Light pollution risk rating based on linear dynamic discrete model

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Abstract. Nowadays, with the development of modern society, it has been more and more difficult for us to see the stars at night[1]. What shaded them? The answer is the "evil light"--light pollution. According to the study, light pollution not only harms people's physical health but also their mental health. To solve this problem[2], a model was created to classify and mark the level of light pollution in any place in the world. Its essence is a deterministic dynamic linear discrete model. This paper first studied different kinds of formula related to the treatment on soil and water. Then this paper compared the characteristics of the light pollution with them and found the differences and similarities which can improve our formula. Finally, to get a obtain a widely applicable index system, a linear weight formula was created, which is for light pollution only. Besides, created the optical intrusion formula and the average glare intensity formula. After comparing with the linear weight formula, the paper choosen the linear weight formula for its flexibility and wide use. Secondly, to make the model more accuracy, the paper selected factors that have strong impact on the light pollution. There are too many factors that can influence the light pollution, though some of them only take a little part in. The paper used the Topsis and factor analysis to find out the factors and their weights. Then this paper developed a scoring system based on the data provided by government. Finally, after searching the data for 57 protected areas, 67 rural communities, 64 suburban communities and 76 urban communities and applying them to the model and calculating, we got the final degree for each samples. And the average marks for each kind of place are0.83,0.69,0.51and0.18(preserve two decimal places). The results are very close to the reality and we used the optical imaging to help you better understand them.

Keywords: Light pollution, linear dynamic discrete model.

1. Introduction

In the world, light pollution is generally divided into three categories, white light pollution, artificial light pollution and color light pollution[3].

White light pollution refers to when the sun shines strongly, the decoration of the buildings in the city reflects the light, which makes the buildings bright and dazzling. Artificial light pollution refers to the dazzling display of advertising lights and neon lights on shopping malls and hotels after nightfall. In the "sleepless city", it is difficult for people to fall asleep at night, which disturbs the body's normal biological clock and leads to low work efficiency during the day. Artificial daylight can also harm birds and insects. Color light pollution refers to some places similar to night clubs, bars and other places with a variety of color light sources. In general, the ultraviolet rays produced by the light in such places are many times stronger than those from the sun. Prolonged exposure to such light can cause dizziness and even illness.

To solve this problem, different countries have introduced relevant regulations[4]. Especially an organization called CIE(*Commission International de l´Eclairage)*has made very strict regulations. In addition to CIE, Australia limits glare from lamps by means of threshold increment. Other countries have adopted legislation, policies and other means to prevent and control light pollution. Light pollution is caused by many reasons, and the degree of light pollution is different in different areas. At the same time, legislators need to consider the effect of policies on other aspects. Such as security, economy, etc. Therefore, the assessment of the risk level of light pollution and the choice of strategies have been puzzling the whole world.

2. Light Pollution Risk Rating Model

2.1. Calculation formula of light pollution risk level

To develop a model for rating light pollution risk levels, we first need a scoring system. Looking up information on the Internet, we learned the single pollution index method. The single pollution index method is to analyze and evaluate the single index item by item through the evaluation criteria. Through index calculation, the largest category of ea×ch factor is selected as the overall evaluation result of the sample. The formula is as follows:

$$P_i = \frac{C_i}{S_i} \tag{1}$$

Pi is the relative pollution value of the factor i; Ci is the measured concentration value of factor i; Si is the evaluation standard value of the ith factor.

However, when we select the corresponding value for calculation, we find that the corresponding concept of this method is very vague. Light pollution can be generalized in many vague terms, but to do so defeats our purpose. In fact, this method is more useful in studying seawater or soil pollution, because there is no need to examine where the pollution comes from. So, we made an improvement and got the linear weight formula as follows:

$$\text{LPI} = L_i \times W_i \tag{2}$$

LPi refers to light pollution risk level at position I.Li refers to Artificial light intensity at factor i and its unit is lx(lux). Wi refers to The weight factor of factor i.

In this formula, we can clearly see what determines the level of light pollution in an area. But the Wi still has problems.

