A diagram to illustrate the distribution of slope and aspect of an area

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***Abstract*—The slope and the aspect are an important property of the terrain in the agriculture related geospatial analysis. The distribution of this values in a determined area can be demonstrated by different tools. This paper describes a diagram and its generating method, that can show the slope and aspect in a geomtrically correct layout, which use a polar coordinate system.**

***Index Terms*—digital elevation model, slope, aspect**

I. Introduction

In many cases, the slope and the aspect are a very important property of the terrain. For example, when we look for the ideal place of a vineyard or a orchard, we search areas, which aspect is south or south-east and the slope is also an ideal value, not too steep but neither too plain. The slope and aspect are also very important in the ecological research like [1], [2], [3], [4], [5].

These important properties determine the ideal location together, the representation of the distribution of slope and aspect also show these two properties together. In this paper, the author demonstrates a trivial solutions of this problem, and the problems of this simple methods. After this, I suggest a diagram for this problem.

II. Classical methods

In this section, I demonstate the distribution of the slope and the aspect by some classical methods. The sample area is a vineyard area near Enying, in Fejér county, Hungary. The coordinates of the center of this area are E18°13’53” and N46°55’32”. (See the Figure 1.)

I calculated the slope and aspect data of this area (see the Implementation section) and showed it by some classical tool.

A. Tables

The different slope and aspect surfaces can be counted by category in an area, and the result of this computing can be presented in a table. For example, the data of the sample area are in the Table I. The columns of this table represent the categories by the slope (between 0 and 2.5 degrees, between 2.5 and 5 degree, etc.), and the rows represent the categories by the aspect (between 0 and 22.5 degrees, between 22.5 and 45 degrees, etc.). One field of this table represents the total area of the surfaces, where the slope and the aspect are also in the specified interval.

The last column and the last row contain summas.

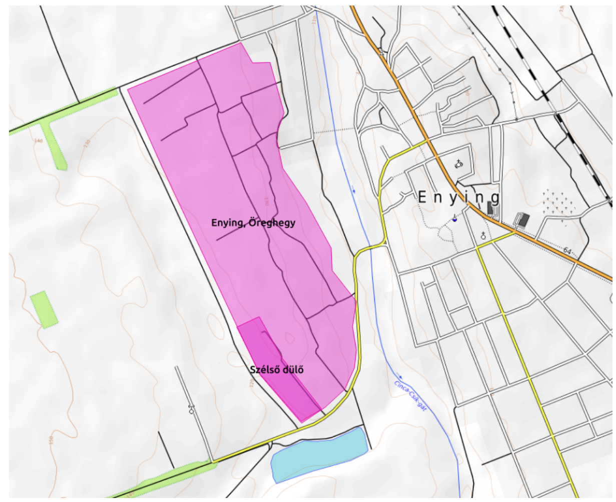

Figure 1. The location of the sample area with the OpenTopoMap data.

Table I
The total areas (hectares) with different slope (horizontal) and aspect (vertical) in the sample area

	0.0°-2.5°	2.5°-5.0°	5.0°-7.5°	7.5°-10.0°	10.0°-12.5°	SUM
0.0°-22.5°	2.45	1.10	0.00	0.00	0.00	3.55
22.5°-45.0°	3.40	2.45	0.15	0.00	0.00	6.00
45.0°-67.5°	4.15	6.95	2.40	0.25	0.05	13.80
67.5°-90.0°	5.20	9.40	3.95	0.65	0.10	19.30
90.0°-112.5°	4.75	6.25	1.75	0.35	0.00	13.10
112.5°-135.0°	3.30	2.35	0.25	0.00	0.00	5.90
135.0°-157.5°	3.10	1.15	0.00	0.00	0.00	4.25
157.5°-180.0°	2.25	0.80	0.00	0.00	0.00	3.05
180.0°-202.5°	2.30	1.90	0.15	0.00	0.00	4.35
202.5°-225.0°	2.15	3.05	1.65	0.25	0.00	7.10
225.0°-247.5°	2.00	3.80	2.15	0.20	0.00	9.00
247.5°-270.0°	1.75	2.55	1.15	0.05	0.00	5.90
270.0°-292.5°	2.05	0.85	0.15	0.00	0.00	3.00
292.5°-315.0°	1.75	0.75	0.00	0.00	0.00	2.50
315.0°-337.5°	2.05	0.60	0.00	0.00	0.00	2.65
337.5°-360.0°	1.60	0.65	0.00	0.00	0.00	2.25
SUM	45.45	44.60	13.75	1.75	0.15	105.70

This table contains many useful data about the terrain of the studied area, but it is not too spectacular. A solution is needed for showing this data in a suitable diagram.

