Chapter 27
General Framework for Land Use Planning in United Arab Emirates

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Abstract An integrated framework is presented for analyzing and evaluating land use planning to address growing land use pressures, taking into account the socio-economic and environmental aspects and the effect of land use change on water resources in United Arab Emirates. In land use planning, it is essential to identify the current problems and then to find proper solutions and their implementation with the aim of planning toward long-term conservation and sustainable use of land resources. This chapter identifies areas of land with high value for conserving water resources to help public sector for their planning activities. A general spatial modeling framework using geographic information system (GIS) capabilities and based on land use suitability units is used for evaluating how planning alternatives could affect water resources and best satisfies defined policies. The framework is applied to United Arab Emirates as a case study. This framework is important for making decisions about land and water resource use, managing growth, growing land use pressures and cumulative effects, reconciling competing demands for land, and integrating land use policies. It is anticipated that the policy makers, land use planners, decision-makers, and engineers can benefit from the framework.

Keywords Framework • Land use planning • Decision-makers • Resource degradation • UAE

27.1 Introduction

The United Arab Emirates (UAE) is located in the southeastern part of the Arabian Peninsula (Fig. 27.1). Due to its geographic location, the UAE has limited arable land, harsh climate, and poor renewable water resources. These natural factors

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Fig. 27.1 Location of United Arab Emirates

have limited the use of available land in UAE. In addition, as a consequence of population growth and economic development in the UAE, since 1970s, the pressure on land use has gradually been increased.

This has affected the land, water, and environmental resources. In this context, it is necessary to set a land use planning framework for optimum use of resources to ultimately achieve sustainable development in the country. This framework will be crucial to assist in decision-making on the location, nature, and control of investment activities to achieve sustainable development.

Land use planning is an interdisciplinary concept intersecting different themes like biodiversity and environment, health, natural resources, water resources and minerals, energy, and engineering infrastructure. It is an iterative process by learning from experience and new findings and adapted for planning according to these new outcomes. Land use planning framework can manage growth, decrease land use pressure and cumulative effects, reintegrate competing demands for land, ensure sustainability of land use for current and future generations, and integrate land use policies.

Best international management practices in land use planning recognize the importance of the setting of a framework for land use planning. For example, Canada-Alberta sets a general framework (Kennett and Schneider 2008) that helped the following: balancing social, economic, and environmental objectives in partici-

patory, inclusive, and transparent approach; management of strategy that combines cumulative effects modeling and policy analysis; institutional capacity; good governance-effective stakeholder involvement, transparency, and accountability in decision-making and monitoring; and strong legislation implementation.

Another important and specific example is from Ireland (Department of the Environment and Local Government 1999). Ireland developed land use framework to delineate land areas in terms of groundwater vulnerability to pollution (combined aquifer map and vulnerability map). The Ireland framework assisted in decision-making; it is used for land surface zoning, created groundwater protection responses, and addressed source water protection issues and groundwater monitoring.

The objective of the present study is to develop a general land use planning framework for UAE to help different stakeholders involved in land use and planning to ultimately achieve sustainable development.

27.2 Land Use Change

The examination of the previous information in the UAE revealed major changes have taken place in land uses. Most of these changes have been in the coastal areas and are due to the main reasons discussed in the following section:

Expansion of urban areas, due to high population growth (6% per annum) in the UAE (MOEW 2010), which is the highest in the world, and due to high economic development.

Expansion in artificial residential and recreation areas, such as building new man-made islands, like the Jumeirah Nakhla Island (Fig. 27.2).

Expansion in agricultural areas due to the government policy to support farmers through subsidies to grow forages. Compared to 1991 (40,000 ha), the year 2008 data show total cultivated areas in the UAE have been increased to over 200,000 ha (Fig. 27.3). In the beginning, the expansion was close to the existing agricultural farming area in Al Ain; later, expansion occurs to the other surrounding arable areas. The trend of gradual increase is shown in Fig. 27.3.

