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RESEARCH ARTICLE

Landsat Image using to Calculate the Relationship between the Biophysical Properties of Soil

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ABSTRACT

Soil biophysical properties include a group of factors that affect plant growth support and their effects on the environment in general. Among the most important characteristics that were examined in the study are the water content of the soil ,the normalization different vegetation index in addition to land surface temperature The study aims to study the spatial distribution of these indicators within the study area and to find the relationship between these indicators and the extent of their impact on some of them, based on satellite image data from Landsat (9,8), and use the spatial analysis tools from GIS program, where The results witnessed a difference in distribution of indicators, as the study showed that the relationship between (NDVI ,LST) and(SMI,LST) which is an inverse relationship , While (NDVI, SMI) are linearly proportional. Finally, the study showed that spatial analysis tools are useful in studying such characteristics.

INTRODUCTION

Information regarding the variability of weather and soil parameters is provided through the devices present on site, including meteorological stations and devices sensitive to soil moisture. On the other hand, both nearby and far-off sensors can be used to measure crop parameters. Particularly interesting by measuring leaf growth and sensing leaf canopy density, which is related to crop health and plant production. This can be repeatedly, not harmful, over large regions, and with amazing detail. Furthermore, the systems of remote sensing are adaptable, allowing for the installation of sophisticated imaging and non-imaging spectroradiometers that can be deployed on satellites and airborne (also known as aerial) devices [1]. Particularly, the radiation spectrum of spacecraft changes rapidly over time. In the 1970s, for example, they were low spatial-high temporal resolution sensors (Advanced Very High-Resolution Radiometer, AVHRR); in the 1980s, they were medium spatial-low temporal resolution sensors (Landsat Thematic mapper, TM); and in the 2020s, they were more advanced sensor constellations that provided high spatial-high temporal resolution (e.g., Sentinel2 , Planet Super Dove) [2]. Numerous applications, including hydrological modeling, land surface monitoring, precision agriculture, and natural resource management, it relies on accurate biophysical mapping of crops characteristics. For instance, the leaf area index (LAI) can shed light on the structure and function of the canopy; on the other hand, the chlorophyll content is highly correlated with the leaf nitrogen content and, as such, serves as an excellent stress indicator (e.g.,

nitrogen deficit) [3]. The majority of forest research studies employed one or two ratio-based vegetation indices (VI), such as (NDVI) or the simple ratio (SR), which are derived from broadband remote sensing data [4]. Among the most important factors affecting the climate in exclusion zones in order to calculate heat islands are (urban form, change in land use, building materials and terrain, location, clouds, air currents, length of the season and length of the day, and clouds) which greatly affect the surface temperature. In areas with a restricted nature, especially the layer near the surface. During this study, the relationship between biophysical factors in the soil in Baghdad Governorate is investigated.

METHODOLOGY

During this study, analysis tools in the GES 10.8 program are used to take advantage of the satellite image of the Landsat 9 satellite to extract the biophysical factors of the soil in the city of Baghdad, such as the vegetation index, humidity index, reflected temperature, and other factors, in addition to studying the relationship between these factors and the effect of some of them on each other.

The surface temperature of the spectrum will be found from infrared band data in a radiometrically corrected form for Band 6 of ETM+, as well as TIRS derivation from Bands 11 and 10. To convert to surface temperature (LST), the digital number (DN) must also be converted to radiation using the formula below [9].

$$CVR=G\,(CVDN) + B \quad \ldots\ldots \qquad (1)$$

To calculate the brightness temperature at Kelvin (k) from the obtained satellite images of the beam From the temperature ranges, we will use the following equation [10]:

$$Tk = K2 / \ln (K1 / CVR + 1) \quad \ldots\ldots \qquad (2)$$

The equation below is used to convert brightness temperature to Kelvin from Celsius

$$C\,^{\circ}=Tk - 273.15 \quad \ldots\ldots\ldots \qquad (3)$$

NDVI : is an important factor used for data analysis in remote sensing especially whether the target being studied contains healthy green plants [6]. That shown that the (NDVI) is an indicator related to the Earth's temperature of surface [11].

