تقييم مصادر و توزيع الكثبان الرملية بالقرب من مدينة بيجي – العراق باستخدام تقانات التحسس النائي

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الملخص :

ان انتاج الخرائط الموضوعية مثل تلك التي تصور غطاء الارض باستخدام تصنيف الصورة يعتبر واحد من اهم التطبيقات الشائعة للتحسس النائي. توجد عدة طرق بالتحسس النائي لتصنيف الصورة والتي تتضمن التصنيف الموجة وغير الموجه وطرق اخرى .يعتبر تقييم الدقة في مخرجات التحسس النائي هوالخطوة الاهم في تصنيف بيانات التحسس النائي ، وبدون تقييم الدقة فان نوعية الخارطة المنتجة تصبح اقل قيمة للمستخدم المستفيد منها. يقوم هذا البحث باستخدام تقانة التصنيف الموجه على بيانات التحسس النائي لاغراض تصنيف غطاء الارض في منطقة بيجي ويقوم بتقييم دقة نتائج تقانة التصنيف باستخدام برنامج ايرداس النسخة ٩,٢ .تستخدم للدراسة صورة لاندسات 7 المتحسس + ETM كبيانات اولية بدقة مكانية 30 m X 30 m. تم تصنيف غطاء الارض في منطقة الدراسة الى 5 اصناف. تم جمع 96 نقاط نموذجية باستخدام النمذجة العشوائية . بينت النتائج بان الدقة الكلية للتصنيف الموجة كانت ٩١,٦٧% واحصاء كابا كان ٠,٨٧٥٧ .

الكلمات الدالة : التصنيف الموجة ،تقييم الدقة ،خرائط غطاء الارض ،التحسس النائي ،العراق.

Assessment of sources and distribution of sand dunes near Baiji City - Iraq using remote sensing techniques

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Abstract

The production of thematic maps, such as those depicting land cover, using an image classification is one of the most common applications of remote sensing. Several methods exist for remote sensing image classification; they include supervised, unsupervised and other approaches. Accuracy assessment of a remote sensing output is a most important step in classification of remotely sensed data, and without accuracy assessment the quality of map or output produced would be of lesser value to the end user. This paper perform supervised classification technique on remote sensing data for land cover classification in Baiji area and evaluate the accuracy result of classification technique using ERDAS IMAGINE V9.2. The study used Landsat 7 satellite image ETM+ as a primary data, with spatial resolution 30 m x 30 m. The land cover classes for the study area were classified into five themes. A total of 96 sample points were collected using Random Sampling. The results showed that the overall accuracy for the supervised classification was 91.67%, where Kappa statistics was 0.8757.

Keywords: Supervised Classification, **A**ccuracy Assessment, Land Cover Mapping, Remote Sensing, Iraq.

Introduction

The knowledge of spatial land cover information is essential for proper management, planning and monitoring of natural resources. For example, it is a desired input for many agricultural, geological, hydrological and ecological models [12, 17]. Due to synoptic view, satellite remote sensing imagery is a viable source of gathering quality land cover information at local, regional and global scales. Land cover is a fundamental variable that impacts on and links many parts of the human and physical environments. This is important for it provides useful information for planning the area. The information contained in digital imagery, acquired by Remote Sensing technology, can be used for mapping, monitoring and assessing the properties of the environmental and territorial feature elements. Classification in remote sensing involves clustering the pixels of an image to a set of classes, such that pixels in the same class are having similar properties. The majority of image classification is based on the detection of the spectral response patterns of land cover classes. Classification depends on distinctive signatures for the land cover classes in the band set being used, and the ability to distinguish these signatures from other spectral response patterns that may be present[6, 15].