Besides,we have other ways to calculate the light pollution. That's the optical intrusion formula. The formula is as follows:

$$LI_{weighted} = \sum_{i=1}^{n} LI_i * \omega_i \tag{3}$$

LIi refers to optical intrusion value at position i.ωi refers to the weight of i.n is the number of corresponding sampling point.

Moreover, the average glare intensity formula can also help calculate the light pollution. The formula is as follows:

$$PI = \frac{1}{n}\sum_{j=1}^{n} L_j \tag{4}$$

PI refers to the average of glare. Lj refers to the glare intensity at position j.n refers to the number of samples.

However, after our further study of these three formulas, we found out that the optical intrusion formula and the average glare intensity formula can not be widely used. That's because their standard for data is too high and most countries won't make survey on them.

Therefore, we finally decide to use the linear weight formula.

Now our problem is how to identify the Wi。

2.2. Further differentiation of Wi

We have got the formula above to help us calculate the risk level of light pollution. However, we are still not satisfied with the definition of Wi. So we made a further study on it and got the formula as follows:

$$W_i = (Wih + Winh) \times Wp \times Wc \tag{5}$$

The notations in the formula are already covered in the Notation section. However, in order to make the model more broadly applicable to different regions, we have elaborated it more precisely.

Wih is a weighting factor of human concern, which considers the negative effects of light pollution on human health and safety. It is marked between 0 and 1.

Winh is a weighting factor for non-human concerns, which considers the negative effects of light pollution on wildlife, ecosystems and the night sky. It is marked between 0 and 1 either.

Wp is a weighting factor for population density, which takes into account the number of people living in a given area, measured on a scale of 0 to 1. A higher Wp indicates a higher priority for reducing light pollution in populated areas.

Wc is a weighting factor for community types that takes into account the different impacts and needs of urban, suburban and rural communities, measured on a scale of 0 to 1. A higher Wc indicates a higher priority for light pollution mitigation in urban areas.

The specific values of li, Wih, Winh, Wp and Wc can be determined through surveys, measurements and expert opinions by stakeholders and local communities. The resulting light pollution risk levels can be used to guide intervention strategies and prioritize mitigation measures for more sustainable and healthy use of artificial light in different locations.

In this paper, the specific weight factor contains items as below:

Wih: Curtain wall material, area spacing, light color, road network planning intensity and direction of ground lighting types, distance of street lamps from residential exterior walls, industrial pattern, length of light poles, building form, proportion of on-beam light, light source flicker, illuminance, illumination time, glare level, light intrusion, street lamp height, location height and density of buildings and roads, GDP and average life[6].

Winh: Terrain, light pole length, upper light ratio, light source scintillation, illumination, illumination time, glare level, light intrusion, zenith brightness, biological species[7][8].

Wp and Wc are decided by the locations. So it's hard and unnecessary to measure it through special items. We could use a photo to conclude it(Figure 1):

Figure 1. Further differentiation of Wi

2.3. The weight of different influencing factors&calculation

Once we know what formula the model uses, we can put the target into the model. But before we do that, we need to categorize the contributing factors. For different regions, its influence factors are also different. At the same time, the weight of influencing factors is also different. The accuracy of the calculation of the proportion of each factor plays a decisive role in the success of the model.

As a result, we spent a lot of time looking for relevant papers and data. It has to be said that although light pollution has seriously affected human physical health, there is still little authoritative research on the subject. To reduce the workload, we've divided the world into four types of places. They are: protected land, rural community, suburban community and urban community. Then, the factors that can influence the levels of local light pollution risk in these four categories are further analyzed and calculated. After using the entropy weight method to calculate, we got the following results separately.

