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Optimal Location of the Solar Power Plant in Sistan and Baluchestan

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Abstract: *The sun as an endless source of energy can be a solution for the energy and environment problems. Non-dangerous solar energy that shines on earth is thousands times more than human's need. The solar energy is clean, inexpensive and endless, and can be exploited in most climatic parts of the earth. The geographical position of Sistan and Baluchestan province at the furthermost southeast of country is the nearest region to the Tropic of Cancer. At half of the year the angle of sun shine is close to vertical. As we know, the identification of different regions with environmental potential capability is very important when using the energy of the region. This needs special attention. We, according to climatic parameters of shining angle, wind blowing and temperature degree, based on information achieved from 2013 till 2018 from Sistan and Baluchestan province weather bureau, and by using hierarchy analytic algorithm software, performed all calculations. Finally, the considered city was selected. This is a privilege for this vast province with high climatic potential.*

Keywords: *Positioning, Solar Power Plant, Climatic Parameters.*

INTRODUCTION

Today, a huge amount of energy being consumed is fossil fuels. The consumption of these fuels has caused two important challenges which are related. On the one hand, industrial areas and large cities have encountered environment pollution problem. Fossil fuels cause production of toxic and polluted gases, acid rains and therefore the pollution of rivers, lakes, underground waters, increase in the amount of carbon dioxide gas in the atmosphere, and increase in greenhouse effect. Continuing the consumption of fossil fuels, in addition to intensifying air, water and soil pollution, increases the earth temperature due to increase in greenhouse gases in the atmosphere. On the other hand, it is observed that fossil energies are finishing rapidly. The effects of high exploitation of these energies are obvious in the variation of weather condition. The only solution is reducing the exploitation of fossil fuels[1].

Geographical View of Sistan and Baluchestan Province

Sistan and Baluchestan province is located at the latitudes of 25 to 31 degree north and 57 to 63 degree east. The geographical position of this province is at the furthermost southeast of country, nearest region to the Tropic of Cancer. At half of the year the sun shine angle is close to vertical. In such a way that on 1st of Tir in Chabahar, the shining angle is 88 degree (Good-tempered, Clear and Berna, 2005).

The Climate of Sistan and Baluchestan Province

Due to geographical position of Sistan and Baluchestan province, on the one hand it is affected by different climatic flows such as India subcontinent wind flow and on the other hand it is affected by high pressure of

[1] Department of Information and Meteorological Statistics of Sistan and Baluchestan Province (2010-2014)

average latitudes. Intense hot weather is the most important phenomenon of this region. This province has hot and long summers, and short winters. Because the minimum temperature rarely reaches zero centigrade degree the plant growth in aquatic areas continues all over the year. The most precipitation is in winter. This area has two distinct seasons of winter with average and cool temperature in Azar, Dey and Bahman months, and hot summer during the other seasons of the year[2]. The average of minimum temperature in the coldest months of the year is between 12 to 13 centigrade degrees. The coldest city of the province is Zahedan and the hottest city of the province is Iranshahr. The difference and fluctuation of temperature between winter and summer and even during a day is high. But, the absolute minimum of temperature rarely reaches zero degree[3]. The coastal areas of the Oman sea is the exception due to the humidity of the sea. Its hot temperature has more humidity. In average, there is no raining during 7 months of the year in this region. The amount of precipitation increases from east to west of this province. The annual average of precipitation is about 75 millimeters and it is irregular. The climate of Sistan and Baluchestan province is generally hot and dry. There is high variety of climate in Sistan and Baluchestan province due to the following factors[4].

