has been penetrated different environmental compartments including soils, waters, and air. Soil pollution and its management as well as different soil pollution sources and the degradation of Egyptian soils are needed more explanation. Different land uses including vegetation as well as future soil issues in Egypt will be also reviewed.

This book will present a comprehensive overview and the vital importance of soils to agriculture, ecosystems, and human life in Egypt. The study of soil resources will allow for more researches and management our challenges including improving soil quality and its sustainability, soil carbon sequestration, and wastewater treatment as well as innovative delivery of nutrients and water for crop production. We also do hope that this book will bring enough knowledge for next generations with continuous delivering proper solutions for different environmental challenges, which we are facing now and in the future. Soil resources could be conserved and sustained only by understanding different soil properties and its processes occurring in the soils.

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1 Introduction

Hassan El-Ramady, Tarek Alshaal, Ahmed S. El-Henawy,
and Mohamed S. Shams

Abstract

Egypt is one of the most old countries worldwide. It has a great history and an amazing civilization. This civilization established and flowered on the two sides of the Nile River. Depending on both the freshwater from the Nile and fertile soils, this civilization is extended for thousands of years. The wonderful location of Egypt besides the temperate weather, the metal wealth, and oil, they enforced Egypt to be a prey to the colonists. So, several colonists tried to occupy the Egyptian lands but it has been destroyed and overcame these enemies. Therefore, the Egyptian soils were and still the domain factor in agricultural production. These soils have several functions in our life associated with the goals of UN sustainable development as well as the ecosystem services. These soil-related ecosystem services also could be subdivided into regulating, provisioning, and cultural subgroups. So, this book is an attempt to discuss the Egyptian soils including the following issues: the historical research of Egyptian soils, the climate and its changes, soil pollution, soil maps and major soil types, soil fertility, and its security, as well as future soil issues.

Keywords

Soils • Egypt • Climate • Soil pollution
Soil security • The Nile delta

1.1 Introduction

Egypt is the third-most populous on the African continent after Nigeria and Ethiopia. About 95% of the Egyptian population lives along the banks of the Nile and in the Nile Delta expanding from the north of Cairo and along the Suez Canal (Fig. 1.1). The total Egyptian population reached more than **93 million people in 2017** according to the Central Agency for Public Mobilization and Statistics (**CAPMAS**). The population in Egypt is expected to grow more than **100** million people by **2023**. The distinguished distribution of population in Egypt has a unique phenomenon. This distribution is recognized as a demographic imbalance due to the following reasons:

(1) About 25% of the total population is squeezed into the Greater Cairo (i.e., Cairo, Giza, and Qalyubia),
(2) About 25% lives in the north coastal governorates (i.e., eight governorates starting from North Sinai in the northeastern coast, Port Said, Damietta, Dakahlia, Kafr El Sheikh, Beheira, Alexandria, and ending with Matruh in the northwestern coast),
(3) About 48% is occupied in the Nile Delta (i.e., Port Said, Sharqia, Damietta, Qalyubia, Gharbia, Menufyia, Kafr El Sheikh, Beheira, and Alexandria governorates),
(4) About 20% is existed in the Upper Egypt governorates (Asyut, Sohag, Qena, Aswan, and Luxor), and
(5) Only about **1.1** million is distributed in the three biggest governorates (New valley, Matruh, and Red Sea).

Concerning the soil and agriculture in ancient Egypt, the Egyptian agriculture has a very long story, i.e., more than 5000 years in the arid climate, which mainly has been dependent on the Nile River (El-Ramady et al. 2013). This agriculture was completely controlled by the flooding of the Nile in ancient times. This system is totally different after beginning the nineteenth century (the era of Mohamed Ali), where the construction of different weirs and dams in the river, in order to control the flow of the Nile, starts the modern agriculture in Egypt. This era could be considered the real revolutionary change in Egyptian agriculture and water use as well as the sustainability of Egyptian agriculture (Satoh and Aboulroos 2017).