In the UAE, forestry plantation was made following the government policy to combat desertification and moderate climate affect and to clean the environment with the slogan “greening the desert.” Natural or wildlife forests do not exist in the UAE. In addition, these man-made forests increased the aesthetic and recreational value of the desert landscapes. Most of the forest areas are located in Abu Dhabi (305,000 ha) and Dubai (47,000 ha) emirates. The remaining five emirates (Ajman, Fujairah, Ras al-Khaimah, Sharjah, and Umm al-Qaiwain) have limited forest areas. Most of these areas are irrigated with brackish groundwater. The total groundwater use for irrigating forestry was about 694 million cubic meters (MCM) in the year 2008 (MOEW 2010).

The urban amenity and landscaping areas represent the parks and irrigated planting areas along the roads. Most of these areas are irrigated with 483 MCM reclaimed water (MOEW 2010). Industrial zones are the areas where factories and oil production activities are common.

Fig. 27.2 Jumierah Nakhla Island (Source: http://www.trekearth.com)

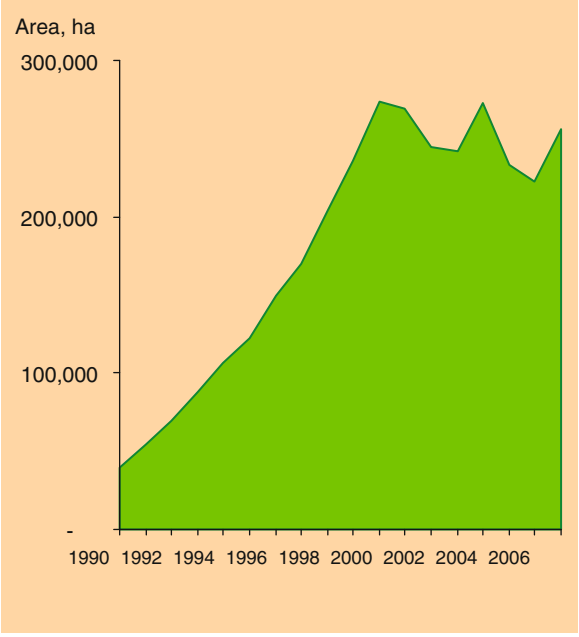

Fig. 27.3 Growth in agricultural areas in UAE (Source: Water Strategy 2010 (MOEW 2010))

27.3 Impacts of Land Use Change on Water Resources and the Environment

The land use change caused several impacts on both water resources and the environment. The main impacts included the following.

27.3.1 Water Resources Degradation

The main degradation was in groundwater. Groundwater is the major source for irrigation. The irrigation is accomplished using both the fresh and brackish groundwater sources. Overpumping, unplanned use, and poor groundwater recharge caused the decline of groundwater levels in most of the agricultural and forestry areas and subsequently depleted this valuable resource in several areas of UAE. The overpumping also caused saltwater intrusion in the coastal areas and migration of poor-quality water from adjacent aquifers in inland areas (Fig. 27.4).

In addition, the intensive agricultural activities degraded the water quality due to overuse of chemical fertilizers and pesticides; this practice has increased the groundwater contamination, for example, nitrate (NO_3) level has reached in some places to more than 650 mg L^{-1} (Robins et al. 2006). This has exceeded the World Health Organization (WHO) standards of NO_3 (50 mg L^{-1}) for drinking water.

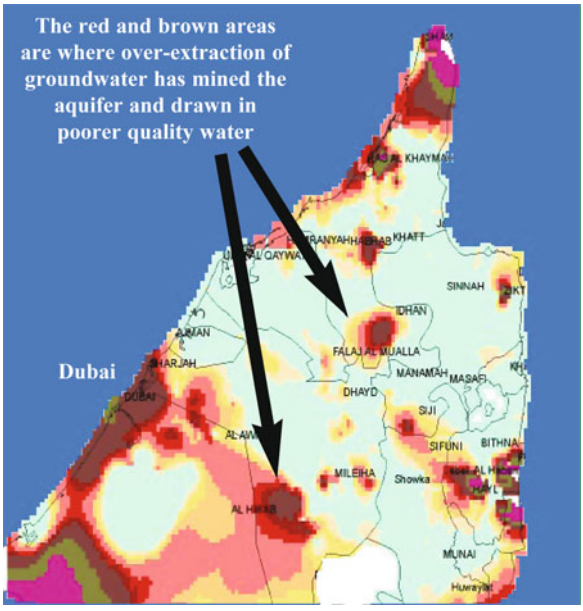

Fig. 27.4 Examples of saltwater intrusion in Northern Emirates (Source: Water Strategy 2010 (MOEW 2010))