Map 1 – The geographical map of province

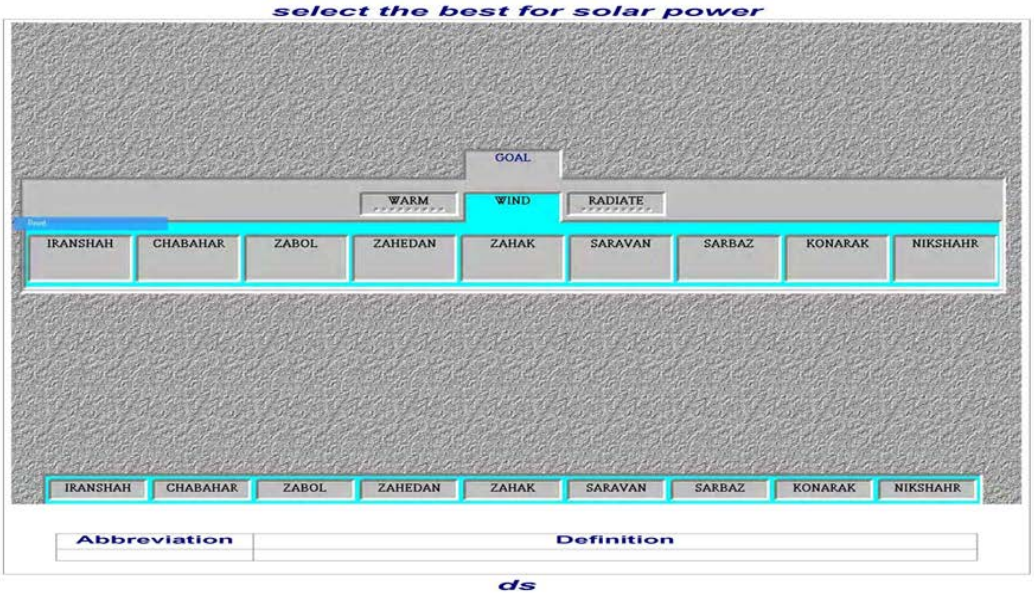
The Formulation of Hierarchy Analytic Algorithm by Using the Software

Now, we need engineering software named Analytical Hierarchy Process (AHP) which is the same as hierarchical analytic process to use all the necessary amounts in order to identify and find the place of solar power plant. This technique is based on binary comparison and makes possible the examination of different scenarios for those who make decisions. When making macro decisions, such as providing annual budget of

[2] Department of Information and Meteorological Statistics of Sistan and Baluchestan Province (2010-2014)
[3] StatisticalYearbookofSistanandBaluchestanGovernorate(2010-2014)
[4] SistanandBaluchestanRegionalElectricityCompany(2010-2014)

country, specialists pursue different goals for example, agricultural development, producing electricity power, economical and social development and change in weather conditions. The decision makers are interested in optimization of all goals (Peacock, 2011). Now, according to the average of the five-year statistics of Sistan and Baluchestan province weather bureau and the average of shining angle we find the considered goal. First, in order to work with software we should form a hierarchy. Here, we have one goal and three criteria which are shining angle, temperature degree and wind blowing. Our options are the province cities. The formation of the related hierarchy with the software is like the following (Ghodsypour, 1999).

Table 1 – The considered hierarchy algorithm



Now, we distinguish the type and condition of binary comparison for three criteria of shining angle, wind and heat. Using preference and numerical comparison enables us to use numbers in the form of a matrix or questionnaire for doing the comparison. So, we evaluate all options in relation to each other according to three specific criteria (Little Zade, Sharifi, and Honest morality, 2006). We should consider a point that inconsistency ratio should not be more than 0.1, because more than this amount, 100% of the used numbers are incorrect. Therefore, the decisions would be wrong and inconsistent with conditions. First, we evaluate the considered options according to the heat. It should be paid attention that the total diameter of the matrix must be equal to one. Also, each option in relation to itself is equal to one. For example, the proportion of Iranshahr to Iranshahr or Chabahar to Chabahar is equal to one. In addition, if the proportion of Iranshahr to Chabahar is equal to 2, the proportion of Chabahar to Iranshahr is equal to 1/2. The number in parentheses explains this concept (Peacock, 2011). We did the binary comparison of options in relation to heat condition by using the software. It indicates that Iranshahr, Chabahar and Nikshahr cities ranked from 1 to 3 respectively. Also, Zahedan, Zahak and Zabol cities have the least temperature (Shafiullah et al., 2010). The following table and diagram show these criteria.