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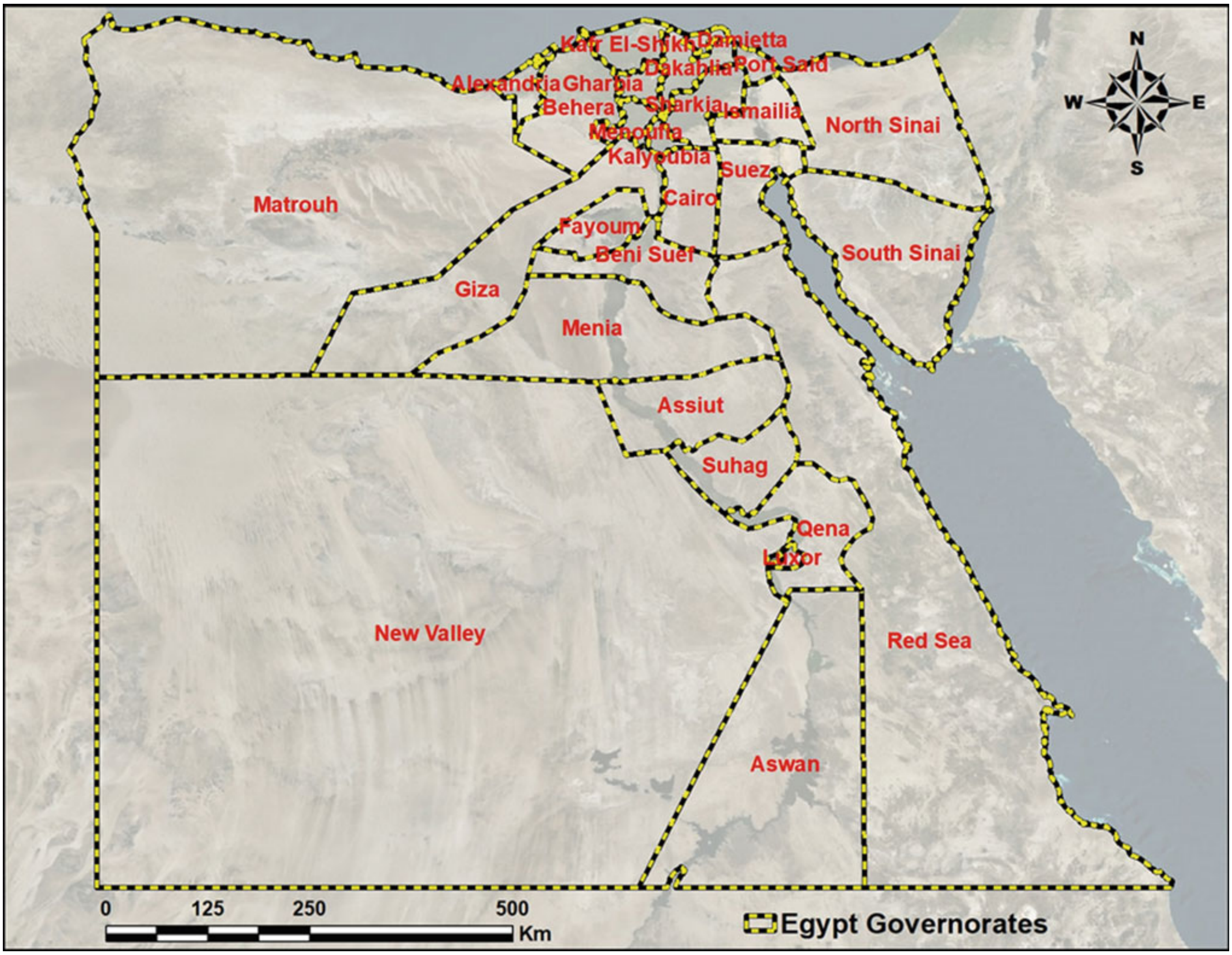