27.3.2 Overgrazing

Due to harsh climatic conditions, the UAE rangelands are very poor in vegetation to meet the demands of grazing animals. The rangelands have been overgrazed above the carrying capacity, and these rangelands have very poor regeneration capacity. The poor management and uses of the rangelands and gradual increase of livestock caused overgrazing which ultimately resulted into degradation of several areas in the UAE.

27.3.3 Loss of Biodiversity and Marine Ecology

Many species are classified as endangered species. These endangered species need protection and conservation for the future generations. Priority species, habitats, and ecosystems include intertidal mudflats, mangroves, vegetated sandy beaches, marine (sea grass, coral), wadis, sand sheets and low dunes, interdunal plains and high dunes, alluvial plains, and jebels.

27.3.4 Air Pollution

The total CO_2 emission from power and desalination plants is about 20×10^6 t a year for the United Arab Emirates. The total emissions in Abu Dhabi Emirate from power and desalination plants is 13.5×10^6 t of gases and particulates per year, and carbon dioxide contributes to 99.65% of total emissions. In addition, nitrous oxide and nitrogen dioxide emissions are about 34×10^3 t per year. While the volume of nitrous oxide is relatively small, it is 200 times more effective as a greenhouse gas than CO_2 and is equivalent to 6.8×10^6 t of CO_2.

27.4 Abu Dhabi Estidama

Mitigating the impacts of land use changes is a big challenge. A remarkable effort was made in Abu Dhabi Emirate to overcome or mitigate the negative impacts of land use changes through developing Abu Dhabi sustainable plan. This plan aimed to achieve sustainable development in Abu Dhabi Emirate named Estidama which is the Arabic name of sustainability to address most of the major challenges and land use impacts mentioned above. The example from Abu Dhabi is discussed in this chapter to highlight the positive aspects taken into account that can guide other emirates and the federal government to achieve sustainable development in the UAE.

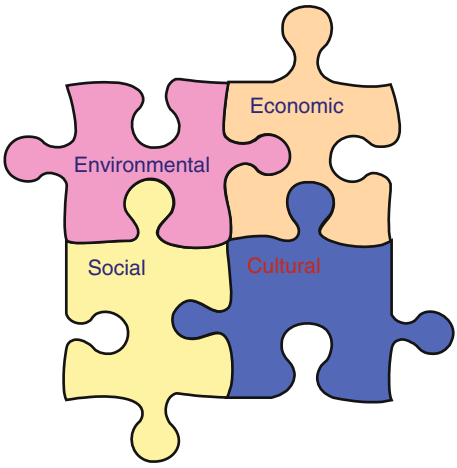

Fig. 27.5 Estidama bases and concepts (Source: Abu Dhabi Urban Planning Council, ADUPC (2010))

Estidama was based on four pillars: environmental, economic, cultural, and social (Fig. 27.5). Aspiration of Estidama was incorporated into Plan Abu Dhabi 2030 and other Urban Planning Council policies such as Development Code. Plan Abu Dhabi 2030 incorporated environmental framework, open-space framework, and land use framework in addition to transportation framework (ADUPC 2007).

The environmental framework incorporated:

1. Preserving mangroves and tidal flats and sea grass beds which are considered the most important ecological resources in UAE.
2. Establishing national park system in order to preserve vital ecologies in both terrestrial and marine environment.
3. Initiate green gradient between the natural core of the park and the urbanized core of the city.
4. Sand belt to ring the city through desert and define the outer limit of growth.
5. Desert fingers to provide undeveloped buffer between the city and coastal towns giving wildlife corridors to the protected coastal areas.