To estimate the NDVI will be use the equation bello:

$$NDVI = ((NIR - Red) / (NIR + Red)) \ldots\ldots \qquad (4)$$

After calculating the NDVI of the satellite image, the percentage of vegetation cover is known through formula (5):

$$PV = ((NDVI - NDVI\ \text{"minimum"})) / ((NDVI\ \text{"maximum"} - NDVI\ \text{"minimum"}))^2 \quad \ldots \qquad (5)$$

Pv(Part of vegetation)

The coverage plant was estimate through NDVI images of the study area

In NDVI images, the emissivity of the Earth's surface is defined as the average emissivity of the elements found on the Earth's surface which can be calculated using equation (12).

$$E = 0.004 * Pv + 0.986\ldots.. \qquad (6)$$

LST is present by the equation: [13]

$$LST = C\,^{\circ} / (1 + (\lambda * Tk / \alpha) \ln (E)) \quad \ldots.. \qquad (7)$$

The Study Area:

The boundaries of the spatial study area include Baghdad Governorate, between two latitudes (-32.54°_-33.79°) north, and two longitudes (-43.83°_ -44.93°) east. Distributed among the administrative units, which amounted to thirteen districts within Baghdad Governorate, and the total area of the study area reached (4555) km2. As for the temporal boundaries, the satellite images were in the year 2024.

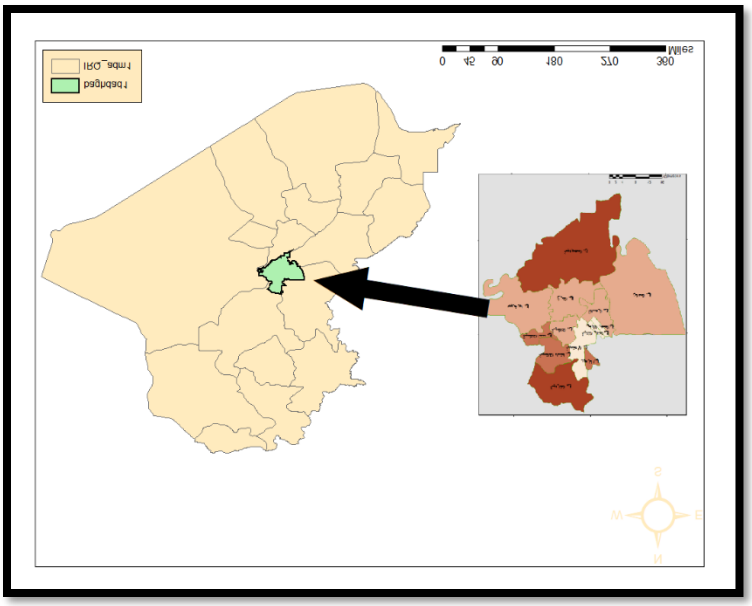

Figure 1: Study Area (Baghdad city)

Data used

To conduct research that includes studying the relationship between the biophysical properties of the soil using RS and GIS, we needed to collect a variety of data. We used the Arcmap 10.8 program and obtained satellite images of the Search area via the Landsat satellite.