Fig. 1.1 Egypt has 27 governorates distributed in the Nile Delta, in East, and West Deserts from Matruh in the West to Red Sea in the East to Aswan in the South. (This map is created by Dr. Noura Bakr)

Egypt has different names in different languages such as German name (Ägypten), English (Egypt), French (Egypte), Latin (Aegyptus), Italian (Egitto), Spanish (Egipto), Hungarian (Egyiptom), the Ancient Greek (Aígyptos or Aἴγυπτος), and Arabic (Misr or Masr مِصر). Concerning the ancient names for Egypt, these names generally recorded the relation between the people, the land, and its agriculture. These include *Ta Akht*, the land of flood and fertile soil; *Ta-meri*, the land cultivated by the hoe; *Kmt*, the black soil; *Tamhi*, the land of the flax plant; *Nht*, the land of the sycomore fig tree; and *Misr*, the safe and civilized country. The name of Egypt was derived from the name of the Earth God, *Ge*, or from *Agpt*, referring to the land covered with floodwaters (Janick 2016).

Egypt is a transcontinental country spanning the southwest corner of Asia Continent and the northeast corner of Africa Continent by a land bridge formed by the Sinai Peninsula. This country could be considered a cradle of civilization, where Ancient Egypt experienced some of the earliest developments in agriculture, writing, organized religion, urbanization, and central government. Therefore, Egypt has one of the longest histories comparing with any modern country and its history could be considered an emerging one of the world's first nation-states in the tenth millennium BC. This history simply could be presented through several monuments including many necropolises, Pyramids, and Great Sphinx in Giza, as well as the ruins of Thebes, Memphis, Karnak, and the Valley of the Kings (Fig. 1.2). This civilization is a great legacy reflecting a significant focus of different archeologists and popular interests worldwide.

Recently, Springer has been published many books about Egypt including the history (past, present, and future) of the irrigated agriculture in Egypt (Satoh and Aboulroos 2017), the Nile River and its great role in the Egyptian life (Negm 2017a), the Nile Delta as one of the Earth's great mega

Fig. 1.2 This place was known with the manufacturing zone of obelisks in Aswan. The ancient Egyptians used to place obelisks in pairs at the entrance of their temples. A number of ancient Egyptian obelisks are known to have survived, plus the unfinished obelisk found partly hewn from its quarry at Aswan. Egyptian obelisks are now dispersed around the world and fewer than half of them remain in Egypt. Photo by El-Ramady (2010)

deltas as well as problems and challenges facing this Nile Delta concerning the agriculture, the shortage of freshwater and other topics (Negm 2017b), the impact of the Grand Ethiopian Renaissance Dam on Egyptian agriculture (Hamada 2017), the future of food gaps in Egypt through the obstacles and opportunities (Ouda et al. 2017), different water resources including the unconventional resources and their impacts on agriculture in Egypt (Negm 2017c), the complicated relationship or nexus among water, energy and food security in the Arab region (Amer et al. 2017) and Middle East (Badran et al. 2017), etc. Therefore, this chapter will highlight on the main geological regions in Egypt, the distribution of different Egyptian soils in these zones, the close relation between soils and climate changes, and soil pollution under different Egyptian conditions.

1.2 Egypt and Its Geological Zones

Egypt has different rocks, mineral, and natural resources. The oldest rocks could be found in the Western Desert, whereas the rocks of the Eastern Desert are largely late Proterozoic in age (Fig. 1.3). It could be divided Egypt into four main areas or regions including (1) the Nile Valley and its Delta, (2) the Eastern Desert, (3) the Western Desert, and (4) the Sinai Peninsula. Each one from the previous areas has particular features. It would be great to highlight some distinguished features for these previous places in the following subsections.

