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RESEARCH ARTICLE

Spatial Analysis of Soil Resources Potential by Using Geography Information Systems (GIS): A Case Study from Thrace Region, Turkey

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HIGHLIGHTS

> Thrace Region's soil and land properties were evaluated and major soil groups, erosion degrees, soil depths and land slopes were determined
> Spatial database of Thrace Region's soil and land properties were conducted.
> The results of this study may help agricultural activities in Thrace Region

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ABSTRACT

The aim of this study is to create spatial distribution maps by determining some land and soil characteristics related to large soil groups, slope classes, soil depths and erosion degrees using digital soil maps in the Thrace region. (Turkey). In the study, 1/25.000 scaled digital soil maps were used. Spatial analyzes were carried out with the help of Arc GIS 10.3.1 program, which is one of the Geography Information Systems (GIS) software. In the study area, non-calcareous brown forest soils cover the most area and its total area is 8550.8 km2. Brown soils cover the least area and the total area is 2.8 km2. The lands varying between 7-12% in the research area occupy the most space and the total of the areas with this slope group is 7354.8 km2. The total area formed by soils with an area of more than 150 cm soil depth is 11332.9 km2. The total area of the lands with a soil depth of 0-20 cm is 40.5 km2. The lands that may be exposed to 1st degree erosion in the study area are the ones that will be exposed to the most damage, and the total of these lands is 10195.1 km2. Fourth class areas that may be exposed to erosion are the areas with the highest and severe erosion risk, and the collection area in the study area has been determined as 318.6 km2. As a result of the study, spatial distribution maps of large soil groups, slope, soil depth and areas that may be exposed to erosion, which will form a basis for similar studies in the Thrace region, were revealed.

Contents

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1. Introduction

Soil, rocks and organic matter for centuries water, wind, etc. It was formed due to disintegration. Soil-forming dissolution occurs as a result of the physical (mechanical) disintegration or chemical weathering of rocks. The most effective factor in mechanical dissolution is the temperature difference.

The greater the temperature difference, the greater the mechanical dissolution. They also cause mechanical fragmentation of rocks in rivers, winds and glaciers. Chemical dissolution occurs with the effect of water, moisture content and temperature. But the temperature has an effect on resolution speed. The soil, which is a living entity on which living things live and shelter, and where the nutrients needed by humans and animals are grown, is the source of life [1]. Soil has importance because it contains the water and mineral nutrients necessary for the growth and development of forest trees [2]. It is necessary to analyze the soil properties very well and to know the changes in these properties after the interventions are made. It should be ensured that the soil can be used in the most efficient way. It has a high potential in terms of agriculture in Turkey. It is necessary to know the characteristics of the soils where we provide a significant part of our nutritional needs. It is possible to use the soil according to its purpose and capacity.

In order to meet the food and clothing needs of the rapidly increasing world population, it is necessary to use it in a sustainable way. It is extremely important to know the land characteristics, to create a database depending on the developing technology, to prepare the soil maps in sufficient detail and to ensure the sustainability of the land without losing their productivity.

Soils, known as the most important natural assets, are not only unique to human life but also have the characteristics of the basic environment for the life of other living things [3].

The nutrient levels of the soils are the basic criteria for qualified and abundant products. Knowing and revealing soil parameters as well as environmental factors for plant nutrition necessitates soil analysis. Plant nutrients that are missing from the soil or that are not sufficient for plant growth in the soil can only be determined as a result of soil analysis [4].

Soil applications of Geography Information Systems (GIS) are mostly focused on land use planning. With the data transferred to the GIS environment as map layers (such as soil map, land capability classes, suitability for irrigated agriculture, suitability for agricultural use and potential use groups), ideal land uses can be determined on a parcel basis. In addition, with these applications, it is possible to create an appropriate management system, including production plans for each parcel, determining the appropriate product pattern according to the rotation system, and producing more than one scenario for rotation applications [5].

The success to be achieved in GIS is directly related to the correct analysis of the variables to be used in the program by the subject experts. GIS allows defining spatial relationships between map features and stores data in an order in the form of thematic map layers that are geographically related to each other. The most basic element of GIS is the database. In addition to all these, GIS also calculates new features related to the details of the maps using the data obtained [6]. The analysis of the layers/parameters (Slope, Aspect, Lithology, NDVI, Elevation, Topographical and Topographical Wetness Index) was used in the study area [7]. Soil survey studies are recognized as important sources of information for land use planning and management of a country. Generally, soil survey needs more time and higher costs because of changes in soil properties [8].