Urban Community			
Items	e	d	Weight(%)
Number of layers	0.971	0.029	7.004
orientation	0.975	0.025	6.074
Lighting period	0.978	0.022	5.375
The distance of the street light from the exterior wall of the house	0.977	0.023	5.595
The lighting style of garden street lamp	0.983	0.017	3.967
Distance of garden street lamp from exterior wall (window) of residence	0.977	0.023	5.406
The height of the garden lights	0.974	0.026	6.143
The color of neon lights	0.98	0.02	4.875
The brightness of the landscape lights	0.967	0.033	7.881
Lighting duration	0.976	0.024	5.801
The height of the light pole	0.98	0.02	4.674
Neon brightness	0.986	0.014	3.241
The light color of landscape lights	0.972	0.028	6.704
Light pole length	0.965	0.035	8.377
Brightness of billboard	0.976	0.024	5.682
Height of street lamp	0.975	0.025	5.89
The light color of the billboard	0.969	0.031	7.313

Figure 2. Factors of Urban Community

For urban community, the main influencing factors are the number of layers, orientation, lighting period and so on. The most influencing factor is light pole, whose weight is 8.377%(Figure 2).

For rural community, the main influencing factors are the number of layers, height of building, road density of street lamp, height of street lamp and so on. The most influencing factor is the light color, which weighs 10.371%. For the protected land, the main factors are the light color, illumination, optical intrusion, zenith brightness and so on. Among them, the most influencing factor is the optical intrusion, which weighs for 16.922%. For rural community, the most influencing factors are the construction period, greenhouse lighting intensity, building curtain wall material. floor lighting type and so on. The most influencing factor is the floor lighting type, which weighs for 13.62%.(Figure 3)

Rural Community

Items	e	d	Weight(%)
Construction period	0.968	0.032	11.295
Greenhouse lighting intensity	0.971	0.029	10.116
Luminaire specification	0.985	0.015	5.137
The distance of the street light from the exterior wall of the house	0.973	0.027	9.411
Building curtain wall material	0.973	0.027	9.424
Floor lighting type	0.961	0.039	13.62
Light intensity of industrial site	0.977	0.023	8.199
Billboard light color	0.975	0.025	8.729
Building location height and density	0.984	0.016	5.522
Duration of construction	0.982	0.018	6.347
Billboard light intensity	0.965	0.035	12.2

Figure 3. Factors of Rural Community

Given the weight of the various factors, we still lack a hierarchy. To solve this problem, we need to set scores for the factors. It's hard to set a standard for all factors. We searched for lots of papers, magazines, the government reports and so on. Finally, according to the characteristics of them, we got a proper standard for different factors mentioned.

For the determination of these numerical criteria, we adopt the numerical correlation model. We got the numerical value of details of the factors. For example, the Zenith brightness, as shown in the figure 4 below, can be divided into nine degrees from 0.1-0.9. The Architectural form can be divided into light, middle and high which scores 0.4,0.7 and 1 separately. The brightness is divided into five categories,50-100 is marked 0.2,100-150 is marked 0.4,150-200 is marked 0.6,200-250 is marked 0.8 and 250-300 is marked 1.

There are many more detailed scoring criteria, but space does not allow for examples.

2.4. The process of the Model

Now that the formula and scoring criteria are in place, we just need to input the target to get its light pollution risk level. But there is still a process involved.

For the target that we put in, it could be urban, rural and so on. In short, it must be somewhere on Earth. In order to be more accurate in positioning, it will enter a judgment stage in the first step, which will be judged as one of urban, rural, suburban, protected area and undeveloped area. Then, the relevant factors within the target area of input are scored. According to the table above it will get the score of each factor. Finally, the score is obtained according to the weight of each factor.

It is shown in Table 1.

Table 1. Numerical Criteria of Brightness

Brightness (Lx)	Degree
50~100	0.2
100~150	0.4
150~200	0.6
200~250	0.8
250~300	1

3. Results

3.1. The establishment of simulation model

The large data prediction model for the user's electricity consumption is implemented in the Clementine software (Figure 5).