The open-space framework aimed to create:

1. Interconnected network of parks and open space
2. Active urban environments to encourage active lifestyles by providing building occupants and users with recreational public open spaces
3. Regionally responsive planning to reflect the unique climatic, social, and historical influences of the site and region in the community planning

The land use framework included:

1. Central business district (Al Sowwah Island).
2. Capital district.
3. Define the limits of growth for the city.
4. Industrial lands are strategically allocated close to the port.

27.4.1 Water Resources Categories

In addition, Estidama defined two water resource categories out of the seven categories that are fundamental to more sustainable development; these include (ADUPC 2010) the following.

27.4.1.1 Preserving the Region's Critical Natural Environments and Habitats: Natural Systems

1. Natural system assessment, protection, design, and management strategy to ensure assets are protected and the impacts are either mitigated or compensated
2. Natural system design and management strategy to minimize demand for resources and ensure the long-term survival and management of landscaped habitat areas
3. Reuse of land
4. Remediation of contaminated land
5. Ecological enhancement to improve the ecological value of the site by planting native or adaptive species
6. Habitat creation and restoration to maintain habitats that are connected to other similar habitats and to increase the ecological value of the site
7. Food systems to create a more localized approach to food with sustainable food production

27.4.1.2 Reducing Water Demand and Encouraging Efficient Distribution and Alternative Water Sources: Precious Water

1. Community water strategy to minimize the overall water consumption and establish water balance
2. Building water guidelines to promote water conservation in buildings within the community
3. Water monitoring and leakage detection to reduce loss of water
4. Community water use reduction to encourage water-efficient landscape design through plant selection, irrigation technology and management, reduced potable water use for heat rejection, minimized evaporative loss, and the use of recycled water
5. Stormwater management to minimize peak stormwater discharge and protect the stormwater drainage system from pollution
6. Water-efficient buildings to promote reductions in the water consumption of buildings

27.5 Proposed Conceptual Framework for Land Use Planning

A framework is developed to help in analyzing and evaluating land use planning and the effect of land use change on water resources (Fig. 27.6). This framework integrates the natural system vulnerability and human intervention into unified