1.2.1 The Nile Valley and Its Delta

The Nile Valley and its Delta (35,000 km^2) were and still the most extensive oasis in the world. This valley and its Delta were created by the longest river in the world (the Nile; 6 853 km). It is well known that the Nile Delta is one of the largest river deltas in the world. It extended from Alexandria in the West to Port Said in the East covering 240 km of Mediterranean coastline and considering the main region for the Egyptian agriculture. It also extends from the North to the South about 160 km in length beginning slightly downriver from Cairo. This Nile Delta is mainly a delta formed in Northern Egypt (Lower Egypt) where the Nile River spreads out and drains into the Mediterranean Sea. The Nile Delta could be characterized with these facts: (1) it covers only about **4%** of Egypt's area but hosts about 48% of the country's population, (2) it consists of about 63% of the Egyptian agricultural land, and (3) it is among the most densely populated agricultural areas in the world recording 1360 inhabitants per km^2 (Negm et al. 2017a, b).

It is well known that the Nile starts its journey and flow into Egypt in the area from the north of Wadi Halfa to Lake Nasser on the Sudanese–Egyptian borders. It is reported that seven branches of the Nile have been ran through the Nile Delta from the first century AD, according to historical accounts. Around the twelfth century, the Nile had only six branches according to the last accounts. Finally, only two main outlets, namely, the east branch (Damietta or Dumyat with 240 km long) and the west branch (Rosetta or Rashid

Fig. 1.3 There are several types of rocks in Egypt, which are formed by different processes as rocks located in the Eastern Desert (Red Sea area in the top four photos) and along the Mediterranean coast as presented in the bottom four photos in Matrouh. Photos by El-Ramady (2010, 2017), respectively

with 239 km long) according to the names of ports located at their respective mouths. The depth of Rosetta branch ranges from 2 to 4 m and its width averages 180 m (Negm et al. 2011). This branch could be used its water in irrigation, drinking, and fishing purposes with a daily flow in average 21,500,000 m^3 per day. The drains receive domestic, industrial, and agricultural wastes (Elhaddad and Al-Zyoud 2017).

Concerning the common soils in both the Nile Valley and its Delta, they are in general alluvial soils. These soils mainly formed from the deposits of the Nile branches, fluviomarine, and lagoon, which located adjacent to the

Fig. 1.4 The area around the monument (the small photo) as a symbol for Egyptian–Soviet friendship or collaboration at the completion of the Aswan High Dam. Photos by El-Ramady (2010)

northern lakes and the coastal plain in the extreme north of the Delta as well as the sandy soils from the coastal plain and beaches (Khalifa and Moussa 2017). The main problem faced by the Nile Delta is represented in no longer receiving an annual supply of nutrients and sediments from upstream because of the construction of the Aswan High Dam (Fig. 1.4); the quality of soils of the floodplains has declined, and large amounts of fertilizers are now used (Negm et al. 2017a, b). For more details about the Nile Delta, see a great book published by Springer carrying this title edited by Negm (2017b), as well as some studies (e.g., Hereher 2010; Mabrouk et al. 2013a, b; Sharaky et al. 2017; Elbeih 2017; Negm and Armanuos 2017; Negm and Eltarabily 2017).

1.2.2 The Western Desert

The Western Desert or the Libyan Desert is a part of the Sahara in Egypt lying between the Nile and Cyrenaica. It is an area of the Sahara, which lies west of the river Nile, up to the Libyan border and south from the Mediterranean Sea to the border with Sudan. Its name derived from the contrast to the Eastern Desert, which extends east from the Nile to Red Sea. The desert covers an area of 680,650 km^2, which represents two-thirds (about **68%**) of the land area of the country. Concerning the geology of the Western Desert, it is mostly rocky desert, though an area of sandy desert, known as the Great Sand Sea, lies to the west against the Libyan border. The highest elevation (1000 m) is recorded for the Gilf Kebir plateau into the far southwest of the country, on the Egypt–Sudan–Libya border. According to the administration position, it is mainly divided among many governorates including the Matrouh Governorate and the New Valley Governorate from there to the Sudan border in the north and west, while in the eastern parts of the Western Desert lie in the Giza, Fayoum, Beni Suef, and Minya Governorates. This Western Desert is barren and uninhabited save for a chain of oases which extend in an arc from Siwa (in the North–West) to Kharga (in the South). On the other hand, part of the Western Desert soils is located by the North Coastal Zone of Egypt. These soils mainly are sandy soils and extend to about 500 km between Alexandria and Salloum city near the Libyan borders covering an area about 10,000 km^2.