Determination of land capabilities Studies has been carried out in many countries such as the United States, England, Wales, Scotland. On the basis of these studies, the USA in 1961. There is a classification made by the Ministry of Agriculture. The first studies on land use in our country were carried out in the USA in 1961. It has been prepared by adapting the method published by the Ministry of Agriculture by the General Directorate of Soilwater. Land use capability classification studies in our country were started in 1978 in the USA. It has been published in the form of a report named “Land Assets of Turkey” based on the criteria used in In this report, our country's lands are divided into 8 classes in terms of land capability [9]. Land use is an important global term for uses for land conservation, the production of agricultural products and other uses by farmers [10]. Sustainable land management requires reliable information on the spatial distribution of soil properties affecting both landscape processes and services [11, 12].

In this study, spatial analysis of some features of the soil resources potential of the Thrace region was carried out using digital soil maps in the Geography Information Systems (GIS). It is thought that the results obtained will make significant contributions to the measures that can be taken for the protection of soil resources.

2. Material and Method

Thrace region; It is a region located in the westernmost part of Turkey and It has 18.665 km^2 area, southeast of Bulgaria and east of Greece. It consists of the provinces of Edirne, Kırklareli, Tekirdağ and some of the provinces of Istanbul and Çanakkale. It constitutes 2.99% of Turkey's land. The region is surrounded by the Istranca (Yıldız) Mountains and the Bulgarian border in the north, the Black Sea in the northeast, the Bosphorus in the southeast, the Marmara Sea, the Dardanelles, Ganos (Isiklar) and Koru Mountains in the south, the Aegean Sea in the southwest, the Meriç River and the Greek border in the west. The wide flat lands between the elevations of the Istranca, Ganos and Koru Mountains in the region and forming the Thrace peneplain are mostly suitable for agriculture [13]. They are humid forests, which are generally located in the northern parts of the region and formed by the effect of the oceanic climate, and the main element is beech and rhododendron [14].

The Thrace region has a continental climate. Summers are hot and winters are relatively cold. The natural vegetation consists of dry forests. The average temperature in January is 2.8°C, the average temperature in July is 23.9°C, and the annual average temperature is 13.2°C. The average annual total precipitation is 559.7 mm. Most of the precipitation is in the winter, spring and autumn seasons. There is little rainfall in the region in summer. The share of summer precipitation in the annual total is %17.6. The annual average relative humidity is around %69.6 [15]. The location and location of the Thrace region, which is the study area, is shown in detail in Figure 1.

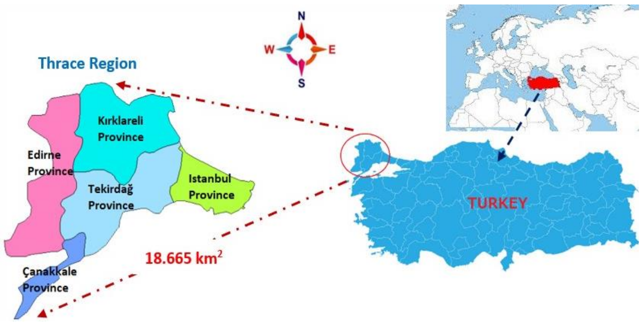

Figure 1 Location of the study area

Within the scope of the study, the classification of major soil groups, erosion degrees, soil depths and land slope distributions of the Thrace region, which is the research area, was carried out spatially in the Geography Information Systems. Arc GIS 10.3.1 software, which is one of the GIS software, was used in the classification. With this software, some soil and land data were analyzed spatially and the results were presented as map output [16]. In the study, 1/25.000 scale digital soil maps were used. Classification processes regarding the soil resources potential of the Thrace region were carried out through digital soil maps [17].

The results obtained were evaluated according to the "Soil and Land Classification Standards Technical Instruction" published by the Ministry of Agriculture and Abolished Rural Affairs in 2005 [18]. Spatial analysis maps were produced by using the layers used in the research and given in Table 1 in classification processes.