Materials and Methods

There are a number of image classification methods for land cover and land use data such as unsupervised classification, supervised classification, and fuzzy classification [11, 15, and 20]. Supervised classification employs such methods as minimum-distance-to-means, parallelepiped, and maximum likelihood classifiers (MLC). MLC uses samples; the spectral characteristics of these sites have used to train the classification algorithm for eventual land-cover mapping of the remainder of the image. Each pixel both within and outside the training sites is then evaluated and assigned to the class of which it has the highest likelihood to be a member [12, 15]. A random sampling method was adopted for collecting sample points. The accuracy assessments of supervised technique were made through a confusion or error matrix. A confusion matrix contains information about actual and predicted classifications done by a classification system. The result of an accuracy assessment typically provides the users with an overall accuracy of the map and the accuracy for each class in the map. Besides the overall accuracy, classification accuracy of individual classes was calculated in a similar manner. The two approaches are user's accuracy and producer's accuracy. The producer's accuracy is derived by dividing the number of correct pixels in one class divided by the total number of pixels as derived from reference data. In this paper, the producer's accuracy measures how well a certain area has been classified. It includes the error of omission which refers to the proportion of observed features on the ground that is not classified in the map. Meanwhile, user’s accuracy is computed by dividing the number of correctly classified pixels in each category by the total number of pixels that were classified in that category. The user’s accuracy measures the commission error and indicates the probability that a pixel classified into a given category actually represents that category on ground. The pixel-based classification was undertaken using ERDAS Imagine v9.2 image processing software. It was a standard supervised classification using the maximum likelihood algorithm. This involved the selection of training areas representative of the five land cover classes. A number of training areas were selected to represent each class. The signature (or spectral mean) of the training area was then used to determine to which class the pixels were assigned. Fluvial and Aeolian processes are the most prominent geomorphogenetic factors forming the investigated area. Wind action is a threat for the surrounding cultivated areas. Quartz sand as well as silt and clay dominates Aeolian deposits in the area. These dust-sized particles are carried out or are caught by vegetation in the area. The major part of these deposits occurs in accumulations known as sand seas. Sand seas constitute areas of dunes of various morphological types and sizes, as well as areas of sand sheets. Greater parts of sand seas occur in the eastern hemisphere arid zones of the Sahara and Arabia. Landsat ETM+ image in figure (1) shows the sand seas in the studied area. Even with a ground resolution of 30 m per pixel, this image shows a wealth of information about dune form and patterns. In the middle of the image, south-to-north barchan dunes occur as dark grey objects oriented in special patterns.

Study Area

Geographical location of the area:

The area under study is located between 33° 51' and 34° 39' latitudes, and 43° 48' and 44° 30' longitudes North West **Baiji**. Its includes Makhool Mountain at the north east side and sand dunes field and Wadi Al- Tharthar on the North West side As shown in figure(1) below.