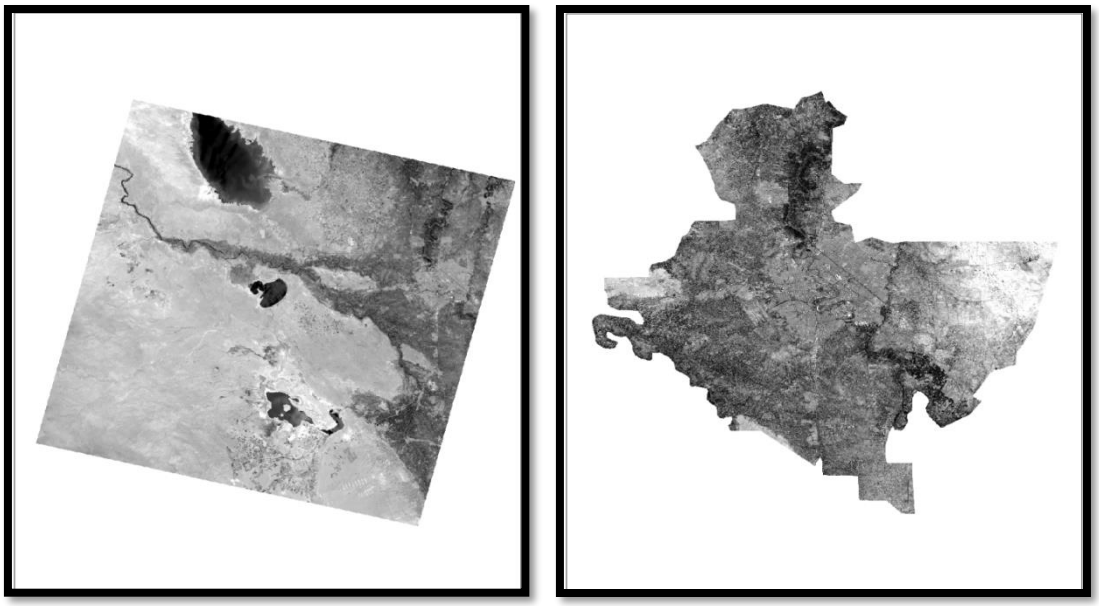

Figure 1: (a) Satellite image of the Landsat satellite (b): Extraction of the study area

Where the visuals are downloaded as in Figure 1, and since one visual does not cover the entire study area, more than one visual is downloaded and merged together using spatial analysis tools, and then only the study area is deducted from the satellite image, as we needed the bands (2,3,4,5,6,10,11) as show in result bellow.

RESULT AND DISCUSSION

1- Soil Moisture Index is a scale used to measure the moisture content of soil: This indicator is used in agriculture, horticulture and environmental research to determine how much plants need water and to adjust irrigation appropriately. Methods for measuring soil moisture vary depending on the tools used, such as remote sensing using devices such as artificial satellites, or using direct measuring devices such as hydrometers, sonar, and electrical resistance. We note from Figure 2 that the Search area was divided as four categories Based on the soil moisture index.

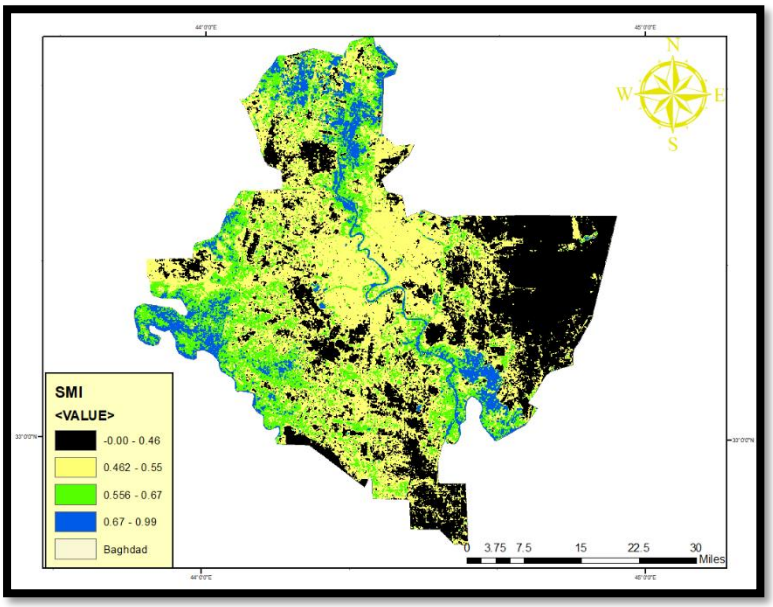

Figure 2: Soil moisture index

The areas in blue are areas with very high humidity, ranging between (0.67-0.99), And the areas in green also have high humidity between (0.556-0.67), As for the yellow-coloured lands, they contain medium-level humidity of (0.462-0.55), but the black areas are in almost dry areas, as a result of their distance from water sources, especially since the spatial image was taken in the summer, when the city of Baghdad enjoys hot and dry weather.

2-Normalization Different Vegetation Index: The vegetation change index is a measure used to monitor and evaluate changes in the composition and distribution of vegetation over time in a given area. During this study, vegetation cover was queried using remote sensing: using satellites to take advantage of high-resolution satellite images, allowing large-scale land monitoring and analysis of vegetation changes.