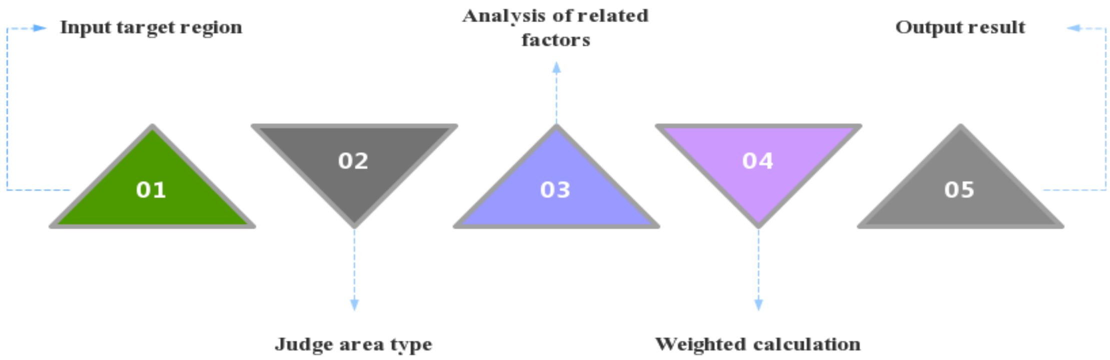

Figure 5. Process of Light Pollution Risk Rating Model

3.2. Analysis of experimental results

According to the question, we need to score four categories of places. They are protected land, rural community, suburban community and urban community[9].

These places have their own characteristics and complex regional situations[10]. It would be very difficult to continue using the old method. However, now we have the Light Pollution Risk Rating Model.

Next, we selected 57 protected areas, 67 rural communities, 64 suburban communities and 76 urban communities. The samples were from around the world and were widely representative. We got the data we wanted from reports issued by the local government and the power supply bureau. These data are from the last five years, and we choose the average to calculate.

We collated the data and obtained average scores for the four major regions.(Figure 6 and Table 1)

