Creating Multiple Seasons Spatial Model (Maps) to Improve and Habilitate the Marshes Area in Southern Iraq

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Abstract: Climate factors are one of the main criterion in the study of any area especially for sustainable development goals. The year in Iraq has four seasons. The important climate factors for the marshes area in Southern Iraq are the temperature, the rainfall, the wind speed and the humidity. This research explained the composition (creating) of 24 climate maps representing the dynamic climate factors for the four seasons experienced by the marshes area in Southern Iraq that is located in three governorates, i.e. Missan, Thi-Qar and Basra. The methodology applies the spatial Interpolation Method using the GIS - IDRISI software. The climate maps of a particular area can be used for multi - purpose study either for development or for preparing a project such as ecotourism. Their capability in dynamic mapping and analysis are one of the most useful applications of GIS for sustainable environmental planning and management. The GIS spatial analytical technique applied in this study can reduce time and cost by 20 – 30 % compared to traditional methods. The created dynamic climate maps for each required climate factor are in high resolution (36m x 32m) pixel. In addition, this method of obtaining climate factors values is the ideal and one of few methods in difficult areas where there are mountains, forests…etc. or in dangerous areas which have such as predators, remnants of war…etc.

Keywords: Interpolation method, spatial climate model (maps), Marshes Area Southern Iraq, Mesopotamian Marshes, climate factors.

1. Introduction

The weather is basically the way the atmosphere is behaving, mainly with respect to its effects upon life and human activities. The difference between weather and climates is that weather consists of the short - term (minutes to months) changes in the atmosphere. Most people think of weather in terms of temperature, humidity, precipitation, cloudiness, brightness, visibility, wind, and atmospheric pressure, as in high and low pressure. In most places, weather can change from minute - to - minute, hour - to - hour, day - to - day, and season - to - season.

Climate however, is the average of weather over time and space. An easy way to remember the difference is that climate is what you expect, like a very hot summer, and weather is what you get, like a hot day. In short, climate is the description of the long - term pattern of weather in a particular area. Some scientists
define climate as the average weather for a particular region and time period, usually taken over 30 years. It’s really an average pattern of weather for a particular region. When scientists talk about climate, they’re looking at averages of precipitation, temperature, humidity, sunshine, wind velocity, phenomena such as fog, frost, and hail storms, and other measures of the weather that occur over a long period in a particular place. When we talk about climate change, we talk about changes in long-term averages of daily weather.

The important reason for studying climate and climate changing is that it will affect people around the world. Rising global temperatures are expected to raise sea levels, and change precipitation and other local climate conditions. Changing regional climate could alter forests, crop yields, and water supplies. It could also affect human health, animals, and many types of ecosystems. Deserts may expand into existing rangelands, and features of some of our National Parks and National Forests may be permanently altered. Human activities have altered the chemical composition of the atmosphere through the buildup of greenhouse gases primarily carbon dioxide, methane, and nitrous oxide (NASA TV 2005).

Geographic information system (GIS) can offer significant support in creating multiple seasons’ climate maps. Their capability in dynamic mapping and analysis are one of the most useful applications of GIS for sustainable environmental planning and management. This paper attempt is to show the significance of the composing (creating) the 24 climate maps to represent the dynamicity of climate factors in four seasons as experienced by the marshes area in Southern Iraq.

2. Study Area

The area of study is located at the Mesopotamian Marshes (Figure 1). It was once the largest wetlands in the Middle East and Western Eurasia. The Marshes formed from annual flood pulses of the Tigris and Euphrates Rivers. In the 1970s, the Marshes covered between 15000 and 20000 km² of water surface and vegetation (UNEP 2001). The long term resiliency of the southern Mesopotamian landscape provided abundant resources to humans since the time of the Ubaid–Sumerian Culture (4000 – 6000 BCE) (Pournelle and Algaze 2010, Hritz et al. 2012). The indigenous people of the Marshes, i.e. the Marshes Arabs have practiced sustainable traditional resource management for thousands of years, developing an iconic way of life that ties them intimately to their wetland landscape (Salim 1962). Traditionally, women took an active role both inside and outside the home, gathering reeds producing handicrafts, helping care for water buffalo, working in the fields, and selling in the market (Algaze, 2001). During the 1980s, the Marshes ecosystem and its inhabitants were subjected to large scale destruction during the Iraq–Iran War. Destruction continued during the 1990s in “one of the world’s worst environmental disasters” when the previous Iraq government systematically drained over 90% of the Marshes in a military action designed to crush its inhabitants (UNEP 2001). With the fall of the previous regime in 2003, the Iraqi people began to re-flood the Marshes, and some Marsh Arab tribes returned to reclaim their lives. Good water years and Iraqi restoration efforts in 2004–2008 resulted in successful rehydration of approximately 58% of the Marshes (UNEP 2005, Al – Handel and Hu, 2015). Uncontrolled releases of water partially restored some areas, whereas restoration failed in other areas because of high soil and water salinity (Richardson et al. 2005, Richardson and Hussain 2006). The re-flooding and rehydration efforts since the fall of the previous regime have thus had highly variable results. Unfortunately, recent drought years, upstream water diversions on the Tigris and Euphrates Rivers, and climate change have desicated large areas of the Marshes, resulting in Marsh inhabitants being displaced and without a livelihood.
3. The Methodology

The combination of GIS and spatial interpolation technique is appropriate for the climate analysis. The proposed spatial model for multi season analysis was accomplished in GIS-IDRISI 17.0 Selva Version software. Other software utilities used in the analysis are ArcGIS 9 (ArcCatalog Version 9.3 and ArcMap Version 9.3), Adobe Photoshop 7.0 and Adobe Acrobat 9 Pro. Data acquisition of the four climate factors (temperature, rainfall, wind speed, and humidity) for four seasons in 2016 was obtained from the meteorological stations in the study area, that is (1 station) in Missan Governorate, (4 stations) in Thi-Qar Governorate and (4 stations) in Basra Governorate as shown in (Table 1). The map of the study area was prepared in hard and soft copy.