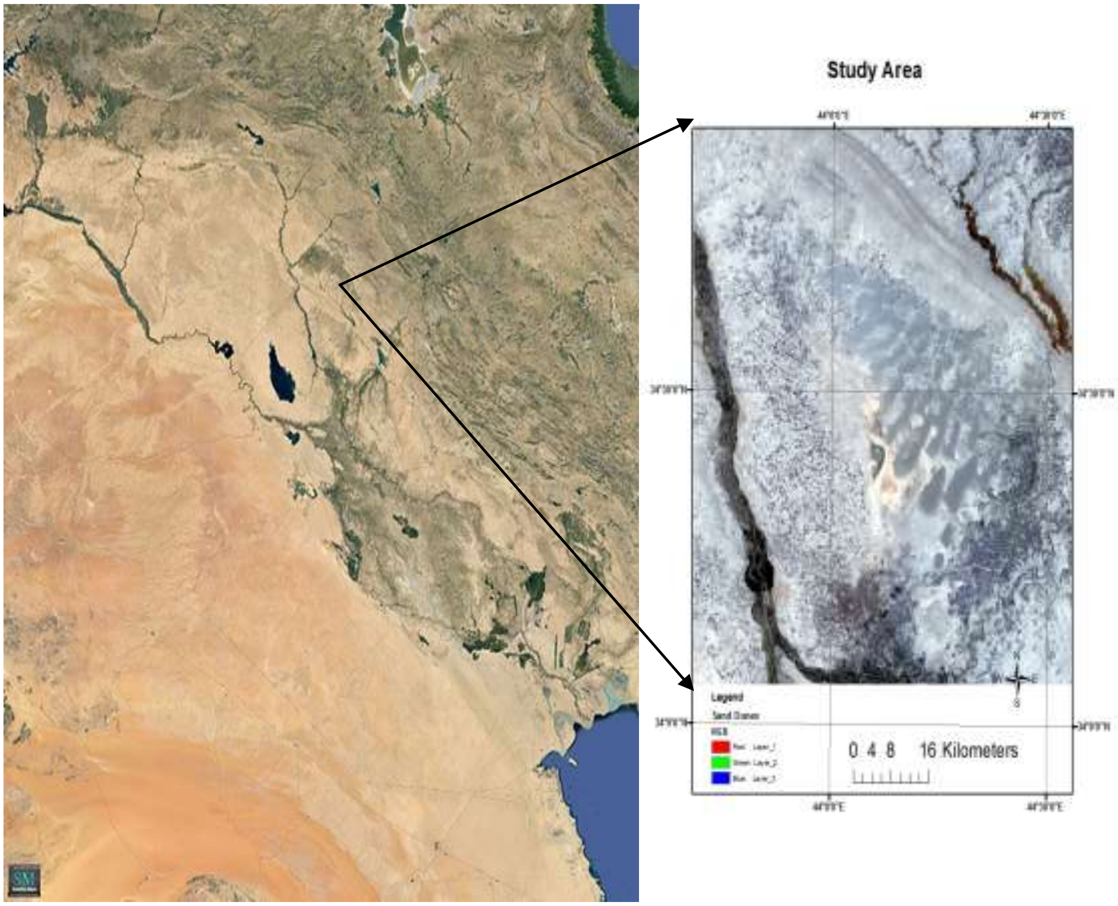

Figure (1): Location of the Study Area.

Climate: Studied area can be classified arid to semi-arid zone [14]. The studied area related to arid Mediterranean region of low mean annual precipitation about 182 millimeter, mean monthly temperature range from 7.6 °C in December and 34.1 °C in August and may be reach to 45 °C at shadow and 65 °C under sun during July and August. The mean annual temperature is 21 °C. Prevalence of north south wind direction which was has high speed on summer season. The climatic data were taken from Baiji station. The total annual evaporation is 3139 mm. The annual relative humidity is 54%, while the mean annual precipitation is 190 mm. Minimum averages annual wind speed is 2 meters/ second near **Baiji**, and maximum speed was 11.76 meters / second at 10 meters height. The data refer to year 2012.

Geological setting: many bed rock units have been exposed at the studied area which is belong to different formations: Euphrates, Fatha, Injana and Mukdadiya Formations. Euphrates Formation (Early Miocene) comprises well bedded, rycrystallized and fossiliferous limestone, which exposed at the core of Makhool Mountain. Fatha Formation (Middle Miocene) comprises alternative of limestone, gypsum, marl, mudstone and sandstone and its thickness about 300 meters, which is exposed at Makhool Mountain. According to Al- Ma΄ala [2], it's exposed at Al-Jazira area to the north west of Wadi Al-Tharthar. Injana Formation (Late Miocene) comprises alternative of sandstone, mudstone and clay stone which exposed on two flanks of Makhool Mountain and its thickness reach to 500 meters. According to Al- Ma΄ ala [2], it's exposed on both sides of Wadi Al-Tharthar and also at Al- Jazira, north west of Wadi Al-Tharthar. Mukdadiya Formation (Pliocene) comprises pebbly sandstone, and mudstone [3, 4].

Vegetation: plant diversity related to the geomorphologic heterogeneity and type of soils. Plant communities of studied area which are growing near sand dunes were subdivided according to morphological features into five plants [1]: *Cyperus conglomerates*, *Onopordon canum*, *Lagonychium farctum*, *Alhagi maurorum, and Astragalus spinosus.*

Land forms: many land forms occurred at studied area which are related to the structure, erosion and deposition. The main land forms are: Peak of Makhul Mountain which is reaches to 400 meters. Slope sediments. Seasonal streams which are include major and minor wades and flows from north east to south west toward wadi Al-Tharthar. Alluvial fans formed at the foothill of mountain from weathered materials and composed of badly sorted sediments. And sand dune had been formed from fine sediments that were transported by distal part to the Tharthar wadi.

