EXPRESSING NUMERICALLY THE LOCAL TOTAL POLLUTION BY USING GENERAL ENVIRONMENTAL QUALITY GRADE (GEQG)

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Abstract. People are speaking about pollution provoked by different means of human activity and they express every kind of pollution measuring it by different measure units, like: ppm CO_2 for atmospheric air, mg of solid particles/ cubic meter of fresh air, dB of noise into a room etc. As effect on to human organism we are interested and we need to express the local total pollution, composed by all kinds of polluting processes exerted on environmental atmosphere, water, soil and so on, but until now there is not a unique measure unit for it. The paper presents a procedure to express numerically, by one single figure, the local total environmental pollution in a certain livable geographic point or small area, in order that this figure to totally characterize the above-mentioned environmental pollution. The paper proposes using of General Environmental Quality Grade (GEQG), a general numerical indicator of the environmental quality of a certain geographical place, area or zone.
Keywords: environmental protection.

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Cuvinte cheie: environmental protection.

1. THE PAPER GOAL

The environmental pollution is numerically and analytically expressed by the measurement results for certain pollution processes as: ppm CO_2 for atmospheric air, mg of solid particles/ cubic meter of fresh air, dB of noise into a room or outside etc. All of them are partial effects onto human organism, they are very important to be known, but the human organism supports in the same time all the pollution effects and we are interested to express the local total pollution exerted onto a person living in a certain area.

Using other words, when a person is preparing to buy a house somewhere, or to live or to work in a certain zone, he is very interested what the local total pollution there is there, or what is the environmental quality of the place or area about. What we are trying to do here is to propose a procedure to express numerically, by one single figure, the local total environmental pollution in a certain livable geographical point or small area, in order that these figure to totally characterize the above-mentioned environmental pollution or its environmental quality. We considered that the best way to do this is to propose and to use the General Environmental Quality Grade (GEQG) of the place about.

2. THE CONSIDERED POLLUTION EFFECTS

The procedure has in view the pollution effects presented widespread, with the definitions that could be found in [1]. For every individual pollutant we propose a seven step scale, marked numerically and visually this way: 10 – Excellent – Dark green; 9 – Good – Green; 8 – Slightly polluted – Light green; 7 – Lightly polluted – Yellow; 6 – Moderately polluted – Orange; 5 – Heavily polluted – Red; 4 – Severely polluted – Brown.

Each pollutant has specific values for each step of the individual scale as in the tab.1. All individual pollutants are part of a pollution group, which has a group scale.

The general list of the pollution group scales comprises:

2.1. Air pollution group scale with n_1 individual scales.

2.2. Water pollution group scale with n_2 individual scales.

2.3. Land pollution group scale with n_3 individual scales.

2.4. Noise pollution group scale with n_4 individual scales.

2.5. Visual pollution group scale with n_5 individual scales.

2.6. Radioactive contamination group scale with n_6 individual scales.

2.7. Radio spectrum pollution group scale with n_7 individual scales.

2.8. Photo pollution group scale with n_8 individual scales.

The problem of expressing numerically the local total pollution is not at all simple, because:

• The results of different measured pollution effects are expressed in different measure units, like ppm, mg/cubic meter, dB, and they could not be mathematically added.

• The pollution effects are not mathematically vectors, they have size, but they don't have direction. As result, they could not be composed as vectors. The pollution effects are scalars, but they could not be added mathematically, because they are of different nature, as it is shown at section 1.

3. WHAT IS DONE UP TO NOW, WHAT WE PROPOSE

That's why up to now only for air quality an pollution index was imagined in different forms, in Romania and abroad [1]. This index shows quantitatively and qualitatively how much the air is polluted. By using the experience accumulated this way and seeing that the pollution has much more effects than that of the air, the authors decided to propose something closer to the aim of the environmental protection, that is a figure expressing not the pollution, but the quality of the environment that all of us we are using.

The result was a seven step scale, marked numerically like that of school grading, in order to use a familiar approach. The best step (excellent) is marked 10, the worst one (severely polluted) is marked 4. In order to have a quick visual information each step has a color, starting with dark green for the best environmental quality (marked ten) and finishing with brown for the worst one (marked four). In the table 1 can be seen the proposed scales for some individual pollution effects.