The hard copy map was initially resampled to register the correct coordinates. Subsequently, the coordinate locations of nine meteorological stations in the study area were determined and were linked to the database consisting the values of the climate data (temperature, rainfall, wind speed and humidity). Initially, the months for each season in the year (per year) was determined as follows:-

i. Winter Season - December, January and February.
ii. Spring Season - March, April and May.
iii. Summer Season - June, July, August and September.
iv. Autumn Season - October and November.
Table 1 Weather Factors for January, 2016

| ID | Governorates | Stations         | R mm | TM °C | Tm °C | T °C | HM % | Hm % | WS m/s |
|----|--------------|------------------|------|-------|-------|------|------|------|--------|
| 1  | Missan       | Ali Al Gharbi    | 8.8  | 17.20 | 4.31  | 10.21| 93.07| 42.64| 2.02   |
| 2  | Kahla        | 1.5              | 17.38| 5.17  | 10.98 | 87.05| 38.91| 1.22  |
| 3  | Thi-Qar      | Chabaish         | 2.7  | 19.64 | 7.43  | 12.94| 86.67| 35.18| 1.55   |
| 4  | Souk El Shuyouk | 1.2         | 18.42| 6.01  | 11.85 | 82.32| 32.09| 1.90  |
| 5  | Shatrah      | 3.2              | 17.81| 4.94  | 11.38 | 84.77| 34.62| 1.34  |
| 6  | Fajr         | 6.2              | 17.63| 5.00  | 10.93 | 83.72| 36.30| 1.74  |
| 7  | Basra        | Abu Al Khasib    | 7.3  | 19.03 | 7.82  | 13.01| 85.34| 35.99| 2.49   |
| 8  | Burjissiyah  | 7.7              | 17.65| 6.43  | 11.61 | 85.67| 35.35| 2.40  |
| 9  | Faw          | 6.4              | 18.21| 7.84  | 12.80 | 82.69| 37.28| 2.98  |
| 10 | Qurna        | 6.5              | 17.98| 6.01  | 11.80 | 83.91| 36.52| 1.64  |

Subsequently, the average values of the four climate factors for each season were calculated. Since the temperature and the humidity have maximum and minimum values, therefore there will be an average of the minimum values and an average of the maximum values considered for each temperature and humidity in each season. Hence, each season has six climate maps representing four climate factors. For example, for winter season there will be:

1. Winter Average Max. Temperature Map.
2. Winter Average Min. Temperature Map.
3. Winter Average Rainfall Map.
4. Winter Average Wind Speed Map.
5. Winter Average Max. Humidity Map.
6. Winter Average Min. Humidity Map.

Similarly for other seasons like spring, summer or autumn will has the same number of maps. Therefore, there will be 24 climate maps of four climate factors for four respective seasons. These maps were derived in the GIS-IDRISI software and their values are then linked the nine meteorological stations.

Finally, converting the stationary 24 climate data into continuous climate maps requires the spatial interpolation process. The spatial interpolation estimates unknown values of climate data within the study area based on the data available at the respective meteorological stations. In this study, the Inverse Distance Weighting (IDW) algorithm available in GIS-IDRISI software was used to estimate cell values by averaging the values of sample data points in the neighbourhood of each processing cell. The weight of each sample is inversely proportional to the distance which means the further away from the point from the unsampled point, the less the weight in helping to know the values.

4. Results and Discussions

The output of this research has created total of 24 continuous climate maps of the study area showing the four seasons (winter, spring, summer and autumn) in the year 2016. It represents the four climate factors (temperature, rainfall, wind speed and humidity) interpolated from nine established meteorological stations. The Figure below described the respective maps.

In the Figure, the legend on the hand right side describes the range of values of each climate factor. The lowest value is on the top while the highest value is in the bottom. From these climate maps, spatial query or search using the cursor inquiry mode for any climate values within the study area is possible. The derived
climate maps were intended for the application of an ongoing ecotourism model in improving and habilitating the marshes area in Southern Iraq. The intended study considers the climate condition in Iraq as dynamic variables that comprises of four seasons i.e. winter, spring, summer, and autumn that influences the climate factors such as rainfall, temperature, humidity and wind speed in each season. Lastly, the study will lead to the development of multiple seasons criteria site suitability model for ecotourism in the marshes area, Southern Iraq.
5. Conclusions

- The climate maps of a particular area can be used for multi-purpose study either for development or for preparing a project such as tourism, ecotourism, the establishment of a factory, cultivation of certain crops... etc.
- The created dynamic climate maps for each required climate factor are in high resolution (36m x 32m) pixel by the Interpolation Method using GIS – IDRISI software.
- The GIS spatial analytical technique applied in this study can reduce time and cost by 20 - 30% compared to traditional methods especially in the improvement and habilitation program where multi-purpose suitability model capability is commonly available in many GIS software.
- In addition, this method of obtaining climate factors values is the ideal and one of few methods in difficult areas where there are mountains, forests... etc. or in dangerous areas which have such as predators, remnants of war... etc.

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