content	Positive factor(D+)	Negative factor(D-)	Composite score	Rank	content	Positive factor(D+)	Negative factor(D-)	Composite score	Rank	content	Positive factor(D+)	Negative factor(D-	Composite score	Rank	content	Positive factor(D+)	Negative factor(D-)	Composite scor	Rank
protected land1	0.019198412	0.086349867	0.818107765	50	suburban community1	0.052347839	0.052177946	0.499187315	169	suburban community58	0.051177089	0.053176131	0.509578247	156	urban community5	0.087956796	0.017495961	0.16591279	247
protected land2	0.017926681	0.087142651	0.829382361	32	suburban community2	0.050226728	0.053963618	0.517932995	142	suburban community59	0.051416344	0.053691355	0.510822286	153	urban community5	0.089231523	0.016624213	0.157045934	261
protected land3	0.018050469	0.087092355	0.828324289	35	suburban community3	0.052332123	0.051706651	0.49699404	173	suburban community60	0.053940474	0.049675201	0.479417816	187	urban community5	0.085016356	0.019943445	0.190010314	200
protected land4	0.018091691	0.087503335	0.828669099	34	suburban community4	0.048970566	0.055371832	0.530674327	132	suburban community61	0.051399247	0.05300753	0.507702007	158	urban community5	0.087543888	0.016739276	0.160517534	257
protected land5	0.019239892	0.085711726	0.816678459	51	suburban community5	0.04883689	0.055285337	0.530965756	131	suburban community62	0.051004734	0.053108187	0.510101785	155	urban community5	0.085483328	0.019904574	0.188869625	206
protected land6	0.018947051	0.086123372	0.819672841	48	suburban community6	0.049478195	0.054588125	0.524551314	134	suburban community63	0.052407904	0.051967708	0.497891286	171	urban community5	0.087924238	0.016822844	0.16060442	256
protected land7	0.016733407	0.088424841	0.840874042	12	suburban community7	0.052970751	0.051147381	0.491243747	182	suburban community64	0.048208107	0.056272281	0.538591808	127	urban community5	0.084955318	0.019859622	0.189473196	203
protected land8	0.017638635	0.088002886	0.833033125	26	suburban community8	0.050036063	0.053703146	0.517674526	143	urban community1	0.087804166	0.017316899	0.164732912	250	urban community5	0.087956796	0.017495961	0.16591279	247
protected land9	0.018574261	0.087060137	0.824164656	42	suburban community9	0.049919834	0.054689278	0.522796504	136	urban community2	0.089221524	0.016428932	0.155502704	264	urban community5	0.089231523	0.016624213	0.157045934	261
protected land10	0.016838242	0.08833617	0.839901725	14	suburban community10	0.051252719	0.052872241	0.507776819	157	urban community3	0.086512492	0.018266305	0.174332071	234	urban community5	0.085016356	0.019943445	0.190010314	200
protected land11	0.018585454	0.086378475	0.822934848	43	suburban community11	0.050516419	0.05382361	0.515848142	144	urban community4	0.088884579	0.01690397	0.159790171	258	urban community5	0.087543888	0.016739276	0.160517534	257
protected land12	0.018277299	0.086609162	0.825742054	41	suburban community12	0.053427415	0.051060421	0.488673349	184	urban community5	0.087369016	0.018606831	0.175576147	231	urban community5	0.085483328	0.019904574	0.188869625	206
protected land13	0.019593612	0.086068232	0.81456303	54	suburban community13	0.050145342	0.054672773	0.521596608	137	urban community6	0.082263924	0.022518622	0.214908142	189	urban community5	0.087924238	0.016822844	0.16060442	256
protected land14	0.015900868	0.089163262	0.848655599	4	suburban community14	0.048631457	0.055656136	0.533679365	129	urban community7	0.085680013	0.019053485	0.181923503	217	urban community5	0.084955318	0.019859622	0.189473196	203
protected land15	0.019382877	0.086066587	0.816187997	52	suburban community15	0.047372632	0.056858504	0.545504022	125	urban community8	0.087454479	0.018878385	0.177540458	226	urban community5	0.086620127	0.018885233	0.178997853	222
protected land16	0.018159735	0.087481714	0.828100284	36	suburban community16	0.053083353	0.051524539	0.49254925	180	urban community9	0.088261249	0.016371115	0.156463204	263	urban community5	0.087743854	0.016856907	0.161154728	254
protected land17	0.016787691	0.088943176	0.841222424	11	suburban community17	0.051063327	0.053188301	0.510191562	154	urban community10	0.087298404	0.018238706	0.172817937	238	urban community6	0.08747652	0.017417432	0.166048012	246
protected land18	0.017239994	0.088479044	0.836926307	17	suburban community18	0.052075421	0.052991276	0.504358445	161	urban community11	0.086567627	0.02005665	0.188105845	207	urban community6	0.086595055	0.018043298	0.172434845	239