Table 2 – Binary comparison of options in relation to heat criterion

	CHABAHAR	ZABOL	ZAHEDAN	ZAHAK	SARAVAN	SARBAZ	KONARAK	NIKSHAHR
IRANSHAHR	2.0	3.0	6.0	3.0	5.0	3.0	2.0	2.0
CHABAHAR		6.0	5.0	6.0	5.0	2.0	2.0	2.0
ZABOL			3.0	3.0	2.0	(4.0)	(7.0)	(6.0)

ZAHEDAN				(3.0)	(3.0)	(4.0)	(5.0)	(6.0)
ZAHAK					(3.0)	(3.0)	(8.0)	(4.0)
SARAVAN						(3.0)	(4.0)	(4.0)
SARBAZ							3.0	(3.0)
KONARAK								(3.0)

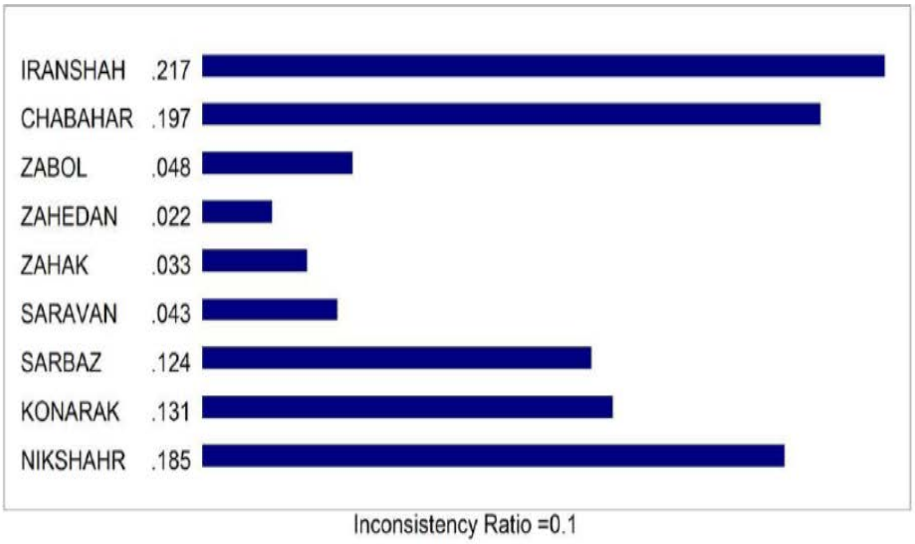


Diagram 1 – The results of table 2

As you have seen before, the inconsistency ratio is equal to 0.1. Consequently, the applied numbers are correct. Our first criterion which was the temperature degree was identified. Now, we examine the next criterion which is wind blowing. It indicates that Zabol and Zahak cities have the most wind blowing. As we know, Zabol city is very important considering wind potential. In such a way that, the wind blows continuously for 120 days during the year. It is known as 120-day winds. This does not mean that there is no wind for the other days, but it is less compared to these 120 days. Saravan and Nikshahr cities have the least wind blowing. Also, the inconsistency ratio is equal to 0.1. The related table on the other page explains all the details and all the options in relation to wind blow criterion clearly (LIU et al., 2010).

Table 3 – The comparison of options in relation to wind blow

	CHABAHAR	ZABOL	ZAHEDAN	ZAHAK	SARAVAN	SARBAZ	KONARAK	NIKSHAHR
IRANSHAHR	2.0	(8.0)	3.0	(4.0)	6.0	4.0	3.0	5.0
CHABAHAR		(7.0)	(4.0)	(5.0)	5.0	2.0	2.0	3.0
ZABOL			5.0	2.0	8.0	8.0	8.0	8.0
ZAHEDAN				(6.0)	5.0	4.0	3.0	5.0
ZAHAK					5.0	5.0	6.0	7.0
SARAVAN						(3.0)	(5.0)	(6.0)
SARBAZ							1.0	2.0
KONARAK								2.0