4. HOW TO USE THE PROPOSED SCALES

4.1. In order to use all the proposed group scales we need the results of all the pollution measurements carried out for the studied place.

4.2. Each measurement result must be inserted into the proper cell of the individual scale and this way that result will receive an operational mark. The minimum individual value mark of each group will determine the respective group mark

4.3. Doing so for all the carried out measurements and having all the attributed marks, the calculus program can establish and show:

4.3.1. The complete list of the all carried out measurements.

4.3.2. The complete list of the all attributed individual marks for each pollution effect (such as those of table 1).

4.3.3. The values n_1, n_2, n_3, n_4, n_5, n_6, n_7 and n_8 (according to section 2).

4.3.4. The complete list of the all attributed group marks for each pollution group scale (section 2)

4.3.5. The graphical representation of the entire attributed group marks (section 4.3.4).

4.3.6. The minimum group environmental quality grade for the considered place. The authors consider that the general environmental quality grade GEQG for a certain place is given by the minimum individual EQG of that place, set up into a group EQG.

4.3.7. The average environmental quality grade AEQG of the considered place, calculated as mathematical mean of the all individual EQG used for that place. This value is necessary when two places with close values of general environmental quality grade GEQG are compared. For a certain place, the GEQG is given by the minimum value of the group EQG, but it is important also what the average value of the group AEQG is. The total number of the individual scales is $n = n_1 + n_2 + n_3 + n_4 + n_5 + n_6 + +n_7 + n_8$. The figure n is that utilized when calculating the AEQG.

Table 1

The Individual Environmental Quality Grade (IEQG) for some pollutants

Environmental Quality Grade for Air Quality

Colour	Grade	Name	SO_2 µg/mc	N_2O µg/mc	O_3 µg/mc	CO µg/mc	MP µg/mc
Dark green	10	Excellent	0…49,9	0…49,9	0…39,9	0…1,9	0…14,9
Green	9	Good	50…74,9	50…99,9	40…79,9	2…3,9	15…24,9
Light green	8	Slightly Polluted	75…99,9	100…139,9	80…119,9	4…4,9	25…39,9
Yellow	7	Lightly Polluted	100…149,9	140…199,9	120…149,9	5…6,9	40…49,9
Orange	6	Moderately Polluted	150…349,9	200…299,9	150…179,9	7…9,9	50…79,9
Red	5	Heavily Polluted	350…499,9	300…399,9	180…239,9	10…14,9	80…99,9
Brown	4	Severely Polluted	500 and more	400 and more	240 and more	15 and more	100 and more

Environmental Quality Grade for Soil Radioactivity and Noise Pollution

Colour	Grade	Name	^{40}K [Bq]	^{226}Ra [Bq]	^{238}U [Bq]	^{232}Th [Bq]	dB/1000 Hz
Dark green	10	Excellent	100...199,9	10...14,9	10...14,9	7...12,9	30
Green	9	Good	200...299,9	15...19,9	15...19,9	13...19,9	40
Light green	8	Slightly Polluted	300.399,90	20...24,9	20...24,9	20...24,9	50
Yellow	7	Lightly Polluted	400...499,9	25...29,9	25...29,9	25...29,9	60
Orange	6	Moderately Polluted	500...599,9	30...39,9	30...39,9	30...39,9	70
Red	5	Heavily Polluted	600...699,9	40...49,9	40...49,9	40...49,9	80
Brown	4	Severely Polluted	700 and more	50 and more	50 and more	50 and more	100

5. WHAT DATA THE COMPUTER IS REQUIRING

To use the computer program the authors consider that the following data are necessary:

5.1. The place name, characterized by geographical and national administrative data, including geographical map data and a short description of using purpose.

5.2. The measurement results for all the pollution effects for which the user is interested.

6. WHAT DATA THE COMPUTER IS DELIVERING

6.1. The place name, characterized by geographical and national administrative data, including geographical map data and a short description of using purpose, as was given at section 5.1 by user.