protected land19	0.016816704	0.088345603	0.840088104	13	suburban community19	0.048601869	0.055811713	0.534525414	128	urban community12	0.088127836	0.016511788	0.157796705	260	urban community6	0.087301507	0.018640193	0.175947647	230
protected land20	0.01791823	0.088169785	0.831100338	29	suburban community20	0.048808061	0.055605869	0.53255221	130	urban community13	0.086519882	0.019039285	0.180366	220	urban community6	0.083159251	0.021673664	0.20674484	192
protected land21	0.017814515	0.087391798	0.830670667	30	suburban community21	0.053488314	0.051043656	0.488306649	185	urban community14	0.085249758	0.01970074	0.187714588	208	urban community6	0.087197185	0.017802646	0.169549281	244
protected land22	0.017386659	0.088076274	0.835139627	21	suburban community22	0.051830581	0.052309542	0.5022996	165	urban community15	0.083269842	0.022201315	0.210496552	190	urban community6	0.087391233	0.017993867	0.170743942	242
protected land23	0.016165544	0.08999009	0.847718452	5	suburban community23	0.052577974	0.051935688	0.496927262	174	urban community16	0.086049165	0.018602699	0.177757934	225	urban community6	0.084992385	0.019846014	0.189301002	204
protected land24	0.015382085	0.091482661	0.856060245	3	suburban community24	0.049935459	0.054216498	0.520551888	138	urban community17	0.086853557	0.01864755	0.176752176	227	urban community6	0.08639317	0.019627647	0.185130127	213
protected land25	0.017191606	0.08764246	0.836011263	18	suburban community25	0.047609207	0.056757874	0.543829278	126	urban community18	0.085435506	0.019314739	0.184388487	214	urban community6	0.086900112	0.018156276	0.172824101	237
protected land26	0.018001801	0.08664056	0.827968319	37	suburban community26	0.050343738	0.054158277	0.518251027	141	urban community19	0.085347401	0.019722048	0.187704876	209	rural community1	0.031853234	0.07256499	0.694945642	89
protected land27	0.017230016	0.088906366	0.837661545	16	suburban community27	0.051735734	0.052587136	0.50408061	162	urban community20	0.085332889	0.019889774	0.189025572	205	rural community2	0.028811827	0.075428989	0.723603211	60
protected land28	0.019921477	0.086366258	0.812570311	55	suburban community28	0.055009456	0.049427427	0.473275585	188	urban community21	0.087899043	0.017105225	0.162900282	252	rural community3	0.031076677	0.07355183	0.702980783	79
protected land29	0.01663778	0.08642071	0.841966151	10	suburban community29	0.050154724	0.054367333	0.52015177	139	urban community22	0.085286391	0.020692864	0.195253912	197	rural community4	0.034241303	0.070006608	0.671539674	120
protected land30	0.019149807	0.086219393	0.818259915	49	suburban community30	0.053914502	0.050135928	0.481842585	186	urban community23	0.085677833	0.018655954	0.178810286	223	rural community5	0.030826731	0.073526422	0.704592242	75
protected land31	0.017462406	0.088473918	0.835161299	19	suburban community31	0.05302197	0.051314981	0.491819822	181	urban community24	0.086779813	0.018153941	0.173003828	236	rural community6	0.031327615	0.074014171	0.702609799	80
protected land32	0.017622532	0.088256451	0.83355968	25	suburban community32	0.050530313	0.053720471	0.515300402	146	urban community25	0.083768572	0.020699297	0.19814032	195	rural community7	0.030432751	0.073904088	0.708322091	71
protected land33	0.018742253	0.086253818	0.821495676	46	suburban community33	0.051843127	0.052484009	0.503071503	164	urban community26	0.086262535	0.01791345	0.171953737	240	rural community8	0.035389262	0.069022275	0.661059849	123
protected land34	0.019901738	0.085997783	0.81206961	56	suburban community34	0.052581976	0.051849025	0.496490742	175	urban community27	0.08631387	0.018909074	0.179704854	221	rural community9	0.034917434	0.069679068	0.666170152	122
protected land35	0.014938329	0.090762624	0.858673656	2	suburban community35	0.050614935	0.05368339	0.514709994	147	urban community28	0.085519936	0.019998905	0.189529237	202	rural community10	0.036282728	0.068042956	0.652216726	124
protected land36	0.019362665	0.085169001	0.814767471	53	suburban community36	0.051716747	0.052713638	0.504772996	160	urban community29	0.088516971	0.0164583	0.156782639	262	rural community11	0.030894108	0.07387287	0.705115976	74
protected land37	0.017462871	0.087767016	0.834050277	23	suburban community37	0.050770125	0.053332727	0.512308025	148	urban community30	0.087973982	0.01788257	0.168932106	245	rural community12	0.029688328	0.074731006	0.715681695	63