Dune Morphology:

Dunes of the studied area are created by interactions between granular material (sand + silt + clay) and shearing flow (the atmospheric boundary layer). The resulting and landforms that are bed forms of Aeolian origin. Their morphology reflects the characteristics of the sediments grain size. The surface wind which determined the sand transport rate as well as the directional variability of the annual wind regime. Natural vegetation has an important role, and interactions with topographic microforms may also result in dune formation in the investigated area. Desert dunes occur in a variety of morphologic types, each of which displays a range of sizes (height, width, and spacing). The satellite image of the area figure (2) shows that most dune patterns are quite regular, and that very similar dune morphological types occur in widely separated sand seas. For example, partly vegetated linear dunes in our area and western and southern desert are almost identical in morphology, as are compound barchan dunes in these places. This suggests that the local response of sand surfaces to airflow is governed by generally applicable physical principles [13, 16]. There are many different approaches to classifying remotely sensed data [10, 5, and 19].

Supervised classification requires prior knowledge of the ground cover in the study site. Classifying remotely sensed data into a thematic map is not a simple task because many factors, such as the complexity of the landscape under investigation, the availability of reference data, the selected remotely sensed data, image-processing and image classification approaches, and the analyst's experiences, may affect classification accuracy [7, 9, and 15]. Many uncertainties or errors may be introduced into the classification results. Training samples are usually collected from fieldwork or from fine spatial resolution aerial photographs and satellite images. Different collection strategies, such as single pixel, seed, and polygon, may be used, but they will influence classification results, especially for classifications with fine spatial resolution image data. In remote sensing land cover mapping study, accuracy assessment is important to evaluate remote sensing final product. The purpose of assessment is important to gain a warranty of classification quality and user confidence on the product**.** The error matrix and kappa coefficient have become a standard means of assessment of image classification accuracy. Assess accuracy of a remote sensing output is one of the most important steps in any classification exercise. Without an accuracy assessment the output or results is of little value [5, 7, 8 and 18]. Therefore, this paper aims to test supervised classification for classifying land cover data in **Baiji** area, and to assess the accuracy of classification by calculating the error matrix, overall accuracy, producer accuracy, user accuracy and Kappa statistics. The digital image processing was carried out using a personal computer equipped with ERDAS IMAGINE software Ver. 9.2 for classification and analysis of the LandSat imagery. The algorithm applied in supervised classification is the Maximum Likelihood Classification (MLC). The study was conducted in **Baiji** and its surrounding area. The location of the study area is shown in fig. (2).