B. Classical diagrams

The classical spreadsheet software (in this case LibreOffice Calc) can be applied to create a diagram from the data series of the Table I. This diagram may be an 3D column diagram,

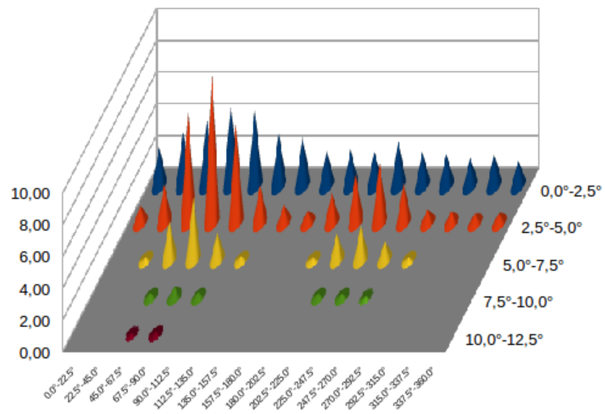

Figure 2. The distribution of the slope and the aspect in a classical diagram. The areas are in hectares. (Created by LibreOffice from the data of the Table I.)

where the X coordinate is the categories of the aspect, the Y coordinate is the categories of the slope and the Z coordinate is the total area of the surfaces. This diagram is in the Figure 2. Using of cones instead of columns are much preferable, because the cones cover smaller area from the elements in the background.

This diagram shows the distribution of the slope and the aspect in the examined area, but there are some problems.

The aspect is an azimuth-like value. The categories of 0°-22.5° and the 337.5°-360° are neighbours, but in the Figure 2. these categories are located in the opposite sides of the diagram. Another problem is that the distance between different aspects are equal in any slope category, but the impact of the difference is higher in larger slope.

III. The proposed diagram

The ideal diagram of the distribution of slope and aspect eliminates the mistakes of the classical diagram (Figure 2.). The places of an element of the diagram have to satisfy two criteria: the places around the north direction (or any other direction) have to be located close to each other, and two places with different aspects have to be located further, where the slope is larger.

The Figure 3. shows my proposal to this diagram.

A. The coordinate system of the diagram

The diagram recommended by the author use a polar coordinate system to perform the described requirements. (See the Figure4.)

The angular coordinate is equal to the aspect. Both of these values are an azimuth-like number, the application in a polar coordinate system is simple.

The distance in this polar coordinate system is proportional to the slope. A function defines the relationship between the slope and the distance in the diagram, for example:

$$d = \frac{w_d s}{2 s_{max}} \tag{1}$$

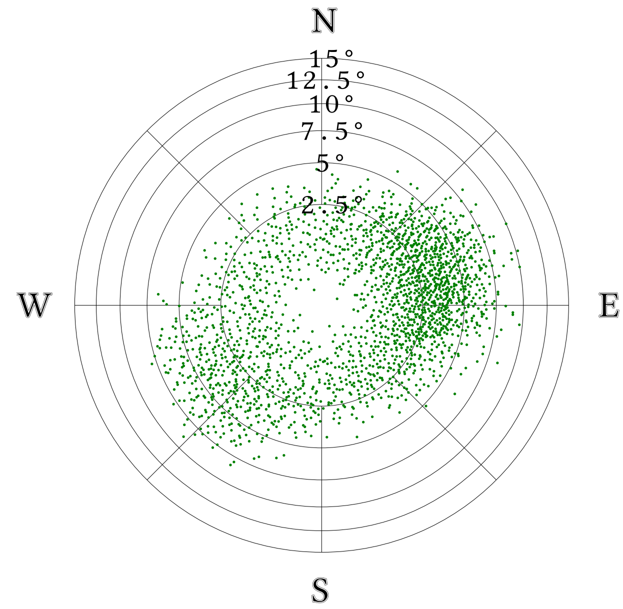

Figure 3. The proposed diagram of the sample area. The slope is proportional to the distance from the centre of the diagram. The aspect is equivalent to the direction from the centre of the diagram. Twenty dots represent one hectar.