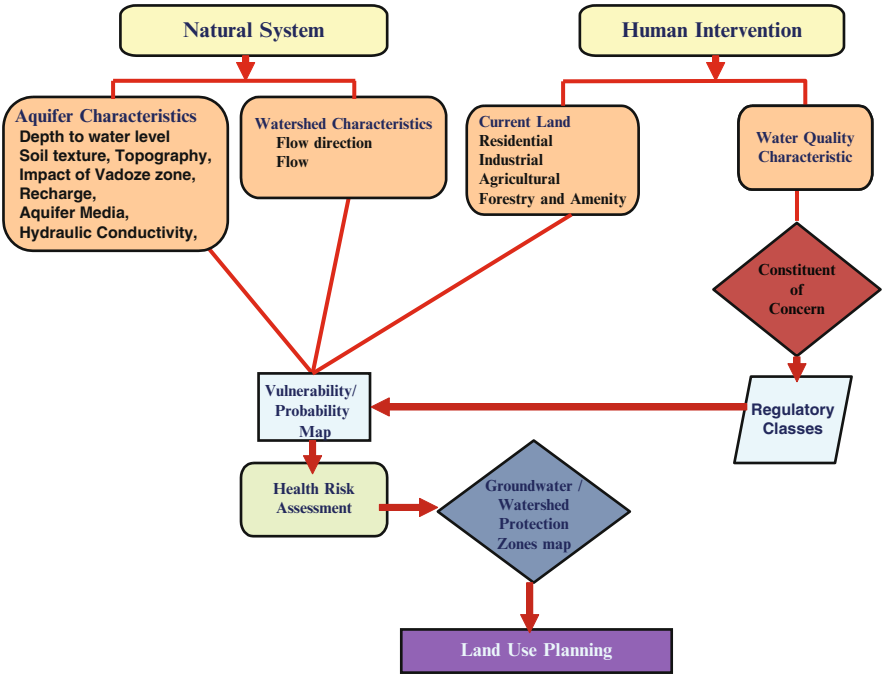

Fig. 27.6 Proposed conceptual framework for land use planning

framework. The natural system characteristics could include depth to water level, topography, soil, recharge, aquifer media, flow direction, and accumulation. Each theme can be detailed according to whatever data is available. On the other hand, human intervention includes all possible parameters that might affect the water resources and the environment. Most importantly are the water quality parameters and accordingly the constituent of concern, for example, heavy metals. Usually, there are certain regulatory limits that define or categorize different concentrations into regulatory limits either according to national standards or international standards (WHO standards). Then, probability of occurrence of certain concentration into one of these regulatory classes can be obtained using either simple probability distribution function (pdf) or state-of-the-art classification methods like artificial neural network, support vector machines, and relevance vector machines. Risk can be assessed based on the probability of occurrence and the consequences of certain pollutant. Finally, the created vulnerability/probability map and water availability and quality zoning map can be used to delineate groundwater and/or watershed protection zones. These delineated groundwater protection zones can be used thereafter as the bases for land use mapping.

Integration of the above-mentioned themes could be accomplished using GIS analysis tools. For example, groundwater quality and availability map can be integrated with current land use map, irrigated/agricultural areas, forest areas, and built-up areas as shown in Fig. 27.7. More themes or layers could be added like

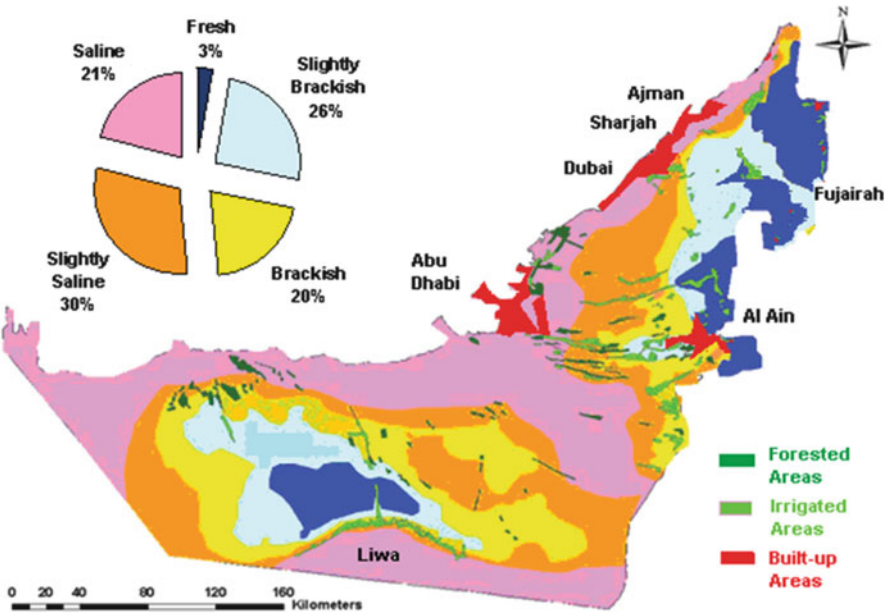

Fig. 27.7 Current land use map and groundwater quality zones (Source: Water Strategy 2010 (MOEW 2010))

land suitability for agriculture map and land salinity. All these detailed maps can help in delineating the land use map.

27.6 Conclusions and Recommendations

The following conclusions and recommendations are drawn from the present study.

It is recognized that the land use planning framework is essential for conservation and stewardship on private and public lands. It is essential to promote efficient use of land to reduce negative impacts of human activities. In order to achieve the goal successfully, the involvement of relevant stakeholders in land use planning is necessary. The impact of land development on water resources and the environment should be managed properly.

In order to integrate all land use planning efforts on national scale, it is recommended to establish federal planning council; establish information system and implement regular monitoring program to support land use decision-making; identify appropriate limits at regional and local levels; define pollution limits for groundwater, wadis, and the environment; define certain types of development in ecologically sensitive areas; and adopt best practices to mitigate development impacts. Land use planning should be linked to other types of planning and integrated into development planning at the emirate and federal level; it should be linked

to national resources planning programs, to strategies in the field of land resources planning, and to land law.

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