Table 1 Classification of layers of soil, major soil groups and land features

Symbol	Explanations	Soil Depths
A	Deep	>150 cm
B	Medium Deep	90-150 cm
C	Shallow	50-90 cm
D	Very Shallow	20-50 cm
E	Litozolic	0-20 cm
Major Soil Groups		
Limeless Brown Soils	Brown Soils	
Red Yellow Podzolic Soils	Hydromorphic Soils	
Rendzinal Soils	Colluvial Soils	
Alluvial Coast Soils	Regosols	
Limeless Brown Forest Soils	Brown Forest Soils	
Vertisols	Alluvial Soils	
Land Slope Classes (%)	**Explanations**	
0-2	Flat or near the flat	
2-6	Slightly slope	
6-12	Medium Slope	
12-20	Steep Slope	
20-30	Very Steep Slope	
30-45	Craggy	
45+	Very Craggy	

In the study, 1/25.000 scale digital soil maps were used. Arc GIS 10.3.1, whose digital soil data is one of the Geography Information Systems software. spatially analyzed and classified using the program. The steps of the classification are shown in Figure 2.

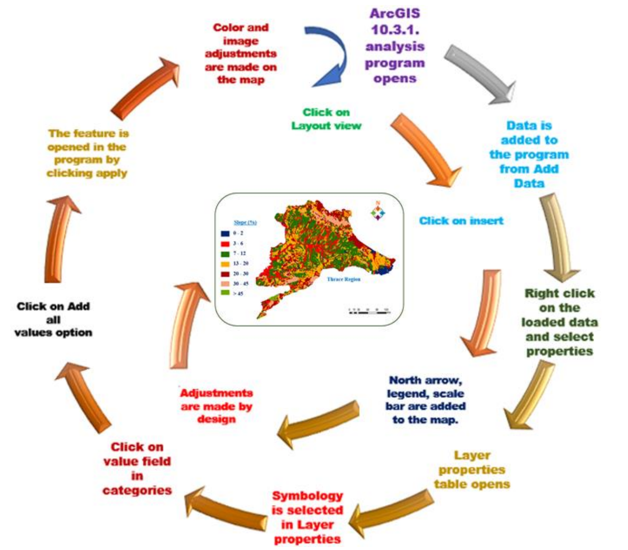

Figure 2 Spatial Analysis Stages of Digital Soil Data

3. Research Findings

In this study, spatial analyzes of large soil groups, slope, soil depth and erosion classes were carried out with the help of digital soil maps by using some land and soil characteristics in the Thrace Region.

3.1. Spatial Analysis of Major Soil Groups

Spatial analysis of major soil groups was made using digital soil data. The spatial distribution map of the major soil groups is given in Figure 3. The areal amount of large soil groups are given in Table 2.

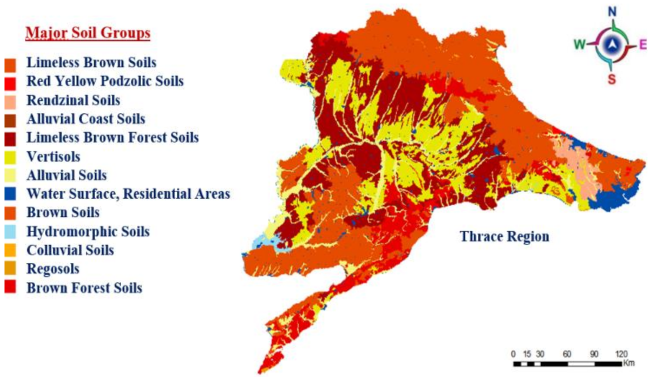

Figure 3 Spatial Distributions of Major Soil Groups

Table 2 Areal Quantities of Major Soil Groups

Major Soil Groups	Area (km2)
Limeless Brown Soils	8,550.8
Red Yellow Podzolic Soils	41.8
Rendzina Soils	490.4
Alluvial Coast Soils	16.1
Limeless Brown Forest Soils	5,416.8
Vertisols	3,795.3
Alluvial Soils	2,060.8
Brown Soils	2.8
Hydromorphic Soils	158.4
Colluvial Soils	9.9
Regosols	22.3
Brown Forest Soils	2148.1
Water Surface and Residential Area	912.2

Limeless brown soils cover a large area of 8,550.8 km^2 in the Thrace region. Lime-free brown forest soils are seen in an area of 5,416.8 km^2. Brown soils cover the least area, with a total area of 2.8 km^2. Brown forest soils are seen in an area of 2,148.1 km^2.