protected land38	0.01810312	0.086517239	0.826963701	40	suburban community38	0.050781298	0.054689422	0.518527056	140	urban community31	0.083067673	0.021699454	0.207120829	191	rural community13	0.032510499	0.072973044	0.691795538	95
protected land39	0.016335525	0.089059267	0.845006334	9	suburban community39	0.052771402	0.051413953	0.493485411	178	urban community32	0.085770382	0.019672317	0.186568795	210	rural community14	0.033613357	0.070590586	0.677427207	116
protected land40	0.016931547	0.087499798	0.837869112	15	suburban community40	0.050999988	0.053256687	0.510822803	152	urban community33	0.084909218	0.019889628	0.189788616	201	rural community15	0.031777048	0.072876215	0.696358742	87
protected land41	0.018230225	0.087199478	0.827086442	39	suburban community41	0.052445927	0.052165928	0.498661727	170	urban community34	0.08822197	0.017491325	0.165460028	248	rural community16	0.032192922	0.072232056	0.691712434	96
protected land42	0.014918501	0.091098327	0.859281764	1	suburban community42	0.049609111	0.054928895	0.525444257	133	urban community35	0.086617091	0.019332851	0.182471555	216	rural community17	0.032790537	0.071687196	0.686148082	106
protected land43	0.016179296	0.088972583	0.846134029	8	suburban community43	0.052394521	0.051772961	0.497016532	172	urban community36	0.08737428	0.018365818	0.1736883	235	rural community18	0.032379157	0.071815892	0.689244766	101
protected land44	0.017387266	0.088064494	0.835116402	22	suburban community44	0.050865209	0.053379821	0.512061067	149	urban community37	0.086829304	0.018565625	0.176152926	229	rural community19	0.031847608	0.0723332	0.694304465	91
protected land45	0.016078874	0.08899494	0.846975444	6	suburban community45	0.053157339	0.050855915	0.48893687	183	urban community38	0.085743474	0.018905727	0.180658111	219	rural community20	0.03257092	0.072000687	0.688529982	103
protected land46	0.018558763	0.085734862	0.822052755	45	suburban community46	0.05325746	0.051872529	0.493413244	179	urban community39	0.087975847	0.017406914	0.165178003	249	rural community21	0.032811824	0.071680553	0.68598835	107
protected land47	0.017495282	0.087149162	0.832812126	27	suburban community47	0.05271444	0.051809653	0.495671872	176	urban community40	0.088317046	0.017133957	0.162482637	253	rural community22	0.02905699	0.075584726	0.722319255	61
protected land48	0.018775568	0.086874726	0.822285699	44	suburban community48	0.051849796	0.052491374	0.503074428	163	urban community41	0.086625287	0.018763776	0.178042913	224	rural community23	0.030375916	0.074651502	0.710781087	67
protected land49	0.01628985	0.089723803	0.846341963	7	suburban community49	0.052215164	0.052343968	0.500615938	167	urban community42	0.087192321	0.01852239	0.175211092	232	rural community24	0.03330789	0.070988205	0.680641066	114
protected land50	0.017923399	0.087783521	0.830442516	31	suburban community50	0.051920158	0.052226352	0.501470016	166	urban community43	0.087989883	0.016876625	0.160934368	255	rural community25	0.033248223	0.071598221	0.682886498	111
protected land51	0.017351876	0.087906705	0.83515001	20	suburban community51	0.049864441	0.054737448	0.523293114	135	urban community44	0.085883684	0.019314688	0.183602534	215	rural community26	0.03263841	0.071643504	0.68701754	105
protected land52	0.018904306	0.086107856	0.81997984	47	suburban community52	0.052797525	0.051772191	0.495097369	177	urban community45	0.089077262	0.016704084	0.157911432	259	rural community27	0.031722843	0.073692037	0.699066743	83
protected land53	0.01748192	0.087631975	0.833685929	24	suburban community53	0.051109435	0.05356067	0.511709337	151	urban community46	0.087637241	0.01795408	0.170033676	243	rural community28	0.02878504	0.076474488	0.726532687	58
protected land54	0.020443817	0.084523956	0.805237203	57	suburban community54	0.05076695	0.053257414	0.511970581	150	urban community47	0.085175787	0.020598104	0.194737128	199	rural community29	0.032076436	0.072659115	0.693738792	93
protected land55	0.018159953	0.087314362	0.827825824	38	suburban community55	0.052057013	0.052040316	0.499919799	168	urban community48	0.086271668	0.01829444	0.174955729	233	rural community30	0.031032081	0.073709752	0.70372792	78
protected land56	0.018033709	0.087522478	0.829155361	33	suburban community56	0.050458959	0.053651832	0.515334015	145	urban community49	0.086751547	0.018616872	0.1766836	228	rural community31	0.029651493	0.07479957	0.716120718	62