6.2. The complete list of the all carried out measurements (according to section 4.3.1).

6.3. The individual numerical and graphical marks (section 4.3.3)

6.4. The pollution group numerical and graphical marks

6.5. The numerical and graphical general environmental quality grade GEQG of the considered place (section 4.3.4)

6.6. The average environmental quality grade AEQG of the considered place (section 4.3.5)

As final result the user has one single figure GEQG that characterizes the environmental quality of the interested place, calculated as result of all the pollution effects measurements. This figure can be used as decisional value when a compared cost to quality analysis is carried out.

Please fill into the yellow fields the pollution group numerical marks

	The general list of the pollution group	Group Marks
1	Air pollution group scale	
2	Water pollution group scale	
3	Land pollution group scale	
4	Noise pollution group scale	
5	Visual pollution group scale	
6	Radioactive contamination group scale	
7	Radio spectrum pollution group scale	
8	Photo pollution group scale	

7. SOME APPLICATIONS OF THE PROPOSED PROCEDURE

7.1. The Case Aa (Place A, user a)

7.1.1. Geographical position A, near to a radioactive source.

7.1.2. The user is interested to know all the possible pollution effects.

7.1.3. By using the pollution measurement results the following group marks were obtained by computer:

– Air pollution group scale – mark 8;
– Water pollution group scale – mark 9;
– Land pollution group scale – mark 7;
– Noise pollution group scale – mark 8
– Visual pollution group scale – mark 7;
– Radioactive contamination group scale – mark 6;
– Radio spectrum pollution group scale – mark 7;
– Photo pollution group scale – mark 8.

7.1.4. As result, the general environmental quality grade GEQG of the place A user a is 6 (moderately polluted), because of the radioactive contamination measured there.

7.1.5. The average environmental quality grade AEQG of the place A user a is 7,50 (slightly polluted).

7.2. The Case Bd (Place B, user d)

7.2.1. Geographical position B, a common rural place.

7.2.2. The user is interested to know all the possible pollution effects.

7.2.3. By using the pollution measurement results the following group marks were obtained by computer:

– Air pollution group scale – mark 9;
– Water pollution group scale – mark 9;
– Land pollution group scale – mark 7;
– Noise pollution group scale – mark 9
– Visual pollution group scale – mark 10;
– Radioactive contamination group scale – mark 9;
– Radio spectrum pollution group scale – mark 9;
– Photo pollution group scale – mark 10.

7.2.4. As result, the general environmental quality grade GEQG of the place B user d is 7, because of the land pollution measured there.

7.2.5. The average environmental quality grade AEQG of the place B user d is 9,0 (good to excellent)

7.2. The Case Ab (Place A, user b)

7.2.1. Geographical position A – the same as 7.1.1.

7.2.2. The user is not interested to know noise pollution mark because he is deaf.

7.2.3. As result, the general environmental quality grade GEQG of the place A user b is 6 (moderately polluted), because of the radioactive contamination measured there. It is the same of that of the user a.

7.2.4. The average environmental quality grade AEQG of the place A user b is 7,43 (slightly polluted).

7.3. The Case Ac (Place A, user c)

7.3.1. Geographical position A – the same as 7.1.1.

7.3.2. The user is not interested to know visual pollution mark because he is blind.

7.3.3. As result, the general environmental quality grade GEQG of the place A user c is 6 (moderately polluted), because of the radioactive contamination measured there. It is the same of that of the user a.

7.3.4. The average environmental quality grade AEQG of the place A user b is 7,57 (slightly polluted).

7.4. The Case Bd (Place B, user d)

7.4.1. Geographical position B, a common rural place.

7.4.2. The user is interested to know all the possible pollution effects.

7.4.3. By using the pollution measurement results the following group marks were obtained by computer:

– Air pollution group scale – mark 9;
– Water pollution group scale – mark 9;
– Land pollution group scale – mark 7;
– Noise pollution group scale – mark 9
– Visual pollution group scale – mark 10;
– Radioactive contamination group scale – mark 9;
– Radio spectrum pollution group scale – mark 9;
– Photo pollution group scale – mark 10.

7.4.4. As result, the general environmental quality grade GEQG of the place B user d is 7, because of the land pollution measured there.