3.2. Spatial Analysis of Land Slope Classes

As a result of the spatial analyzes made in Arc GIS 10.3.1 software, the spatial distribution map of the land slopes in the Thrace region is given in Figure 4. The areal values of the slope classes are calculated and presented in Table 3.

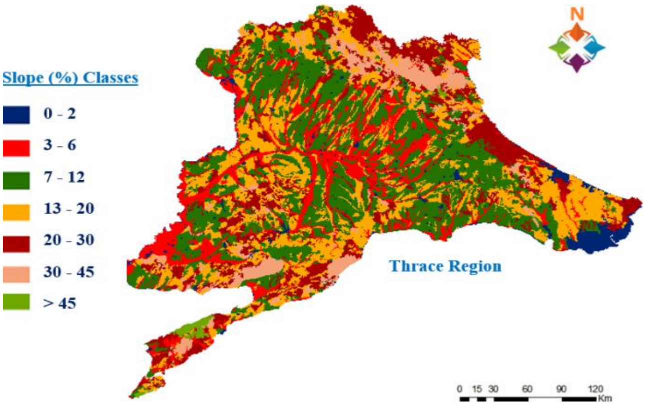

Figure 4 Spatial Distributions of Slope Classes

Table 3 Areal Quantities of Slope Classes

Land Slope Classes (%)	Area (km 2)
0-2	912.2
3-6	3,604.6
7-12	7,354.8
13-20	6,166.7
20-30	3,818.2
30-45	1,592.7
>45	176.5

As can be seen, the slope values are divided into 7 different classes. The areas defined as 0-2% in this slope classification were determined as water surfaces. The area classified with 7-12% constitutes the largest area with 7,354.8 km^2. This area is described as moderately sloping. The least area is 176.5 km^2 with a slope greater than 45%, and this area is classified as a very steep slope.

3.3. Spatial Analysis of Soil Depth Classes

As a result of spatial analyzes using digital soil maps, classifications of soil depth levels were carried out and their spatial distributions are given in Figure 5. The areal values of soil depth classes are shown in Table 4.

Table 4 Areal Quantities of Soil Depth Classes

Soil Depths	Area (km^2)
A (>150 cm)	11,332.9
B (90-150 cm)	5,339.6
C (50-90 cm)	5,428.2
D (20-50 cm)	572.4
E (0-20 cm)	40.5
Water Surface and Residential Areas	912.2

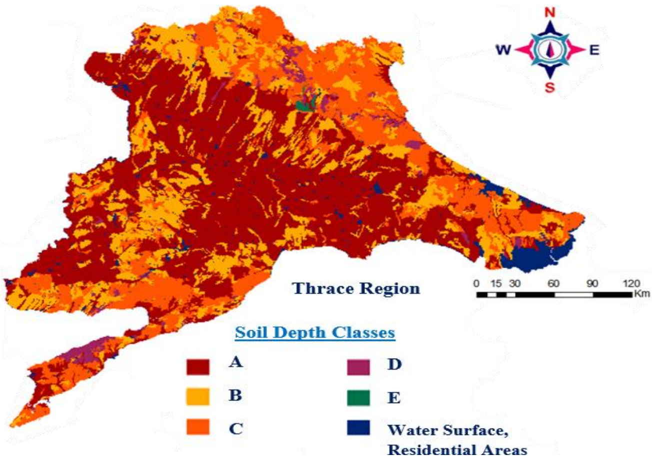

Figure 5 Spatial Distribution of Soil Depth Classes

As can be seen, when the soil depth values are examined, the areas formed by the A class soil depth cover the largest area with 11,332.9 km^2. It has been determined that the areas with class A soil depth are especially concentrated in the middle parts of the study area. The total area covered by the settlements and water surfaces in the research area was calculated as 912.2 km^2. Areas with class E soil depth cover an area of 40.5 km^2.