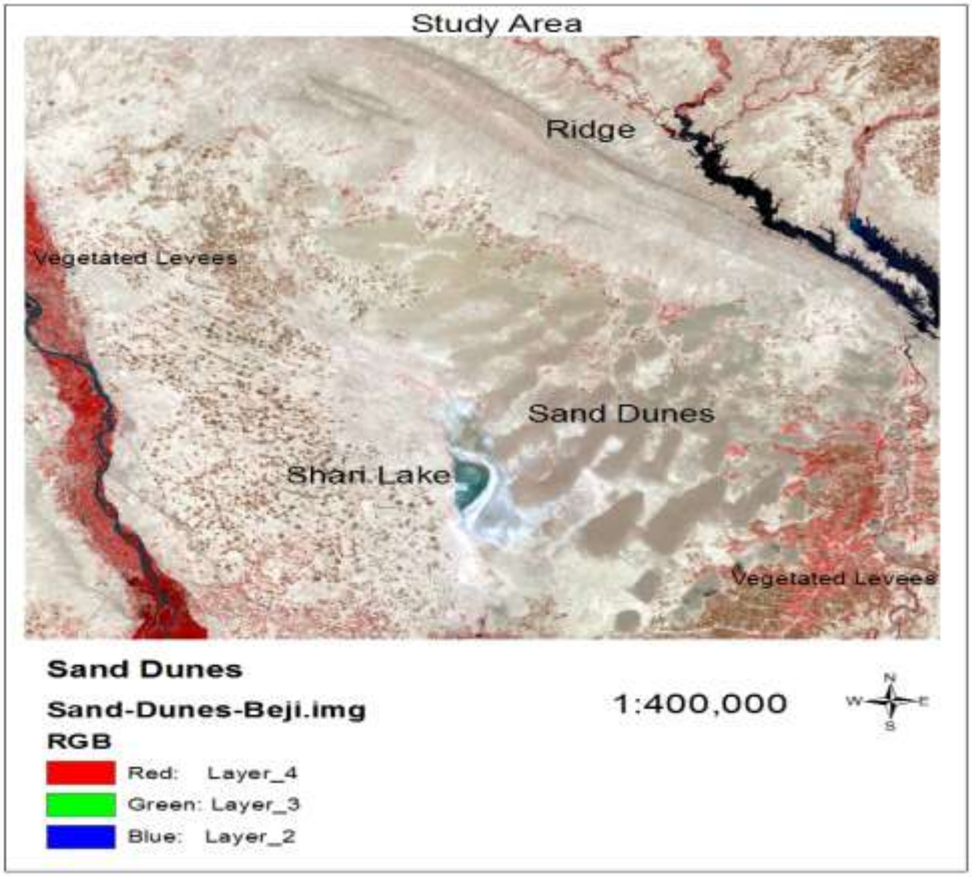

Figure 2. Landsat 7 ETM+ image of the study area.

Results and Discussion

The elevation of studied area range from 400 meters above sea level (a. s. l.) on the top of Makhool Mountain and less than 110 meters (a. s. l.) near Wadi AL-Tharthar. The elevation differences caused steep slope between the top of mountain and foothill, and gentle slope between foothill and Wadi Al-Tharthar. The tops and highlands of the mountain, which includes Euphrates, Fatha, Injana and Mukdadiya Formations that are comprises limestone, Gypsum, marl, clay stone, sandstone, mudstone and conglomerates, became a source or positive areas of sediments and the lowland near Wadi Al-Tharthar became basin of deposition. During rainy seasons, steep slopes help streams to flow with high velocity, high discharge and high energy which enable it to transport high amount of large fragments and coarse grains of sediments to deposits them on alluvial fan, while the distal part of the streams transports fine fraction of sediments which includes fine and very fine sand, silt and clay near Wadi Al-Tharthar. During dry seasons, which extends about 8 months, the temperature may be reaches 65˚C and the prevalence of NW, W wind speed activated wind action on dry sediments near Wadi Al-Tharthar to form erosion and sedimentation features particularly sand dunes. Sand sediments also transported from Al- Jazira area by wind agent and deposited near Wadi Al-Tharthar[2]. Wadi Al-Tharthar and surrounded low land areas became basin of deposition for the sediments which are transported by seasonal streams from the north east from Makhool Mountain. And also for the sediments which are transported by wind agent from the North West from Al- Jazira area.

The primary data used in this study was Landsat 7 satellite image with 30 m spatial resolution. The classification of the data was examined and divided into classes based on natural grouping and trained samples. The result of the supervised classification technique is shown in Figure 3. The classes were Sand Dunes, Vegetated Levee, River Terraces, Alluvial Fans and Al-Sharry Lake.

