Using Google Earth Engine development environment for remote sensing image analysis, Al Shuwija marsh case study

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Abstract. As a result of climate change, including changing the timing of rainfall and the fluctuation of its quantities, in addition to changing the timing of snowmelt, and thus the variation in the amounts of torrents led to a clear change in the areas of flooded and humid lands, especially in the eastern side of Iraq bordering the Islamic Republic of Iran. This study aims to determine the maximum and minimum submerged area of Al Shuwija marsh basin using Landsat imagery (1984-2019) and provides statistical data on their scale to support planning and studies in this extent. Global Surface Water web application was called into Google earth engine (GEE) platform which used Landsat 5, 7 and 8 imageries to distinguish water and other feature through the spectral reflectance characteristics of different features through thermal band. Near-infrared and shortwave-infrared have been used to isolate pixels procured over vast water from those gained over different surfaces. And then create a chart that summarizes the area of surface water in this basin. Then the GEE conversion function used to convert raster to vector as a step before export result as a vector data which ease to use for calculating area of water classes. So briefly, the result is spatial data (polygon features) of water classes for study area in Keyhole Markup Language (kml) or ESRI Shapefile formats can be downloading from user account at google cloud.

1. Introduction

In recent times, there has been a change in the hydrological condition of the region due to several factors [1], the most important of which is climate change[2][3], and thus leads to a change in the area of permanent and seasonal water bodies, which greatly effects on planning. One of the most important natural resources on the planet, water is very necessary and indispensable because life begins with water and nourishes aquatic life [20]. In addition, changes in climate and increased human activities have increased surface temperature, decreased precipitation, and increased desertification [12]. GIS has kept enhancing and can be a successful aid in mapping, investigation and imaging of flooded areas and dry docks [13]. Remote sensing data provide a valuable and stable data source for mapping, terrain understanding, disaster management, and civil engineering infrastructure planning [22]. The main problem with the planners responsible for water management, as well as the authorities responsible for investing lands surrounding the water body(Al Shuwija marsh), is no database to classify surface water, at least within the study area. So the study is aim to create Geodatabase for seasonal and permanent marshes water by find an automatic ways through programming language (JavaScript or Python) at Google Earth Engine Platform (there is many sources of row data can be used for classification maps, one of these data can be satellite imagery [14]), Images obtained by remote sensing techniques are a major source of row data for mapping and to monitor the natural and artificial features on the earth surface [15]. The remote sensing dataset provides a brief perspective on the Earth's surface and thus can

be used to assess a water event [16]. The geodatabase contains classified data (Classification is the way that by it, things are linked to a common class or type[18]) of water surface gives us an opportunity to benefit from the information contained in the satellite images that helps us distinguish with relatively acceptable accuracy between the presence and absence of water within the study area[8]. Google Earth Engine (GEE) is a programming platform for presenting and analysing geospatial data for academic purposes, government projects and non-profit business and government users .With GEE we can visualize and interact with the Globe and view data as a terrain, satellite images, 3D building and perform analysis on them (water surface coverage, snow cover, change detection analysis and time-lapse…etc.)[4]. GEE contains public data archive of satellite imagery for about forty years back, and it`s available for global scale.

2. Study area

The marshes are among the largest wetland ecosystems in the Middle East, and have played a major role by supporting wildlife and biodiversity [23].
Al Shuwija is a marsh which locate at Wasit governorate, Iraq. and it`s bounded to the north of Al Kut city, exactly at geographic location shows below. Table (1).

Table 1. Shows vertices coordinate of study area`s polygon.

Vertices	Longitude (dd)	Latitude(dd)
1	45.324399	32.998677
2	45.581203	33.143209
3	46.200559	32.769247
4	46.039443	32.64338
5	45.887695	32.576547
6	45.463344	32.864444
7	45.38713	32.88183
8	45.324399	32.998677

Al Shuwija consists of two main parts, one is locating at northern of Badra– Dowboni road, and the second at southern of Kut – Badra road which meet through a small stream. The area of whole marsh is about 900 sq.km. Fig. (1) and Fig. (2) illustrate change of submerged area of marsh between two epochs.

Figure 1. Shows submerged area of a Marsh at 17-5-1984 [10].