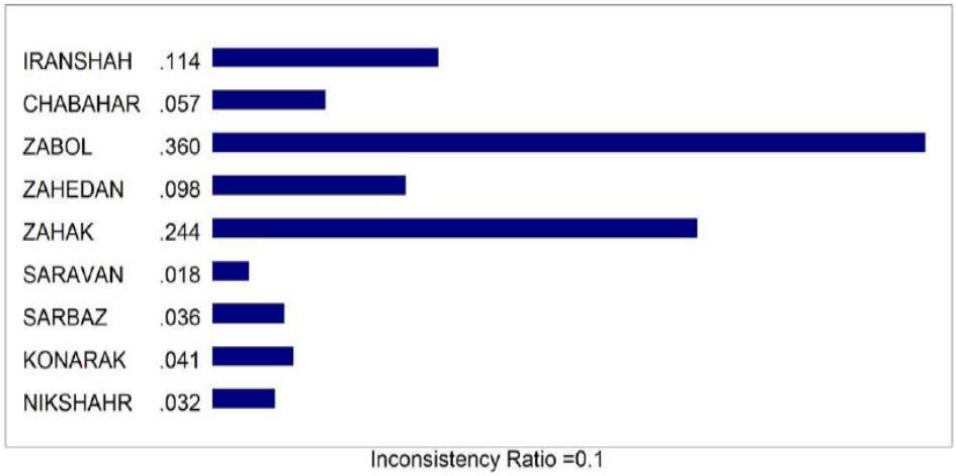


Diagram 2 – The results of table 3

Now, we examine the same previous steps for shining angle.

Table 4 – The binary comparison of options in relation with shining angle

	CHABAHAR	ZABOL	ZAHEDAN	ZAHAK	SARAVAN	SARBAZ	KONARAK	NIKSHAHR
IRANSHAHR	2.0	3.0	2.0	2.0	2.0	(6.0)	4.0	(6.0)
CHABAHAR		3.0	2.0	2.0	(4.0)	(5.0)	3.0	(4.0)
ZABOL			(4.0)	(4.0)	(5.0)	(9.0)	3.0	(5.0)
ZAHEDAN				2.0	(5.0)	(7.0)	30.	(5.0)
ZAHAK					(3.0)	(6.0)	4.0	60.)
SARAVAN						(5.0)	3.0	(5.0)
SARBAZ							5.0	2.0
KONARAK								(6.0)

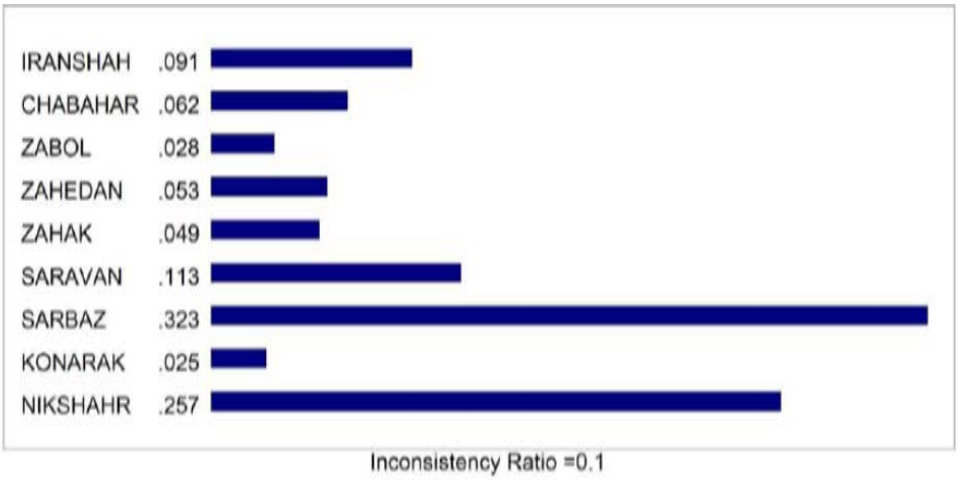


Diagram 3 – The results of table 4

Now, according to the data in the software and software calculations, the most shining angles are in Sarbaz and Nikshahr cities. Their inconsistency ratio like other options is equal to 0.1. Now that we achieved the options in relation to each other and according to the criteria, and considering the achieved numbers in the

inconsistency ratio part we can achieve the inconsistency ratio for each criterion from the sum of these numbers. It is very interesting, because the numbers are actually inserted into the software and the inconsistency ratio is equal to zero (Tahir and Absalyamova, 2011). This means that there is complete consistency and real data are inserted for each criterion.