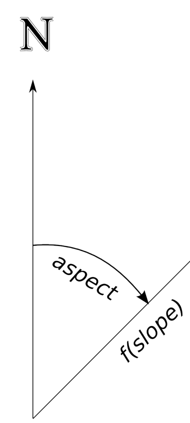

Figure 4. The polar coordinate system of the diagram.

where d is the distance in the diagram, w_d is the width of the diagram, s is the slope, and s_{max} is the maximal slope, which is shown in the diagram. The d and the w_d are in the units of the diagram (millimeters, pixels or other units), the s and s_{max} are in degrees.

Another possible example:

$$d = \frac{w_d}{2} \sqrt{\frac{s}{s_{max}}} \tag{2}$$

B. The distribution of the diferent slope and aspect surfaces of the area

The fields of TableI belong to a sector of the diagram. (The angle and the distance are limited by the values of the intervals

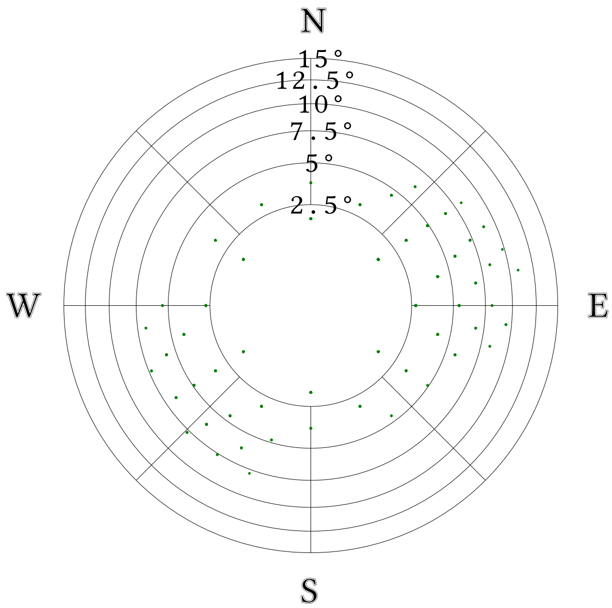

Figure 5. The diagram of the sample area without (quasy-) random modification of the dot's places.

of the table.) This sectors can be colored in proportion to the area, or a dot density representation can be applied.

Each pieces of the suface of the area has a dot in the diagram, the slope and the aspect of this surface element determines the place of the dot in the diagram. If we use the equation (2), the areas of the sectors are equal, and the dot density impression's will be like a coloring with a scale from light to dark.

IV. Implementation

A Python 3 application was written for creating the above described diagram. This program reads the data of areas from a CSV file and the digital elevation model (DEM) data from a one arc second SRTM ([6], [7], [8]) file. The polygons of the areas are descripted by an WKT (well-konwn text) in the CSV file. The program reads the elevation data directly from the 1×1 degree SRTM tiles without any transformation.

The SRTM dataset contains elevations rounded to whole numbers in meter, because of the slope and the aspect will be only quantized values. The places of this values can be viewed in the Figure 5. The points of this diagram are in determined places, and we can not see, how many points are a position.

The program uses a pseudo-random shift in the points to the points of the result will not be in overlapped positions. I use a 2,3 Halton sequence ([9]) for generate a quasy-random point sequence for this step.

The program creates SVG files as output. The dots are circles in this file. The fill of this circles may be transparent, because the overlapped places will be darker in this solution, and the output will be specious. (See in Figure 6.)

The program contains more different slope scales, and choice by the maximal slope value. The legend of the isoslope lines are in the northern part of the diagrams, because the important locations usually are in the southern part.