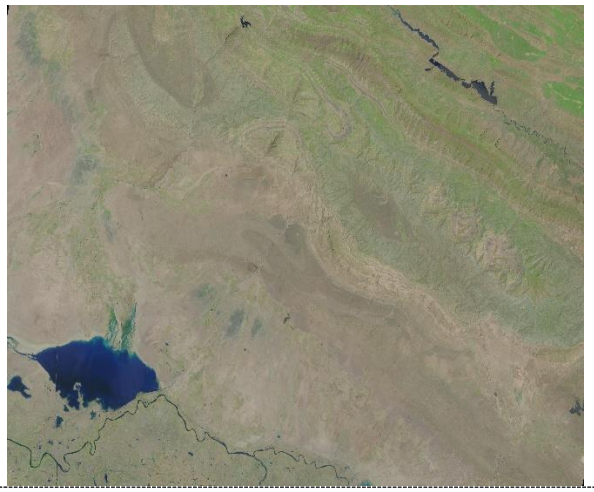


Figure 2. Shows submerged area of a Marsh at 17-5-2019 [10].

Duration, cost and urban development, as well as the growth of commercial factories and warehouses within agricultural areas near water bodies necessitated conducting this study for planning purposes [19].

3. Materials and tools

A model is a value prediction tool designed to represent a realistic copy if properly constructed [21].
So, the Satellite data is the main and basic material for building spatial databases in general and especially with regard to vector data as in this study. As the basis of this work depends initially on the classification of satellite images with spectral beams into two main categories, presence and absence of water, based on the thermal and short-wave spectrum of the Landsat 5,7and 8 satellites [5][6].
Global Surface Water (GSW) web-mapping application developed by The European Commission's Joint Research Centre (ECJRC) as a framework of Copernicus Program, it`s provide dataset and map which show the distribution of water surface along 36 years back, theses dataset support management of water resource, Urban and Agricultural planning, modelling of climate and support better informed water-management decision-making. These data generated through Landsat 5, 7 and 8 imageries based on Expert System (ES).
Expert systems (ES) are a collection of computer programs can perform a difficult task at human level. It`s applied branch of artificial intelligence (AI) which makes machines more useful, expert system do things that cannot be done and it`s do it faster.

3.1. Methods

The method is simply summarized in the beginning by defining the study area through a polygon marked on one of the spatial digitization programs such as Google Earth as a polygon feature, and this was determined, where the polygon includes all the study area of the water surface body (the marsh) in its northern and southern parts in the KML format. Then this formula was converted into a shapefiles format inside Arcmap program, where this format consists of 6 files, 4 of which are called to be uploaded on the GEE platform (shp, dbf, prj, shx).
The restriction on using the analysis dataset for computational input sources is due to the low spatial resolution ranging from 10 meters to hundreds of meters [17].

The reason for creating a GIS programming model was the successful performance of terminating and extracting spatial tasks [13].
Now the feature dataset for define the boundary of study area uploaded and saved at user account in these platform (GEE).
At the main page of platform, exactly in code editor tab, it`s where user start coding and perform a script by using JavaScript programming language, the result will appears on the right side of window on console and spatial result data appears at map down of window.
At first start with upload study area as a polygon feature to the platform using (Assets) tab on the left side of code-editor window.
Assets>>> New >>>Table upload shape files (shp, dbf, prj, shx or zip).
On the script window start to import feature of study area and define it as a variable:

```
Var Study_Area = users/user_account/Study_Area
type: FeatureCollection
id: users/sajjadco94/Study_Area
version: 1613030020699208
columns: Object (13 properties)
AltMode: Integer
Base: Float
Clamped: Integer
Extruded: Integer
FolderPath: String
Name: String
PopupInfo: String
Shape_Area: Float
Shape_Leng: Float
Snippet: String
SymbolID: Long
system:index: String
```

Then define image dataset of GSW as a variable and call by code the raw data of the transition band and clipped it by study area using script:

```
Var dataset =
ee.Image('JRC/GSW1_2/GlobalSurfaceWater').select('transition').clip(Study_Area
)
var Band = {
  bands: ['transition'],
  min: 0,
  max: 10,
  palette: Color
};
```

Transition layer band take changes between eleven classes of water occurrence (No change, Permanent, New permanent, Lost permanent, Seasonal, New seasonal, Lost seasonal, Seasonal to permanent, Ephemeral permanent), as shown in Table (1) below [24].