3.4. Spatial Analysis of Erosion Classes

As a result of the spatial analyzes made in Arc GIS 10.3.1 software, the erosion degrees of the study area were analyzed spatially. The spatial distribution map obtained is given in Figure 6. The areal amounts of erosion classes are shown in Table 5.

Table 5 Areal Amount of Erosion Degrees

Erosion Degrees	Area (km^2)
1	10,195.1
2	7,602.7
3	4,597.1
4	318.6
Water Surface and Residential Areas	912.2

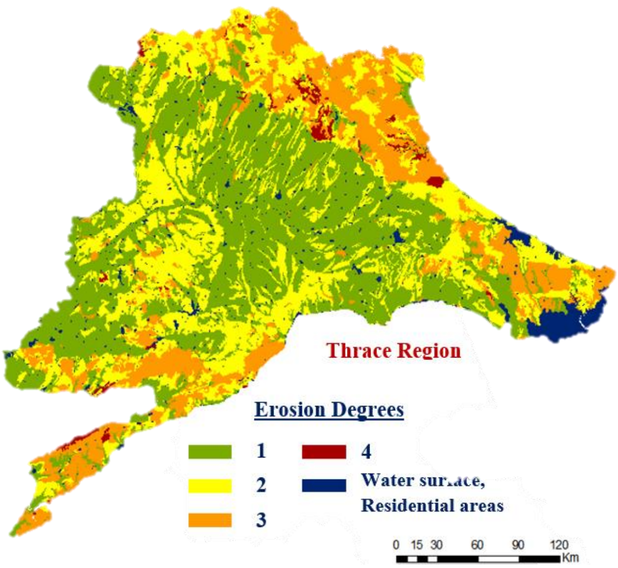

Figure 6 Spatial Distribution of Erosion Degrees

Considering the erosion degrees, the areas that can be exposed to 1st degree erosion cover the largest area of 10,195.1 km^2. These areas show areas that are slightly exposed to erosion. It has been determined that the areas that may be exposed to 4th class erosion cover an area of 318.9 km^2. These areas show areas exposed to severe erosion. When we look at the Thrace region in general, it is seen that the erosion in this region is not very serious. The schematic view of the database created for the evaluation of the soil resources of the Thrace region in the study is given in Figure 7.

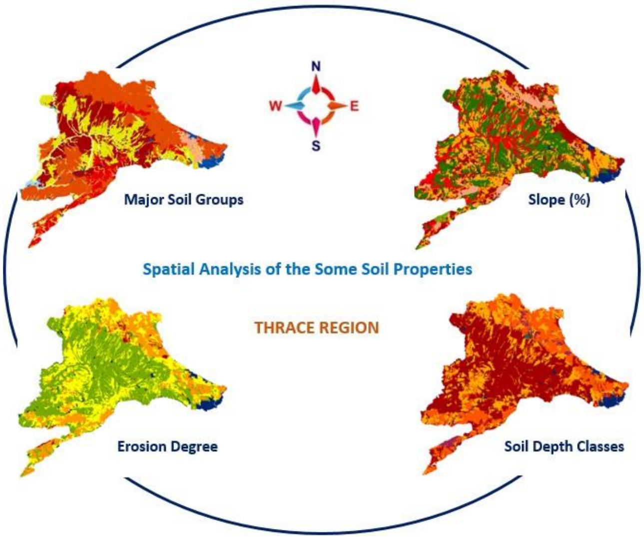

Figure 7 Spatial Database of Thrace Region's Soil Properties

In this study, the soil properties of the Thrace Region were examined. These features are; A total of four spatial analysis distribution maps were created, including large soil groups, land slope, soil depths, and degrees of erosion. When the large soil groups are examined; It has been observed that brown forest soils cover an area of 2,148.1 km^2 in the region, and regosols cover an area of 22.3 km^2. When the slope characteristics of the region are examined, it is seen that the areas with a slope of 13-20% are 6,166.7 km2, and the areas with a slope of 30-45% are in an area of 1,592.km^2. C class soils with a depth of 50-90 cm cover an area of 5,428.2 km^2. D class soils with a soil depth of 20-50 cm are calculated in an area of 572.4 km^2. When the erosion map was examined, it was determined that the areas that could be exposed to 2nd degree erosion were 7,602.7 km^2 and could be exposed to moderate erosion. It has been determined that the lands that can be subject to 3rd degree erosion are 4,597.1 km^2 and that these areas may be exposed to severe erosion. As a result of the study, a database on soil resources for the Thrace Region was created and made available to all beneficiaries.