7.4.5. The average environmental quality grade AEQG of the place B user d is 9,0 (good to excellent)

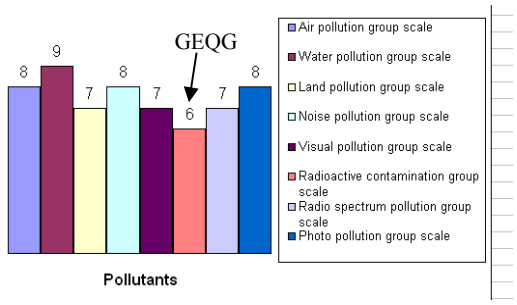

Fig. 1. The pollution group numerical and graphical marks for case Aa.

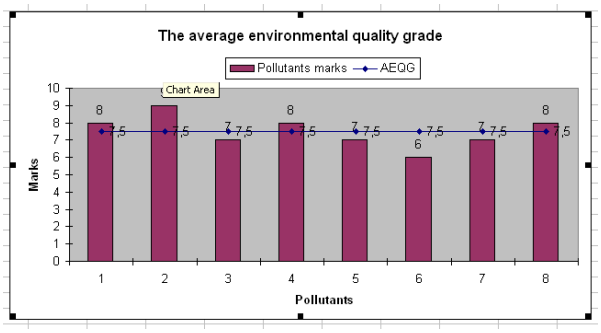

Fig. 2. The average environmental quality grade AEQG for case Aa.

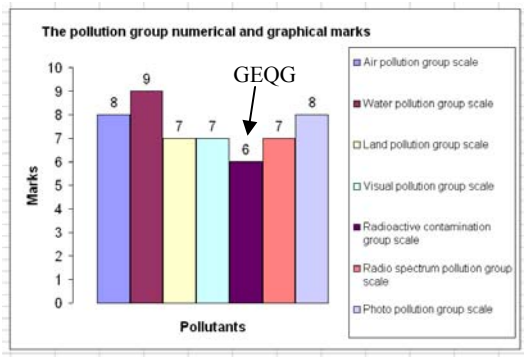

Fig. 3 - The pollution group numerical and graphical marks for case Ab

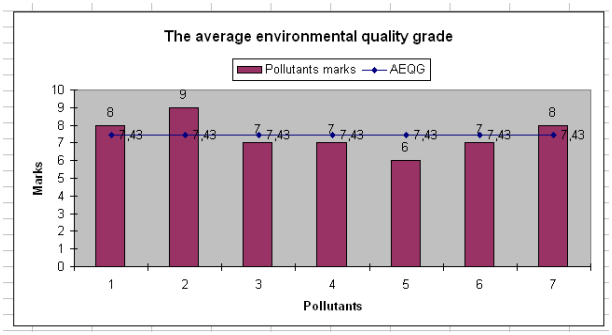

Fig. 4 - The average environmental quality grade AEQG for case Ab

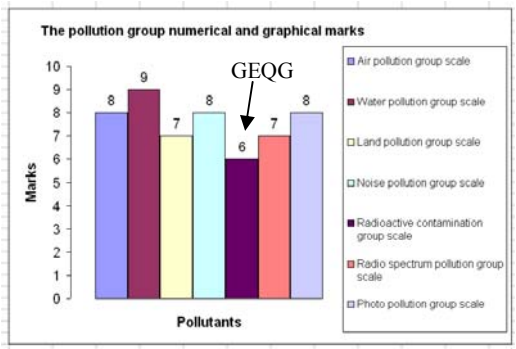

Fig. 5 - The pollution group numerical and graphical marks for case Ac

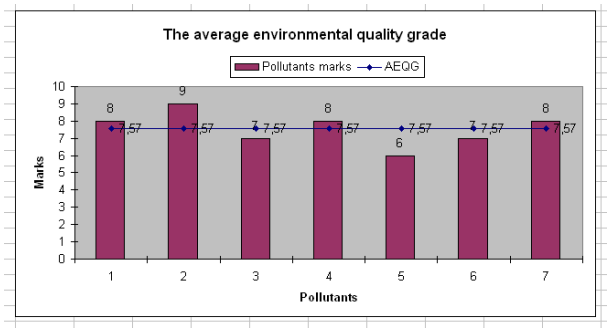

Fig. 6 - The average environmental quality grade AEQG for case Ac

7.5. The Case Ce (Place C, user e)

7.5.1. Geographical position C, somewhere at mountains, far away from radioactive sources.

7.5.2. The user is interested to know all the possible pollution effects.

7.5.3. By using the pollution measurement results the following group marks were obtained by computer:

– Air pollution group scale – mark 10;
– Water pollution group scale – mark 10;
– Land pollution group scale – mark 8;
– Noise pollution group scale – mark 9
– Visual pollution group scale – mark 9;
– Radioactive contamination group scale – mark 9;
– Radio spectrum pollution group scale – mark 8;
– Photo pollution group scale – mark 8.