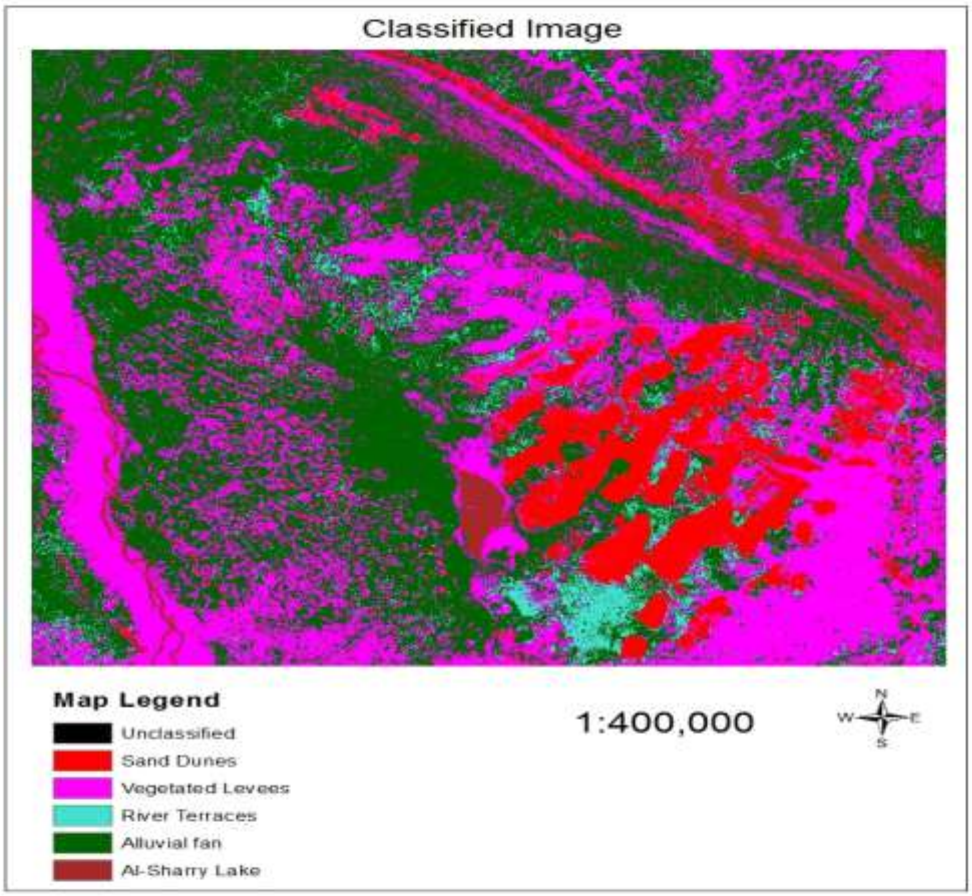

Figure 3. Supervised classification of Landsat 7 image of the study area.

The accuracy assessments of supervised technique were made through a confusion or error matrix. A confusion matrix contains information about actual and predicted classifications done by a classification system. Land cover class for the study area was divided into five theme classes as shown in Table 1 below.

Table (1): Confusion matrix of the supervised classification image

Classified Data	Reference Data					
	Sand Dunes	Vegetated Levee	River Terraces	Alluvial Fans	Al-Sharry Lake	Row Total
Sand Dunes	15	0	0	0	0	15
Vegetated Levee	0	27	1	1	0	29
River Terraces	0	0	4	0	0	4
Alluvial Fans	4	2	0	40	0	46
Al-SharryLake	0	0	0	0	2	2
ColumnTotal	19	29	5	41	2	96

Accuracy assessment was considered by Kappa coefficient, overall accuracy, and percentage of commission pixel and omission pixel is shown in Table 2 and 3. Producer and user accuracies for each class were calculated along with the overall accuracies.

Table (2): Accuracy Totals

Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
Sand Dunes	19	15	15	78.95%	100.00%
VegetatedLevee	29	29	27	93.10%	93.10%
River Terraces	5	4	4	80.00%	100.00%
Alluvial Fans	41	46	40	97.56%	86.96%
Al-Sharry Lake	2	2	2	100.00%	100.00%
Totals	96	96	88		

Overall Classification Accuracy = 91.67%
Overall Kappa Statistics = 0.8757.
The results of Kappa statistics for the five themes are shown in table (3).

Table (3): Conditional Kappa for each category

Class Name	Kappa
Sand Dunes	1.0000
Vegetated Levee	0.9012
River Terraces	1.000
Alluvial Fans	0.7723
Al-Sharry Lake	1.000

Conclusions

While a great deal has been written about change analysis techniques using remotely sensed data, very little has been written on the subject of accuracy assessment of change products. A standard accuracy assessment procedure for baseline land cover products involves the use of the error matrix. The error matrix is an effective descriptive tool for organizing and presenting accuracy assessment information and should be reported whenever feasible.

Classifying remote sensing imageries to obtain reliable and accurate land use and land cover (LULC) information still remains a challenge that depends on many factors such as complexity of landscape, the remote sensing data selected, image processing and classification methods, etc. Change in land use and land cover (LULC) is gaining recognition as a key driver of environmental changes. Preserving the environmental resources while maintaining or enhancing the economic and social benefits from their use is a present day challenge. Land cover mapping via remote sensing is an important tool for conservation and land management. A critical component to land cover mapping is defining the classification. A classification scheme must be sufficiently detailed to meet the goals to which the map will be applied yet simple enough to accurately map the classification units with the available data and classification methods.

Classifying remotely sensed data into a thematic map is not a simple task. Many uncertainties or errors may be introduced into the classification results; thus, much effort should be devoted to the identification of these major factors in the image classification process and then to improving them.

Assess accuracy of a remote sensing output is one of the most important steps in any classification technique. Without an accuracy assessment the output or results is of little value.

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