It is well known that several natural depressions or oases are scattered in the Western Desert including these famous oases: Siwa, Bahariya, Farafra, Kharga, and Dakhla. The Western Desert also contains promising reclaimed areas including Darb El-Arbain, Toshka, East El-Uwienat, and some wadis of High Dam Lake. Concerning the soils of these natural depressions or oases, they mainly depend on source of parent materials, the erosional patterns, sedimentation environment and eluviation deposit of salts, carbonate, and gypsum. Therefore, the characterization of these soils may show differences with regard to mineral content, their texture, and depth to water table or bedrock, in addition to numerous types of morphopedological features such as accumulation of carbonate and gypsum, salts, shales, and iron oxides (Khalifa and Moussa 2017).

It is worth to mention that there are mainly five famous oases in Egyptian Western Desert: Siwa, Kharga, Dakhla, Baharia, and Farafra. Siwa Oasis is considered an important Egyptian oasis as a deep depression (about 20 m below sea level). It is one of the most isolated Egyptian settlements, with 23,000 people, mostly Berbers who developed a unique culture and a distinct language of the Berber family called Siwi. The Siwa Oasis (derived from the Berber word Isiwan) is an Egyptian oasis located between the Qattara Depression and the Egyptian Sand Sea in the Western Desert, nearly 50 km east of the Libyan border, 300 km from southwest of Mersa Matrouh, and 560 km from Cairo as well as about 80 km in length and 20 km wide (Fig. 1.5). Agriculture through the cultivation of dates and olives is the main activity in Siwi as well as handicrafts like basketry. Tourism has become a vital source of income from recent decades. Much attention has been given to creating hotels that use local materials and display local styles (Aldumairy 2005). Definitely, further studies are needed to investigate several treasures in the Western Desert of Egypt such as Attwa and Nabih (2015), El Ayyat (2015), El Nady and El-Naggar (2016), and Temraz et al. (2017).

1.2.3 The Eastern Desert

The part of Egypt is located east of the Nile River called the Eastern Desert. It is the section of Sahara or Desert between the river Nile and the Red Sea. It extends from Egypt in the north to Eritrea in the south and also comprises parts of Sudan and Ethiopia. The Eastern Desert of Egypt represents about **22%** of the surface area of the country (223,000 km^2) but due to the limited availability of water, this area is undeveloped (Abdel Moneim 2005). The main geographic features of the Eastern Desert are the western Red Sea coastline (with the Red Sea Riviera) and the Eastern Desert mountain range that runs along the coast, the highest peak of which is Shaiyb al-Banat (2187 m). The Eastern Desert is a popular setting for safaris and other excursions. The Eastern Desert includes some governorates, i.e., Suez, Qina, and Red Sea.

There are many mountains and wadis (e.g., W. El Laquita, W. Qena, W. El Assuity, and W. Al-Allaqui) flowing toward the Nile River and the Red Sea. The soils of this desert are mostly deep and very steep, and their soils display young stages of development, whereas soils of the wadis are mainly shallow to deep coarse or moderately fine-textured, with variable content of gravels (Khalifa and Moussa 2017). Recently, several investigations carried out

Fig. 1.5 Siwa is a deep depression, where saline soils could be resulted from high groundwater, and many areas are used in salt production as presented in last or bottom photo (left). The right photo is a view for Siwa Oasis that has been taken over Dakrour Mountain representing a side for the modern city, and other photo represents the old town of Shali in Siwa Oasis. Photos by El-Ramady, April 2017

focusing on different fields of the Eastern Desert of Egypt including remote sensing (e.g., Abou El-Magd et al. 2015; Nigm et al. 2015), geomorphological and geochemical studies (e.g., Abdel Moneim 2005; Mohamed and Abu El-Ela 2011; Emam 2013; Emam and Saad-Eldin 2013), studies of mineralization (e.g., Abd Allah 2012; Mohamed 2013; Omran and Dessouky 2016; Surour 2017), and others.

