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Modelling Land Change Scenarios in the Gaza Strip and Impacts on the Environmental Elements

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Abstract

The Gaza Strip has been a theatre of conflict for decades. Each of these conflicts has left its mark, and a significant environmental footprint has developed in the Gaza Strip over time. The population growth rate and the urban expansion it drives affect the whole region. In general people prefer to live close to the urban facilities and infrastructures, usually found in the center of the residential areas, and to avoid the dangerous areas. The Gaza Strip has been directly involved in many wars, most recently in 2008, 2012 and 2014. The 2014 war was the most destructive in terms of buildings and infrastructure. The Israeli offensive against the Gaza Strip was launched on 8th July and continued until 26th August 2014. It left devastation all across this region, ranging from damage to complete destruction of thousands of homes. Post-war reconstruction is likely to exacerbate the normal urban growth rate, so placing a greater burden on this already congested country.

Land use and land cover change is a major global environmental change issue, and projecting changes are essential for the assessment of the environment. The Gaza Strip will have grown over 2.4 million inhabitants by 2023, and the land demands will exceed the sustainable capacity of land use by far. Land use planning is one of the most difficult issues in the Gaza Strip given that this area is too small. Continuous urban and industrial growth will place additional stress on land cover, unless appropriate integrated planning and management actions are instituted immediately. Planners need further statistics and estimation tools to achieve their vision for the future based on sound information. Therefore, this study combines the use of satellite remote sensing with geographic information systems (GISs). The spatial database is developed by using five Landsat images gathered in 1972, 1982, 1990, 2002 and 2013. Three GIS models are selected for simulation by the year 2023: Geomod, CA_Markov and Land Change Modele rusing Idrisi Selva. The projected urban area will have under gone an increase of 212.3 km2 by the year 2023in the used models, and the percentage of urban are awill account for 58.83 % of the Gaza strip by 2023.

Analysis of land use and land cover change is of prime importance for understanding the ecological dynamics resulting from natural and human activities, and for the assessment and prediction of environmental change. The population of the Gaza Strip will have grown to more than 2.4 million by 2023 all of whom are forced to live within an area of some 365 km2. This growth in population will lead to an increase in land demand, and will far exceed the sustainable land use capacity. The Gaza Strip is a relatively small area in which land use planning has not kept up with land development. Continued urban expansion and population growth in the future will place additional stress on land cover, unless appropriate integrated planning and management decisions are taken immediately. Decision-makers need further statistics and estimation tools to achieve their vision for the future of the Gaza Strip based on sound, accurate information. This study combines the use of satellite remote sensing with geographic information systems (GISs). The spatial database was developed by using six Landsat images taken in 1972, 1982, 1990, 2002, 2013 and 2014, together with different geodatabases for those years. Five past trend scenarios were selected for simulation to be completed by the year 2023 using the Land Change Modeler in the Idrisi Terrset software. These different scenarios, one of which takes into account the damage incurred during the 2014 War, try to cover the possible variations in areas and spatial distribution resulting from changes in land use. As an average over the five scenarios, by 2023 the projected urban area will have increased to 206.24 km2 or 57.13% of the Gaza Strip.

Groundwater is a very important natural resource in Khan Younis Governorate (the study area) for water supply and development. Historically, the exploitation of aquifers in Khan Younis Governorate has been undertaken without proper concern for its environmental impact. In view of the importance of quality groundwater, it might be expected that aquifer protection to prevent groundwater quality deterioration would have received due attention. In the long term, however, protection of groundwater resources is of direct practical importance because, once pollution of groundwater has been allowed to occur, the scale and persistence of such pollution makes restoration technically difficult and costly. In order to maintain basin aquifer as a source of water for the area, it is necessary to find out whether certain locations in this groundwater basin are susceptible to receive and transmit contamination. This study aims to: (1) assess the vulnerability of the aquifer in Khan Younis Governorate to contamination, (2) discover which parts of the aquifer are most vulnerable, and (3) provide a spatial analysis of the parameters and conditions under which groundwater may become contaminated. To this end, we applied the DRASTIC model within a Geographic Information

System (GIS) environment. The model uses seven environmental parameters: depth of water table, net recharge, aquifer media, soil media, topography, impact of vadose zone, and hydraulic conductivity to evaluate aquifer vulnerability. Based on this model and by using ArcGIS 9.3 software, an attempt was made to create vulnerability maps for the study area.

According to the DRASTIC model index, the study has shown that in the western part of the study area the vulnerability to contamination ranges between high (in 26.16% of the total area) and very high (in 3.14% of the total area), due to the relatively shallow water table with moderate to high recharge potential, and permeable soils. In the eastern and south-eastern part of this Governorate, vulnerability to contamination is moderate (43.44%). In the central and the eastern part, vulnerability to contamination is low (27.24% of the total area) due to the depth of the water table. The DRASTIC Model also indicates that the highest risk of contamination of groundwater in the study area originates from the soil media.

The impact of vadose zone, depth to water level, and hydraulic conductivity offer moderate risks of contamination, while net recharge, aquifer media, and topography are low risk factors. The coefficient of variation indicates that topography makes a high contribution to variations in the vulnerability index. Depth to water level, and net recharge make moderate contributions, while the impact of the vadose zone, hydraulic conductivity, soil media, and aquifer media are the least variable parameters. The low variability of the parameters implies a smaller contribution to the variation of the vulnerability index across the study area. Moreover, the “effective” weights of the DRASTIC parameters obtained in this study exhibited some deviation from that of the “theoretical” weights. Soil media and the impact of the vadose zone were the most effective parameters in the vulnerability assessment because their mean “effective” weights were higher than their respective “theoretical” weights. The depth of the water table showed that both “effective” and “theoretical” weights were equal. The rest of the parameters exhibit lower “effective” weights compared with the “theoretical” weights. This explains the importance of soil media and vadose layers in the DRASTIC model. It is therefore important to get accurate and detailed information about these two specific parameters. The GIS technique has provided an efficient environment for analysis and is capable of handling large amounts of spatial data. In view of these results, the DRASTIC model has proved to be a useful tool that can be used by national authorities and decision makers, especially in agricultural areas in which the chemicals and pesticides most likely to contaminate groundwater resources are applied.

The Gaza Strip suffers from an acute problem in the water quality and quantity. Groundwater is used as drinking water, for agricultural uses, and industrial processes. Salinity is increasing in groundwater in the Gaza Strip. Seawater intrusion is the main source of salinity. A chloride ion-selective is used as indicator of salinity for analysis and modelling of salinity of groundwater in the Gaza Strip by 2023. Research depends on three models for prediction of chloride concentration in groundwater: Forecasting, Linear regression and Multiple regression for the year 2023. The result of three models showed water salinity will increase in all areas in the Gaza Strip by the year 2023. Only a small area in the North Governorate will keep less than 250 mg/L of chloride concentration in fresh water, which represents 4.56 % of the total of the Gaza Strip area. The analysis of seawater intrusion within the cross sections is clear along the coastline and outspreads from the Mediterranean Sea to the East part of the Gaza Strip.

Keywords: Land use, groundwater, salinity, scenario, seawater intrusion, urban, modelling, GIS, remote sensing.

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