Table 2. Shows number of classes of transition band.

0	No change
1	Permanent
2	New permanent
3	Lost permanent
4	Seasonal
5	New seasonal
6	Lost seasonal
7	Seasonal to permanent
8	Permanent to seasonal
9	Ephemeral permanent
10	Ephemeral seasonal

Then reclassifying image dataset into eleven classes from 0 to 10, each number describe the name of class respectively:

```
var zones = dataset.gt(0).add(dataset.gt(1))
.add(dataset.gt(2)).add(dataset.gt(3)).add(dataset.gt(4))
.add(dataset.gt(5)).add(dataset.gt(6)).add(dataset.gt(7))
.add(dataset.gt(8)).add(dataset.gt(9)).add(dataset.gt(10));
zones = zones.updateMask(zones.neq(0));
```

Finally, after all that the classes of water surface will extracted depending on their number and then when run the script the result will be a spatial data (shapefile) contain the water categories described them by number of class in the attribute table of it (Fig.3).
The result appear on the tasks tab on the right side of scripting window, after run of extraction, the ESRI shapefiles (shp, dbf, prj, shx, cpg, fix) will saved on google drive user account as a polygon features with their classes can be displayed and analyzed in any program can deal with ESRI shapefile format, Arcmap for example. (Fig.3) shows scripting results at platform and (Fig.4) shows downloaded spatial data from google user account.

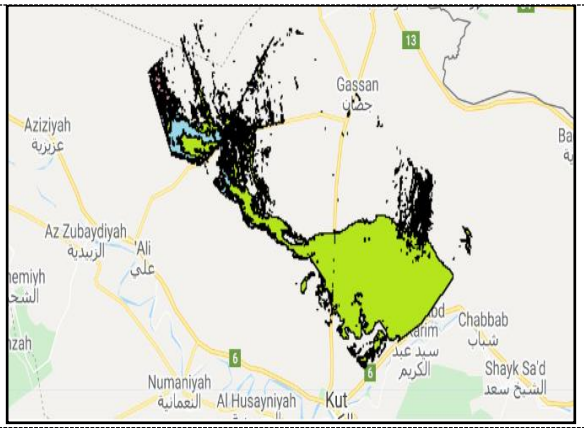


Figure 3. Shows the spatial data as a result of running script.