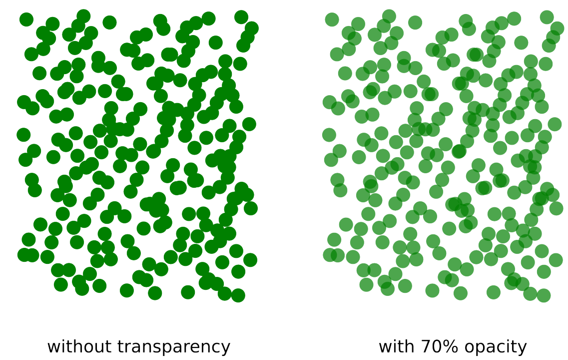

Figure 6. The dots without transparency and with transparent drawing.

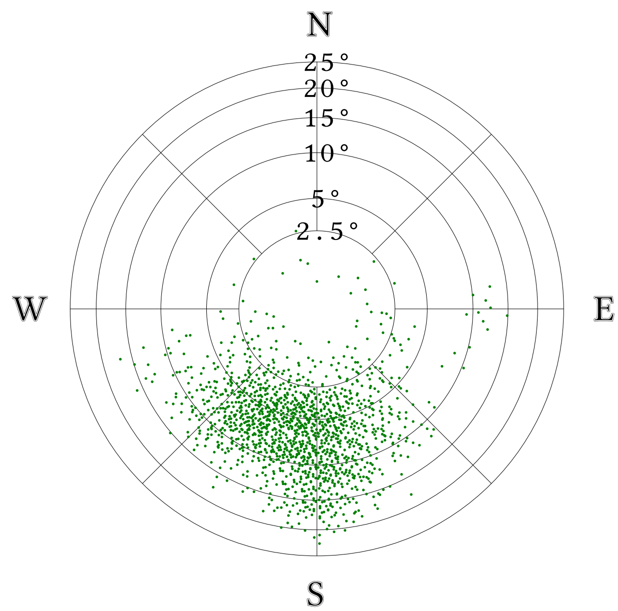

Figure 7. The diagram of an vineyard area Tokaj, Hungary. Twenty dots represent one hectar.

V. Examples

I create some diagram from other areas. The Figure 7. represents a vineyard area from Tokaj, the famous Hungarian wine-grower city.

Another example are in the Figure 8. This is a wine and fruit grower area near in Csór, not too far Székesfehérvár.

VI. Conclusion

The proposed diagram shows the distribution of the slope and the aspect together. This diagram can be used, when we want to demostrate the distribution these properties in an area. This may be useful when we search an ideal place for a vineyard, an orchard or an solar power plant.

The set of ideal slope and aspect can be delimit in the polar coordinate system of the diagram. The viewer can see the ideal distribution and the real distribution together.

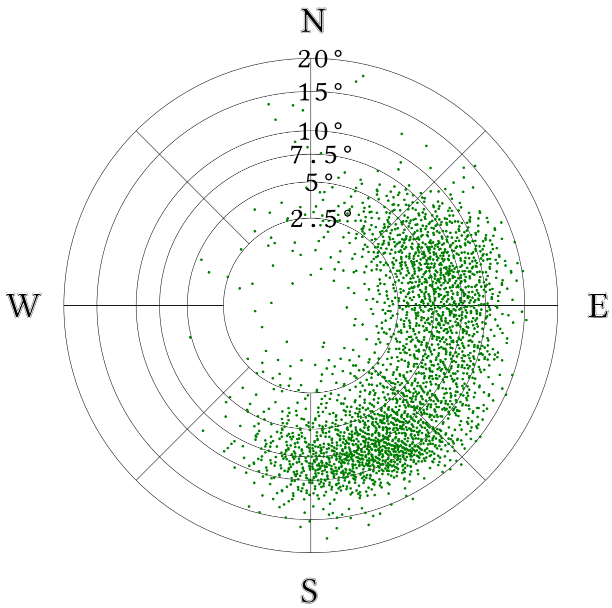

Figure 8. The diagram of an vineyard area in Csór, Hungary. Twenty dots represent one hectar.

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