protected land57	0.017830276	0.087980608	0.831489209	28	suburban community57	0.051536954	0.053125745	0.507590053	159	urban community50	0.084104867	0.020732627	0.197759663	196	rural community32	0.033483743	0.071712484	0.681702056	112
rural community33	0.031172965	0.073277203	0.701551797	82	rural community41	0.032473841	0.072684967	0.691192379	98	rural community52	0.032956569	0.071754863	0.685262932	73	rural community64	0.033228823	0.072127119	0.684604188	109
rural community34	0.033526402	0.070874909	0.678869913	115	rural community42	0.031897143	0.07221284	0.693620704	94	rural community53	0.032510928	0.072218777	0.689572999	108	rural community65	0.033064011	0.071465742	0.683688038	110
rural community35	0.031573236	0.073343165	0.699062911	84	rural community43	0.028656806	0.076020294	0.726236147	59	rural community54	0.030648968	0.073866024	0.706750513	99	rural community66	0.03440646	0.070557271	0.672206202	119
rural community36	0.032509661	0.072174694	0.689450623	100	rural community44	0.03195116	0.072649513	0.694541542	90	rural community55	0.031056119	0.073048995	0.70168498	72	rural community67	0.033190329	0.070888058	0.681102583	113
rural community37	0.032542207	0.072096345	0.689003659	102	rural community45	0.02975922	0.074689548	0.71508309	65	rural community56	0.034330196	0.069994344	0.670928852	81	urban community6	0.08578727	0.019525386	0.185403983	212
rural community38	0.030359852	0.074524489	0.710539704	68	rural community46	0.031697963	0.073147647	0.6976701	86	rural community58	0.032506047	0.071769062	0.688266479	121	urban community7	0.08394718	0.021125371	0.201055085	194
rural community39	0.031633601	0.072524269	0.696291785	88	rural community47	0.03376942	0.070472669	0.676048129	118	rural community59	0.029754778	0.074864581	0.715590131	64	urban community7	0.085524434	0.018994704	0.181734219	218
rural community40	0.03191965	0.072362436	0.693910513	92	rural community48	0.030265075	0.074578545	0.711331269	66	rural community60	0.031519496	0.072858492	0.698025452	85	urban community7	0.086083524	0.01970812	0.18629184	211
					rural community49	0.033936251	0.071232648	0.677316668	117	rural community61	0.030731181	0.073246111	0.704443343	77	urban community7	0.087156989	0.018046726	0.171540768	241
					rural community50	0.030406058	0.074119768	0.709104832	69	rural community62	0.032458484	0.072659478	0.691218483	97	urban community7	0.087982371	0.01723077	0.163770133	251
					rural community51	0.030561232	0.074353518	0.708704143	70	rural community63	0.03067224	0.0737943	0.706391733		urban community7	0.084522288	0.021716121	0.204409317	193

Figure 6. Data of Different Areas

Table.2. average scores for the four major regions

	protected land	rural community	suburban community	urban community
Average scores	0.831561845	0.694904587	0.508835721	0.178400724

From the table, we can see that the protected areas scored the highest and the urban areas scored the lowest. Suburbs and rural areas had similar scores. And that fits with what we know. Because urban communities have the high level of development and large population. Therefore, the density of the building is high, and the reflection of sunlight is strong. At the same time, there are more street lights at night, which consumes a lot of electricity and the greater the risk of light pollution. The protected areas, most of which are off the beaten track, are dominated by plants and animals. No more light pollution.

4. Conclusions

In the process of making the model, this paper found that it took a lot of time to search and integrate the data because of the high demand for data. And since the unit system differs from place to place, this paper needs a uniform unit to calculate [11]. This introduced an error. If there are too many or too few details, the accuracy will also be reduced. After calculation, this paper found that the optimal range for the number of factors is between 11 and 26, after which, the accuracy decreases by 0.73% for each increase or decrease in the number. This model provides great ideas and solutions. In addition, This model focuses on the computation of data, which can prove the validity of the solution more effectively and has a very wide range of applications.

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