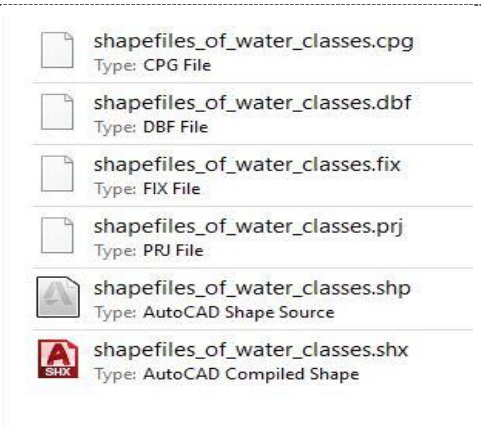
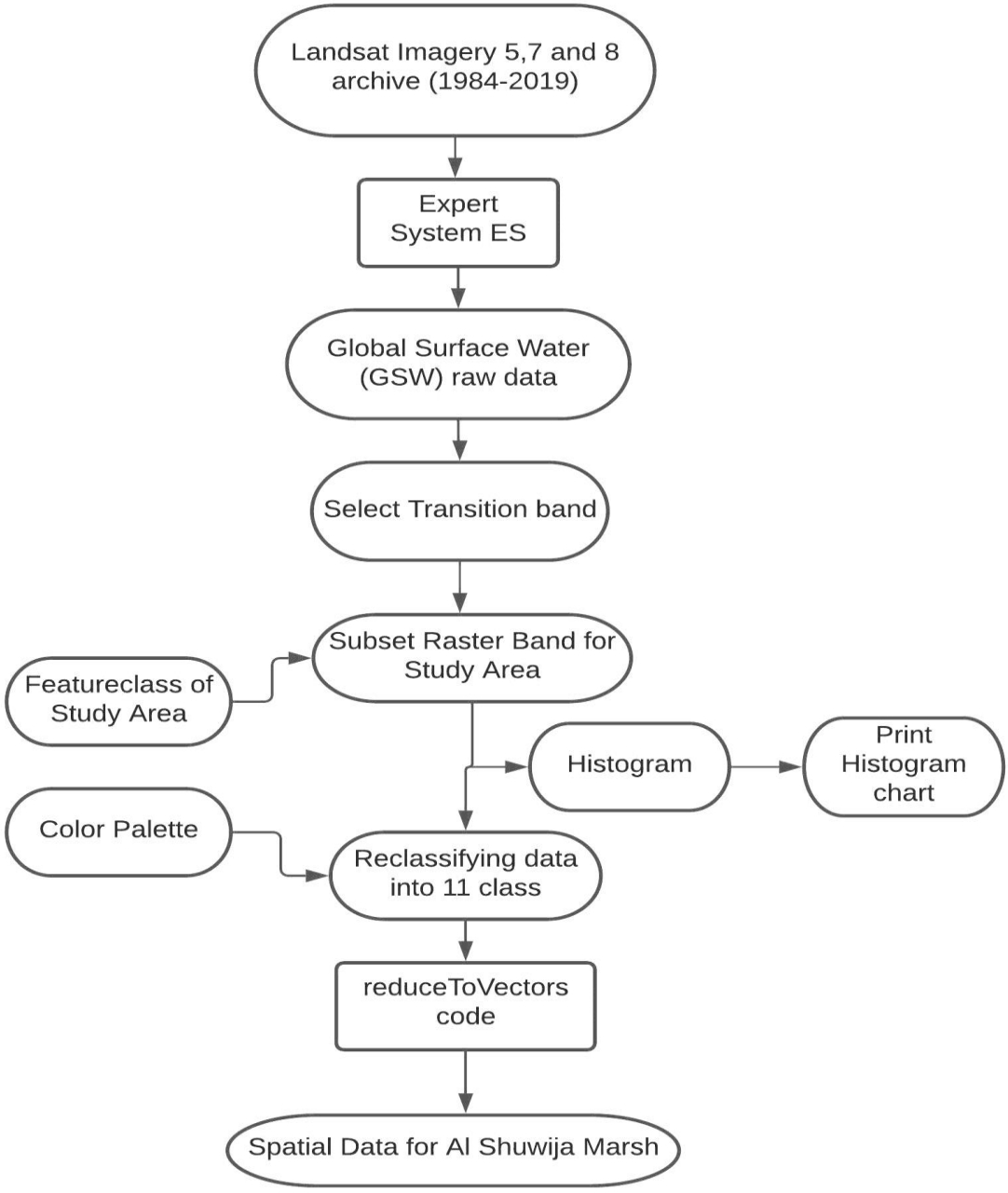


Figure 4. Shows Esri Shapefiles downloaded from Google user account.

4. Methodology

The flow chart below has shown process step to extract spatial data for Al Shuwija Marsh:



FlowChart model for extract water class

Figure 5. Shows the flow chart of extraction code model.

5. Results

The result was spatial data (vector data) of water transition with their classes for Al Shuwija marsh can be provide as feature data for planning and mapping to the Governmental institutions concerned with the water management in Iraq, institutions and organizations concerned with monitoring and following up the changes taking place in the Iraqi marshes and wetlands, as shown below Fig. (6).