1.2.4 The Sinai Peninsula

Sinai or the Sinai Peninsula is an Egyptian peninsula situated between the Mediterranean Sea to the north and the Red Sea to the south, serving as a land bridge between Asia and Africa. It is the only part of Egyptian territory located in Asia. Sinai has a land area of about 60,264 km^2 (about **6%** from total area of Egypt) and a population of approximately 639,586 people. Administratively, the peninsula could be divided into two of governorates, e.g., South and North Sinai. The formal name of Sinai is called *Ta Mefkat* or the land of turquoise according to the ancient Egyptians. It is well known that Sinai is triangular in shape. This shape is lying on the southern Mediterranean Sea (in the north) and southwest and southeast shores on Gulf of Suez and Gulf of Aqaba of the Red Sea. A big gap could be realized concerning the investigation of soils of Sinai from different point of views like mineralogy, soil pollution, water harvesting, mining and topography, botanical species, etc. However, an increased interest regarding soil researches in Sinai could be noticed (e.g., Badreldin et al. 2017; El Hady 2017; Sultan et al. 2017; Zaky 2017).

This Peninsula generally is a hot-dry desertic climate. The soils of Sinai could be divided into different zones including (1) soils are mainly moderately deep or deep, gravelly, coarse-textured soil, and located in the south Sinai; (2) soils are deep highly calcareous, gravelly coarse- or moderately- or over fine-textured soils and located in the central part of Sinai; and (3) soils of the alluvial coastal plains, which are located parallel to both the Gulf of Suez and Gulf of Aqaba, are deep, gravelly, coarse-textured soils and deep calcareous, coarse to moderately textured soils (Khalifa and Moussa 2017).

1.3 Egypt and Its Soils

Soil is the main supporter, as well known, for all terrestrial life forms as well as the crucial maintainer for this life. Soils also perform several critical functions for the global population including (1) dividing of precipitation into surface and ground waters, (2) supply and storage of both nutrients and waters for plant growth, (3) disposal and renovation of anthropogenic wastes, (4) habitat for different soil organisms, and (5) support for buildings, roads, and other infrastructures. Soils are also a major reservoir of the global carbon and have the ability to serve as a sink for atmospheric carbon in order to reduce greenhouse gasses with proper management. Soils have enough resilience but also definitely are subject to degradation if managed improperly (West et al. 2017). Day by day, several books, reviews, and articles are published to focus on soils and their roles in our terrestrial life forms such as Piccoli et al. (2017), Kaczynski et al. (2017), Vimal et al. (2017), etc.

The management of soil and water resources in Egypt faces several problems such as the scarcity of water and the majority of the Egyptian lands are desert. So, Egypt could be considered as one of the poorest countries in the world from the cropland point of view (Khalifa and Moussa 2017). Generally, most of the cultivated lands in Egypt are located close to different banks of the Nile River, in the Nile Delta, and the main canals of the Nile Valley. Furthermore, the average per capita share in agricultural land has steadily decreased as follows: 0.12, 0.10, 0.06, and 0.04 ha in 1950, 1960, 1990, and 2013, respectively. Moreover, many reasons enforced the quality of agricultural soils to degradation or deterioration including (1) low investment and management of the agricultural drainage since the 1950s, (2) decrease the soil fertility due to crop intensification, (3) the absence of silt from the Nile after the construction of High Dam, and (4) the rising level of groundwater (Khalifa and Moussa 2017).