7.5.4. As result, the general environmental quality grade GEQG of the place B user d is 8 (slightly polluted), because of the land pollution, radio spectrum pollution and photo pollution measured there.

7.5.5. The average environmental quality grade AEQG of the place C user e is 8,75 (good to slightly polluted)

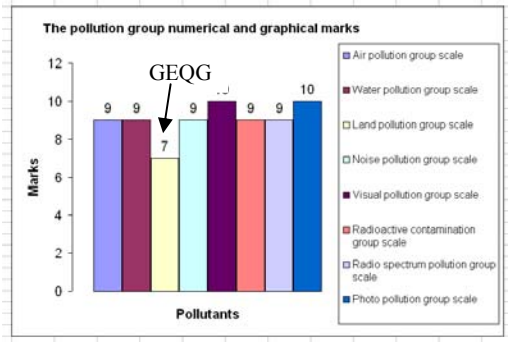

Fig. 7. The pollution group numerical and graphical marks for case Bd

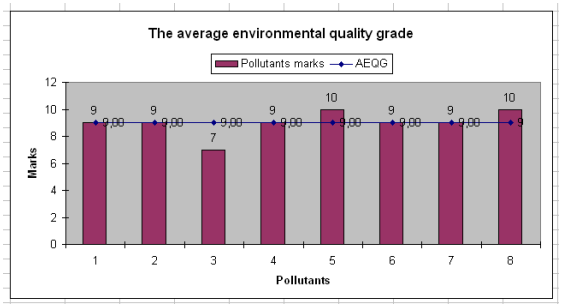

Fig. 8. The average environmental quality grade AEQG for case Bd

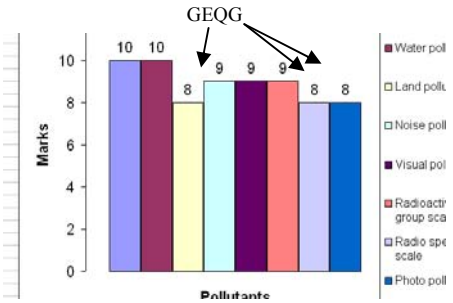

Fig. 9. The pollution group numerical and graphical marks for case Ce

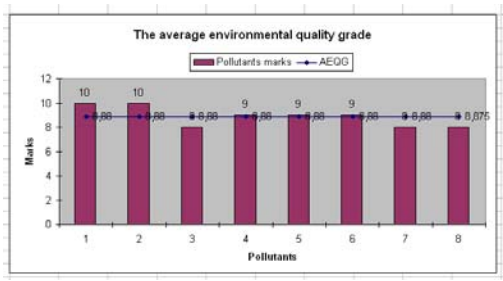

Fig. 10. The average environmental quality grade AEQG for case Ce

8. CONCLUSIONS

• The proposed procedure gives the possibility to express directly, by one single figure, the overall quality of the environment in the place we are interested.

• When expressing numerically the environmental quality grade we can quantify better than we use only the color scale. For instance, all the 3 cases Aa, Ab and Ac have the same Light green box (slightly polluted), while their AQEG are different (7,50 for Aa, 7,43 for Ab and 7,57 for Ac).

• Graphical representation allows us to see at a glance the GEQG and the general contribution of every group mark to the value of AEQG.

• The value GQEG expresses the most severe pollution of the considered place, but to know more about other pollution effects, we have to consult the graphical representation and the value AQEG. For instance, in the case Bd the value of GEQG is 7,00 (lightly polluted), while the overall situation shows that AQEG is 9,00 (good).The situation is much different for the case Ce, where both GQEG and AQEG are situated in the same light green box, that is 8,00 for GEQG and 8,75 for AQEG.

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