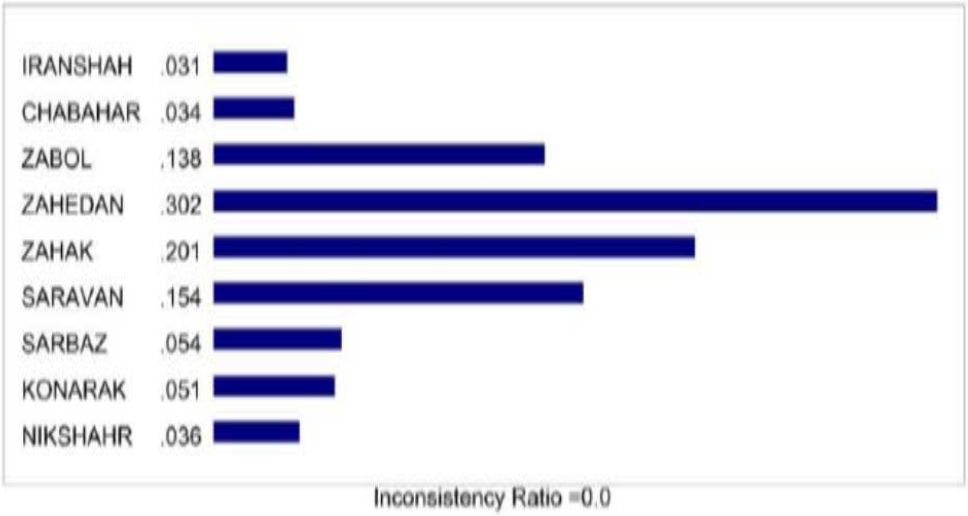


Diagram 4 – The calculation of the proportionate weights of options and criteria (heat)

We insert the numbers we achieved for the heat criterion options in heat criterion part and make sum of them. After the calculations the results are shown in diagram 23. The most is related to Zahedan with inconsistency ratio of zero. As we mentioned, we choose the same process for wind criterion. The results are shown in the following diagram (Canvov et al., 2009).

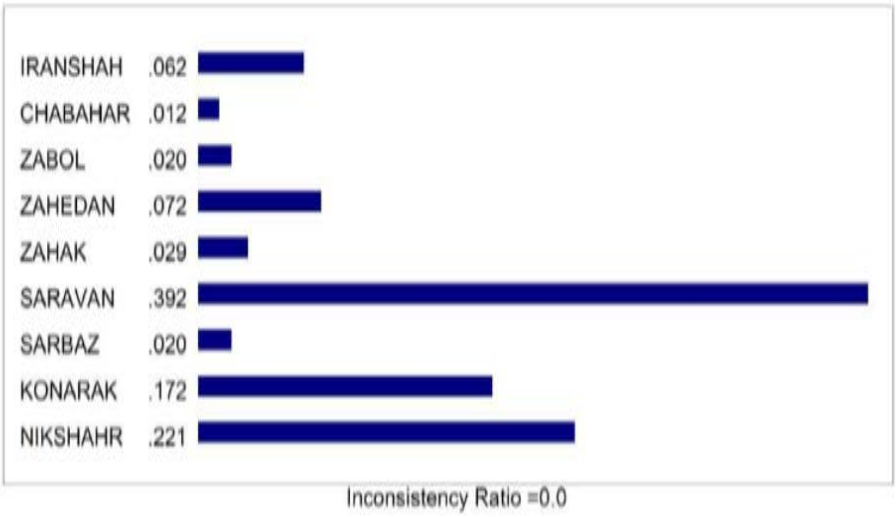


Diagram 5 – The calculation of proportionate weights of options and criteria (wind)

The most value in the diagram is for Saravan and Nikshahr cities with inconsistency ratio of zero. Now, we assess the same procedure for options of shining angle criterion. The following diagram shows this.