4. Discussion

It is very important to use the soils in the most efficient way. For this reason, it is necessary to know the soil properties in the best way. For this, it is of great importance that soil analyzes are carried out and interpreted correctly.

Studies for the determination of soil resources and land characteristics are carried out effectively by the European Union Commission in European countries. Our country in the European Union Harmonization Process, Common Agricultural Policies, Environment Action Plan, etc. It has to prepare the harmonized soil information needed within the Union due to specific EU policies Landslides, floods, etc. occurring in our country. environmental disasters and earthquakes have demonstrated the importance of having comprehensive and sufficient soil knowledge in order to prevent such disasters or to reduce their effects. It is possible to solve the problems related to the use and management of our country's soil and water resources, to produce new data and to create an up-to-date Soil and Water Resources database that will enable the subsequent changes to be followed. In our country, all country lands were examined and mapped between 1966-1971 by using 1/25,000 scale topographic maps by the General Directorate of Abolished Topraksu.

This study was carried out according to the 1938 American classification system, and the mapping unit was based on large soil groups and their important phases. In addition, these maps were digitized by the Abolished General Directorate of Rural Services, National Information Center for Soil and Water Resources, and the Turkish Geography Database was created with the help of Geography Information Systems [19]. Accurate assessment of the spatial variability of soil properties is a key component of the agriculture ecosystem and environment modeling [20]. There are many studies on spatial evaluation of some soil properties. For example; In a study conducted in Kırşehir province using digital soil maps, large soil groups, land use capabilities, soil depths, land slopes and erosion classes were spatially analyzed and classified in the GIS [21]. In a study conducted to determine some soil and land characteristics of Kayseri province; soil depths, slope and erosion classes, large soil groups and other soil properties were determined using 1/25,000 scale digital soil maps by using Geography Information Systems (GIS). As a result of the study, spatial distribution maps of some soil and land characteristics of Kayseri province were produced [22]. Another a study conducted in Adıyaman, soil samples were taken from 19 villages of the city center. Soil texture, pH, EC, $CaCO_3$, Ca, Mg, B, and Na contents were determined in these samples. The results obtained were evaluated spatially and spatial change maps of the study area were created [23]. In a research conducted for the Mapping and Interpretation of Some Soil Properties of the Middle Kelkit Basin with the Inverse Distance Weight Method (IDW), 164 soil samples were taken. In soil samples, pH, EC, Texture, P, N and $CaCO_3$ values were determined. The obtained results were analyzed using the IDW interpolation method with the help of Geography Information Systems. At the end of the research, spatial distribution maps of some soil properties related to the study area were created [24].

A GIS-based soil database was created to be used in soil planning and monitoring studies. In the study, a part of Büyükçekmece basin within the borders of Istanbul Province was chosen as the application area and 42 soil profile samples were taken from the field. Soil profile information collected from the field, satellite images of the field (Ikonos -1m) and various soil maps produced in the past were transferred to the GIS (Arc GIS) environment. As a result of the geostatistical analysis, various thematic maps of the soil such as pH and EC of the field were produced and a soil database was created that will allow the monitoring of the field [25]. In a land research study carried out in the Dedeli and Çetinkaya Villages of Bafra district of Samsun province

(Turkey) and their close vicinity on an area of approximately 1762,4 hectares, soil survey was carried out and 1/25,000 scaled digital soil maps were produced. Later, a soil database was created using these digital soil maps and analysis reports [26].

5. Conclusion

As seen in the literature, there are many research studies on the determination of soil properties and their spatial evaluation. In this study, some soil and land features of the Thrace region were evaluated by using Geography Information Systems and spatial distribution maps were created for some soil features.

Soil and land resources must be kept in a database and this information must be constantly updated. The spatial distribution maps of some soil properties obtained as a result of the study will make significant contributions to the agricultural activities to be carried out in the Thrace Region. It will be inevitable that databases on soil properties to be obtained in other similar studies will provide significant benefits to agricultural development.

Declaration of Conflict of Interest

The authors declare no conflict of interest.

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