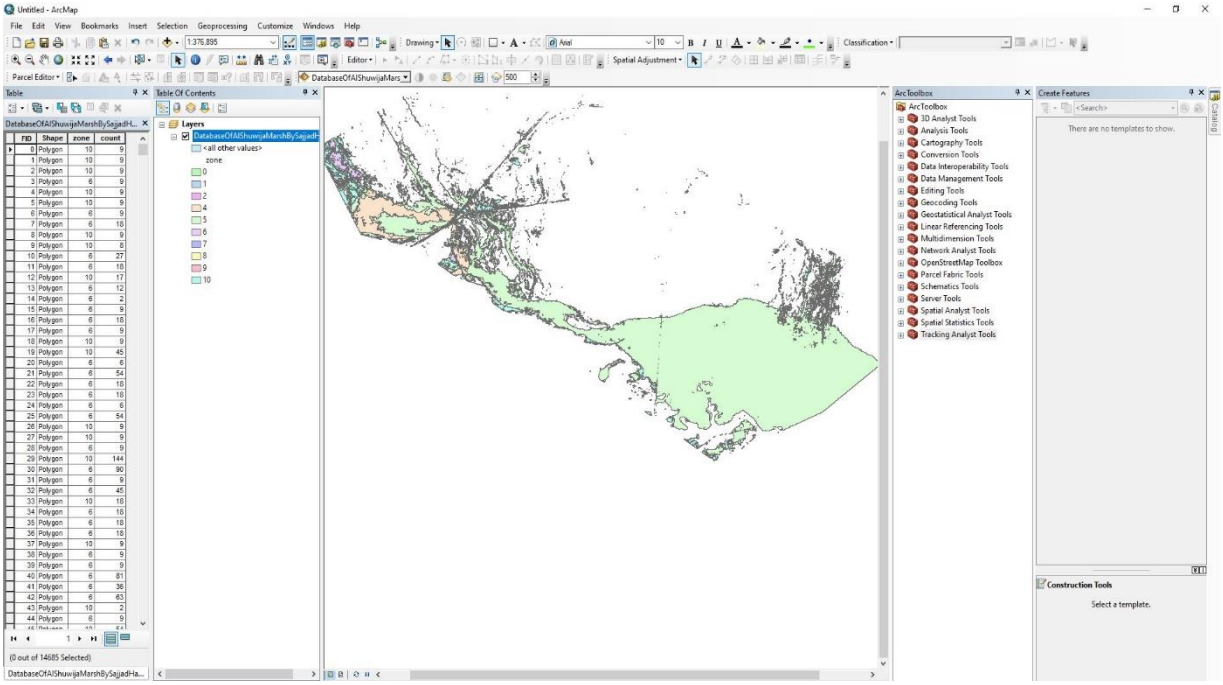


Figure 6. Shows the spatial data of water classes for study area.

Histogram below Fig. (7) Shows water classes and each one shows number of pixel has contain, then depending on spatial resolution of images, it led to calculate area of each class.

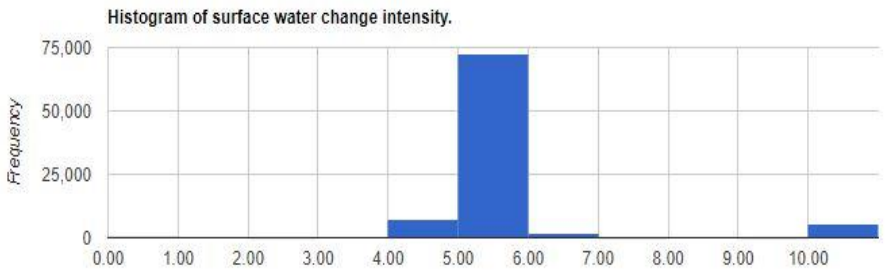


Figure 7. Shows histogram of spatial data extracted.

6. Conclusion

Throughout the entire process of extracting the surface water database of Shuwija Marsh, we note that the amount of data extracted is very large and with acceptable accuracy to some extent, and that process was done relatively quickly compared to the data processing operations that are done using offline image analysis programs for satellite images such as (QGIS, Arcgis, Erdas Imagine,…etc) and here it can be

said that The process of using Google Earth Engine platform, starting from uploading the boundaries of the study area and passing through calling web applications for surface water (GSW) to classifying the study area and then extracting the database according to the specified classifications, all of this was done without need a high-performance personal computer, nor even need to download raw image data of remote sensing satellites, all this was done only through the use of short code (JavaScript) through which the process was carried out on Google Server.Here, we have provided a spatial database for the authorities concerned with water management in the Iraqi government and non-governmental organizations, through this data it is possible to know the new boundaries of water bodies and re-examine the sites of projects and investment blocks if they are located within these new boundaries of the water body, as well as update the data of studies which aims to invest the water basin for agricultural, industrial or tourism purposes, in addition to knowing the new flood limits to protect the settlers in these areas from the threat of seasonal floods.

Decision making takes a lot of efforts including time and experience for the purpose of obtaining accurate and fruitful results. More work is needed to determine the ability of such papers to improve overall accuracy through the use of various modern technologies [11].

7. References

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