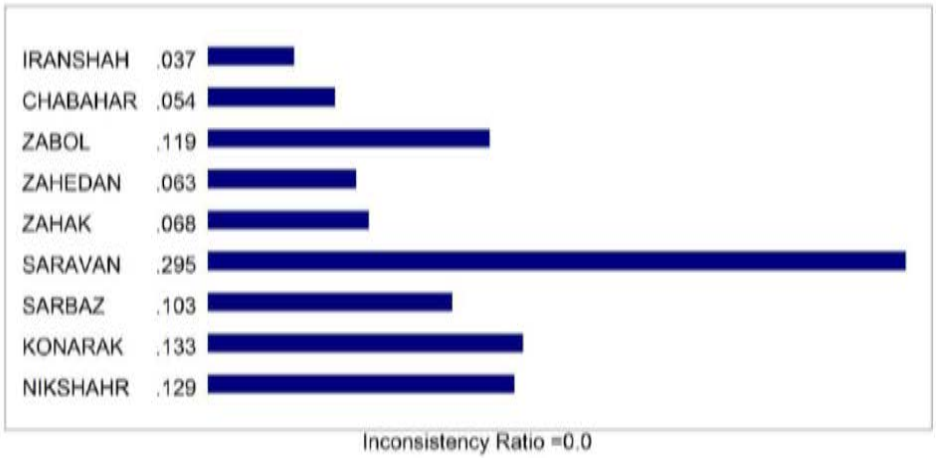


Diagram 6 – The calculation of proportionate weights of options and criteria (shining angle)

Now, we have reached the stage that we should compare criteria with each other. But we do this according to previous comparisons. The following diagram shows this.

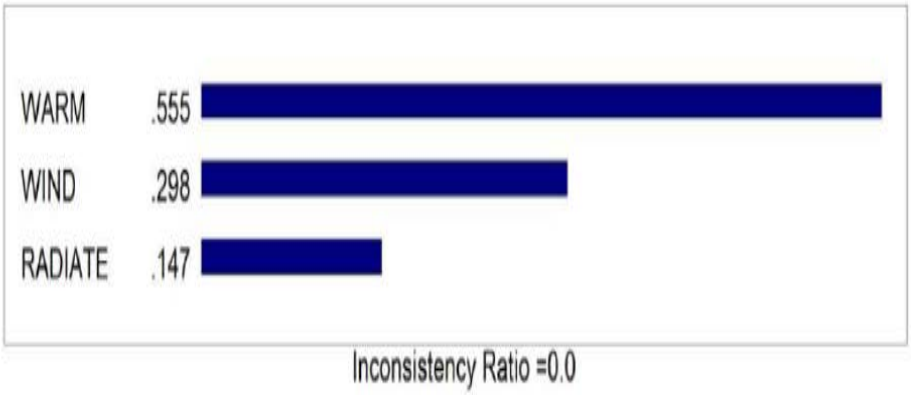


Diagram 7 – The comparison of criteria with each other

Now, after binary comparison and calculation of proportionate weights of options and criteria, it is necessary to calculate the final weight of each option. So, we use the synthesis model. We go on target menu and choose synthesis option. In this way, we observe the problem final solution. It is shown in the following diagram.

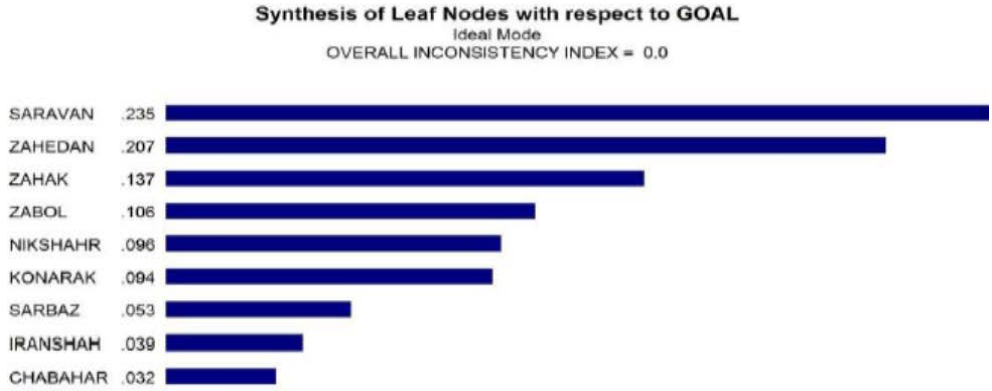


Diagram 8 – The final weight of options in Ideal Mode

Conclusion

By using three climatic parameters and five-year statistics of province weather bureau and putting them in the software, and calculation of binary comparison, proportionate weight and final weight it was specified that Saravan city is the best place for the establishment of solar power plant.

Suggestions

1. The selection of the best place for the establishment of solar power plant in each city.
2. The selection of the best place for the establishment of the solar power plant in order to install combined solar-wind system in province.
3. Technical – economical assessment of the establishment of solar power plant in Sistan and Baluchestan province.

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