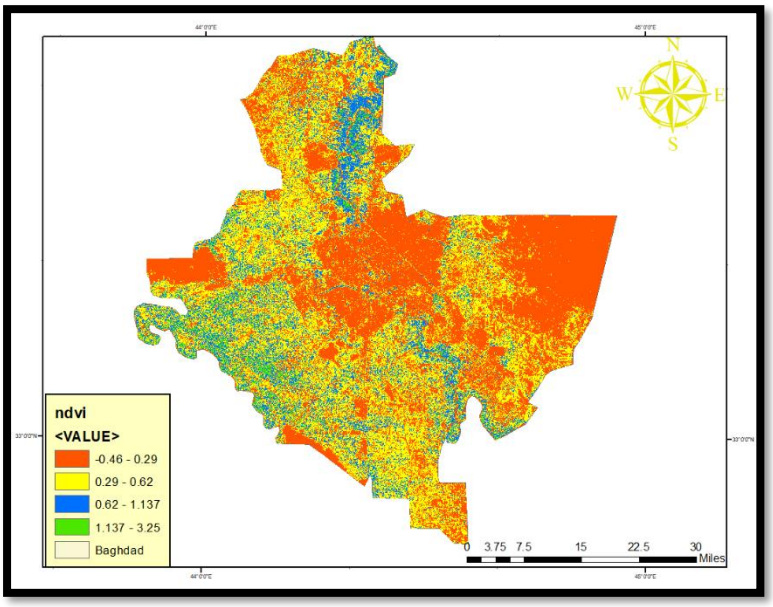

Figure 3: Normalization Different Vegetation Index.

As shown in Figure 3, the Baghdad was divided as four classis based on the density of vegetation, and the areas colored green with the highest density came in first place, as a result of their proximity to rivers and wet areas, as we observed in Figure 2. Followed by the areas in blue, and in last place are the areas marked in red, as they have little vegetation cover as a result of drought and their distance from sources of water and humidity.

3-Land Surface Temperature Index: The Earth's surface temperature index was calculated using satellite images, as it represents an important tool for monitoring and analyzing surface temperatures in different regions of the world. This was done using what is known as “thermal sensing” or “thermal imaging” using satellites, in particular Band (10), to enable us to create detailed thermal maps of the study area. Explains the distribution of heat on the surface, and determines the temperature differences between different regions.

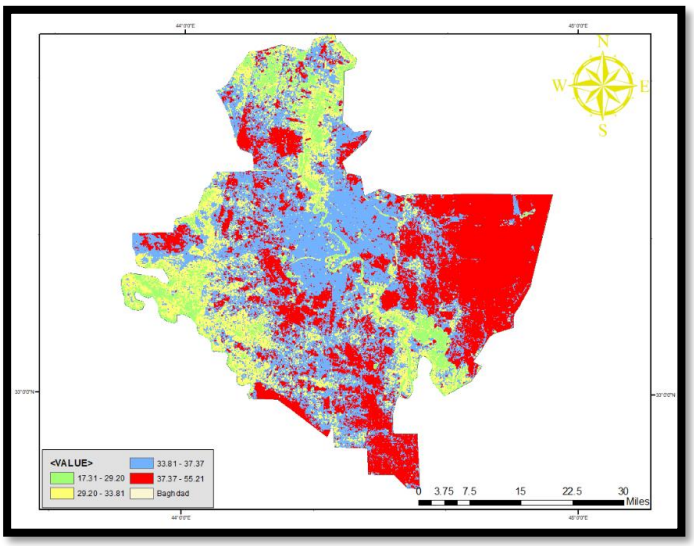

Figure 4: Land Surface Temperature Index.

The results of Map No. 4 indicate that there is a variation in reflected temperatures within the study area. Moreover, four categories appear to us according to the intensity of the reflected spectrum. The lands in red are characterized as areas of intense reflectivity, as a result of the dryness of those areas and their little vegetation cover, as we saw above. In Figure 2 and 3, the areas with the color blue are also considered to have high reflectivity, followed by the areas with the color yellow, which are areas with medium reflectivity of the spectrum. The green color is an indication of lands with low reflectivity for temperature because they enjoy dense vegetation cover and humidity.

4-The Correlations: There are several steps that must be taken to find the relationship between biophysical factors using spatial analysis tools. The first steps begin by creating a raster file consisting of 60 columns and 60 rows. Note Figure 5 and 6.