1.4 Soils and Climate Changes

Climate change was and still one of the promising issues in soil sciences, where the forming and genesis processes of soils highly depend on many elements of weather. In other words, all processes in soil system mainly depend on humidity or precipitation or the water availability and temperature as well as on biological activities, which control the soil characteristics and their functions for both the environment and human societies (Blum 2005). Therefore, any change in climate will affect significantly the soil. Several publications nowadays have been focused on the effects of climate changes on soils such as carbon sequestration for climate changes (Ussiri and Lal 2017), water and land security in dry regions under climate changes (Ouessar et al. 2017), the adaptation of climate changes in Africa (Filho et al. 2017) or in Pacific Countries (Filho 2017), global soil security, energy and climate changes (Field et al. 2017; McCarl 2017), and others (e.g., Barmentlo et al. 2017; Bosch et al. 2017; Coyle et al. 2017; Lin et al. 2017; Rao et al. 2017).

Climate changes can influence different soil eco-services at both local and regional scales. Therefore, soil and other environmental sciences have the ability to determine future climate change impacts on soils and terrestrial ecosystems. Furthermore, it could be monitored the following research issues regarding the cause–response relationships between specific soil changes and climatic changes as follows:

(1) The impacts of climate change including changes in temperature, humidity, precipitation, and wind velocity in soil processes;
(2) Different indicators for the soil changes and their development with time;
(3) The impacts of changes in the soil on different eco-services including biomass production, air–water interactions, biodiversity, and human health;
(4) The impacts of the changes in the soil on both social and economic systems as well as their feedback; and
(5) Different strategies and operational procedures for the mitigation of impacts on ecological, social, and economic systems (Blum 2005).

1.5 Soil Pollution in Egypt

Pollution of agricultural soils in Egypt has become one of the serious challenges facing the Egyptian nation. Both rapid urbanization and industrialization in Egypt have been led to a very high accumulation of pollutants including trace elements (Cd, Cr, Pb, Zn, Fe, Cu, and others) and organic pollutants in water, soils, sediments, air, etc. Concerning pollution of soils, it was and still a very hot spot attracting several researchers worldwide to find the proper and sustainable method in remediating this problem. Therefore, the quality of soil is very important and dangerous for human health and environmental aspects.

Soil is a complex, dynamic, and open heterogeneous system. This system needs in general hundreds or thousands of years for genesis and mature. This heterogeneity of soils results from chemical, physical, and biological characteristics as well as soil constituents under macro-, micro-, and nanoscales. Furthermore, due to variability in seasonal rainfall, temperature, parent materials, and vegetation, different soil types could be found and each of these soils has distinguished physical, mineralogical, biological, and chemical properties (Saha et al. 2017; Shankar and Shikha 2017). This heterogeneity of soil also armed it with a high resilience power helped soils to overcome many agro-ecological problems like soil pollution. Therefore, it should sustain and maintain land resources, because these resources are common habitat of several macro- and microorganisms. These soil faunae have variable degree of sensitivity toward pollutants (Saha et al. 2017; Bashkin 2017).

There are many global environmental problems in general including global warming, acid rain, ozone depletion, pollution, over-population, depletion of natural resources, waste disposal, deforestation, and loss of global biodiversity (Singh and Singh 2017). So, soil pollution is considered one of the dangerous global problems. Several hazards could be listed resulted from soil pollution including (1) loss or decline in soil productivity; (2) reduce in soil biodiversity; (3) killing some plants, fishes, and other aquatic organisms in rivers and lakes (Fig. 1.6); (4) loss in crop diversity; and (5) pollutants may impair soil stability that will be harmful to human health. It is estimated that pollution of water and soil could reduce the yield of crops by about 15–25% over the total cropped area and the years (Saha et al. 2017; Singh and

Fig. 1.6 The El-Gharbia drain (Kitchener) is one of the largest open drainage systems in the Nile Delta (about 59 km) and collects about 12% of the disposal water including agricultural and industrial effluents (from factories in Tanta, El-Mahalla El-Kubra, and Kafr El-Zayat to deliver into the Mediterranean Sea in Baltim and causes a pollution of soils around it). Photos by El-Ramady (2015)