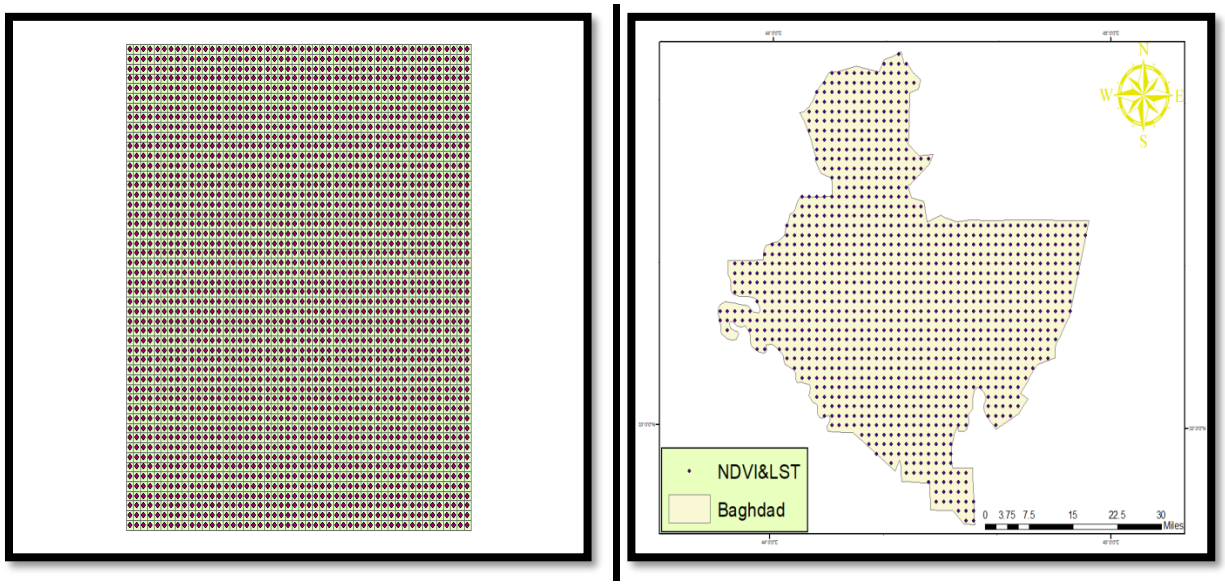

Figure 5: (a) the point shape file **(b) Clipping point shape file**.

Now, after creating the point file, we put the value of each variable at that point for all points, then we find the relationship between those variables shows figure 6.

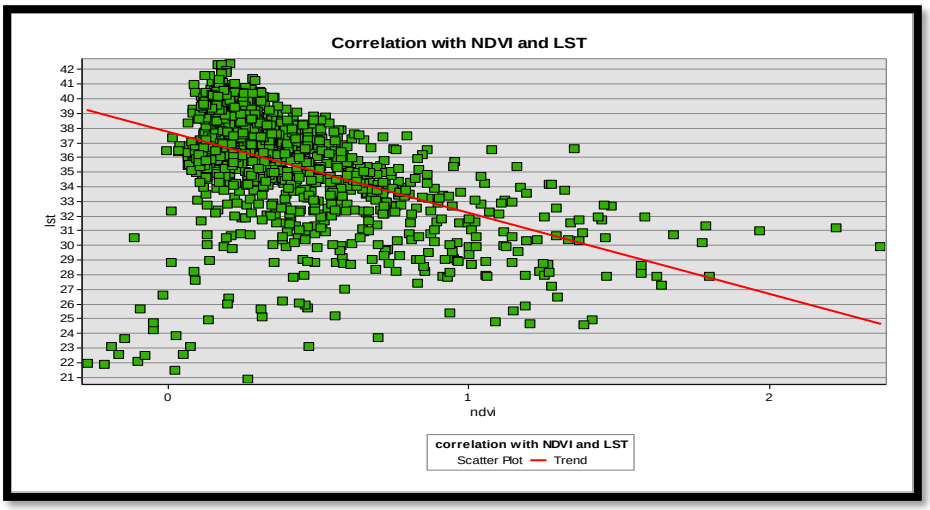

Figure 6: (a) the Correlation between NDVI and LST

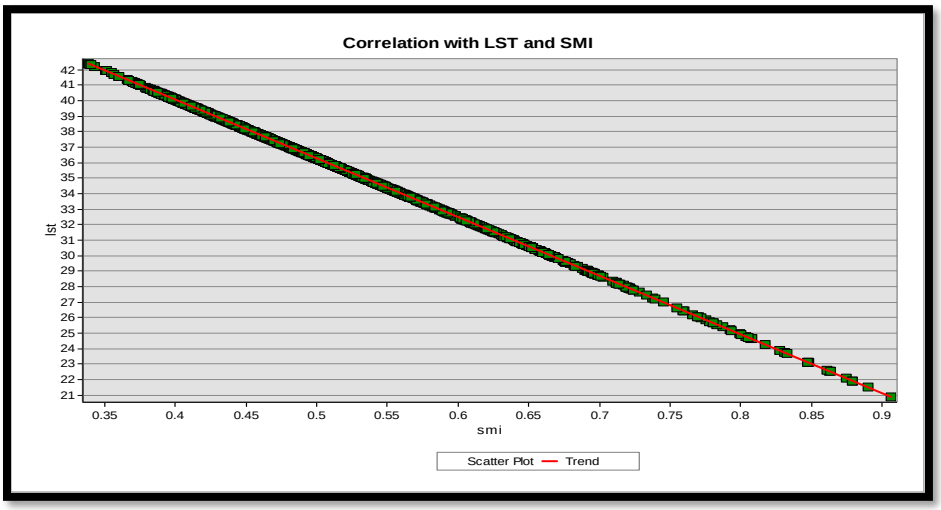

Figure 6: (b) The Correlation between LST and SMI

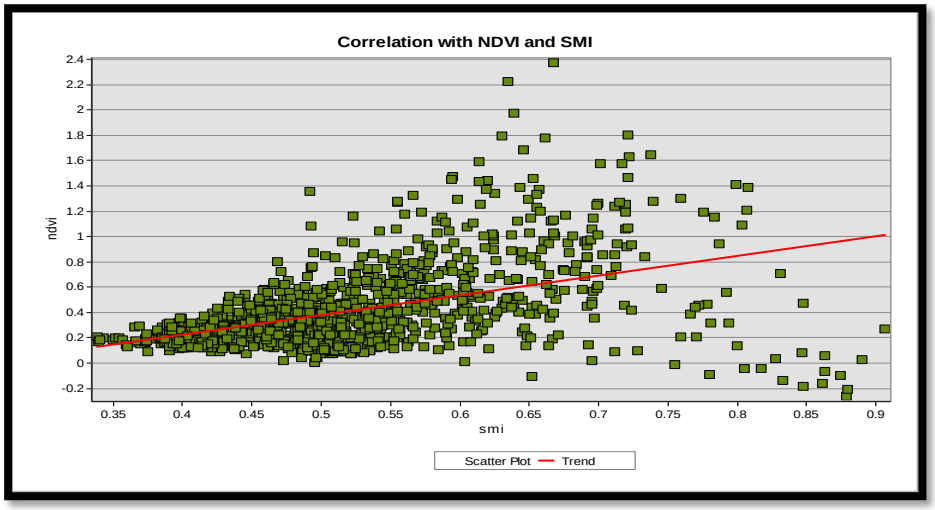

Figure 6: (c) The Correlation between NDVI and SMI

Points for the selected sample from SMI, LST and NDVI and used to establish the association between these factors and then depicted graphically using a two-dimensional scatter plot as in Figure 6. As shown, a relations is negative, which means if the SMI and NDVI index rise, the LST index decreases and vice versa. The relationship among SMI and NDVI is a linear relationship, as both of them increase as the other increases, and vice versa

CONCLUSION

Spatial analysis tools are very valuable tools in revealing soil biophysical parameters. These tools allow researchers and experts in agriculture and the environment to accurately and comprehensively understand the physical and biological properties of soil in specific areas. . This precise data enables detailed soil characteristics to be identified at every point within a specific area. With their capabilities to collect large-scale data and create holistic images of soils, spatial analysis tools allow the identification of regional patterns of biophysical properties. These patterns can be used to understand spatial variations of soil. Finding the relationship of variables with each other, as spatial analysis tools can include techniques such as remote sensing and geographic information systems,

which allows linking environmental variables such as altitude, climate, humidity and reflectance and finding the relationship between those variables and the effect of some of them on others.

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