Producing of Solar Radiation Maps in Iraq Using GIS Technology

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Abstract: *Information technology can give solutions in order to improve the quality of life. Solar energy is an important renewable energy source for the world. The design of any solar energy system needs a good understanding of the solar radiation data in a place. In this research, 14 Iraqi climatic stations radiation data were used for the years 2013 to 2015 from Iraqi Agro meteorological Network at Ministry of Agriculture. Database have been designed and calculated by using ArcGIS is used for spatial interpolation and mapping activities. Surface radiation map have been generated by using ordinary kriging technique. Different models are tested, namely Spherical, Gaussian and Circular model. Creation of digital grid maps activates it possible for gain climatic information at any location, whether there is an observation station or not. The outcomes performance that the Spherical performs better than Gaussian and Circular approaches.*

Key Words: *Renewable Energy, database, Solar Radiation Maps, GIS, Iraq.*

1. INTRODUCTION:

Accurate atmosphere information is important for developing an efficient solar power generation system. In which three years monthly meteorological data for Iraq are studies, it has been obtained from Ministry of Agriculture / Iraqi Agrometeorological Network of Iraq to predict for solar radiation maps [1]. solar beams datum supply information on how much of the sun's power strike the surface at a spot on earth over a particular special. Sun's power is free, pure, great and inexhaustible source of energy [2]. The aim of this system is to experience few types, namely Gaussian, Circular and Spherical types. The attached errors, prediction errors include: mean error, mean standardized error, root mean square error, root mean square standardized error and average standard error were studied.

2. METHOD:

Many environmental activities rely on the amount of solar radiation at the ground level. Ground gauges are often available, even for long time series, and are used as input for spatial interpolation models for producing continuous maps of sun rays [3]. Prediction of spatial information has attracted significant research interest in modern periods. It is challenging especially when spatial data include errors and unobserved parameters. statistical estimators are used to predict the unknown attribute values from the known values of known enclosure data points, a general shape of which is referred as kriging in the area of graphic information system [4].

In the recent years, Kriging has become a essential spatial prediction tool in database [5]. Kriging is a spatial interpolation technology that examine both the distance and the degree of variation between observed data points when estimating values in unknown areas [6]. The basic form of the kriging estimator is:

$$Z^*(u) - m(u) = \sum_{\alpha=1}^{n(u)} \lambda_{\alpha[Z(u_\alpha)-m(u_\alpha)]} \quad (1)$$

The aim is to locate weights, λ_α that decrease the variance of the estimator

$$\sigma^2_{E(u)=Var\{Z^*(u)-Z(u)\}} \quad (2)$$

with the unbiasedness limitation

$$E\{Z^*(u) - Z(u)\} = 0 \quad (3)$$

The random field (RF) of $Z(u)$is invalid into residual and trend components

$$Z(u) = R(u) + m(u) \quad (4)$$

with the residual component process as an RF with a fixed average of zero and a fixed covariance (equation of lag, h, but not of position, u)

$$E\{R(u)\} = 0 \quad (5)$$

$$Cov\{R(u), R(u+h)\} = E\{R(u).R(u+h)\} = C_R(h) \quad (6)$$

The lagging covariance equation is derived from the entrant semivariogram type,

$$C_r(h) = C_0(0) - \gamma(h) = Sill - \gamma(h) \quad (7)$$

Thus the semivariogram we feed to a kriging program should represent the lagging component of the parameter. The three main kriging types, simple, ordinary, and kriging with a trend, differ in their treatments of the trend component, $m(u)$[7]. Root Mean Square Standardized Prediction Error (RMSSPE) use to evaluate the accuracy, its equation below:

$$RMSPE = \sqrt{\frac{\sum_{i=1}^{n}[[\hat{z}(s_i) - z(s_i)]/\hat{\sigma}(s_i)]]^2}{n}} \quad (8)$$

3. RESULTS AND DISCUSSION:

In this study 14 Iraqi climatic stations' radiation data were used for the years 2013 to 2015. Data have been designed and calculated by using Excel, ArcGIS 10.2 is used for spatial interpolation and mapping activities. Surface radiation Maps have been generated by using ArcGIS ordinary kriging interpolation technique. Experimental results show that the Spherical model has very good level of accuracy and a predictable manner. Below represent samples of produced maps of solar radiation. The samples are for February for year 2013 to 2015.

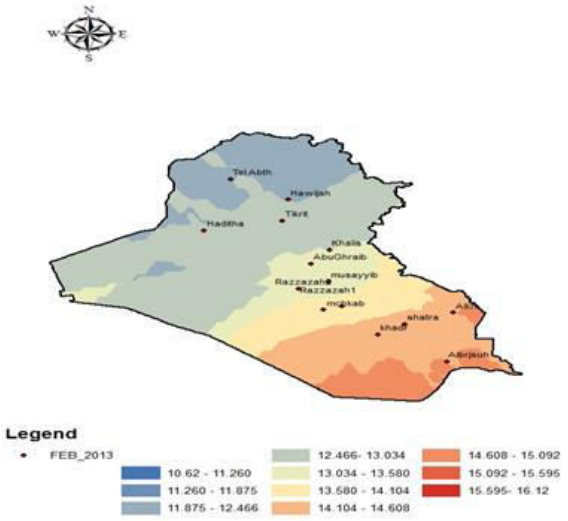

Figure (1): Solar Radiation Map, February 2013

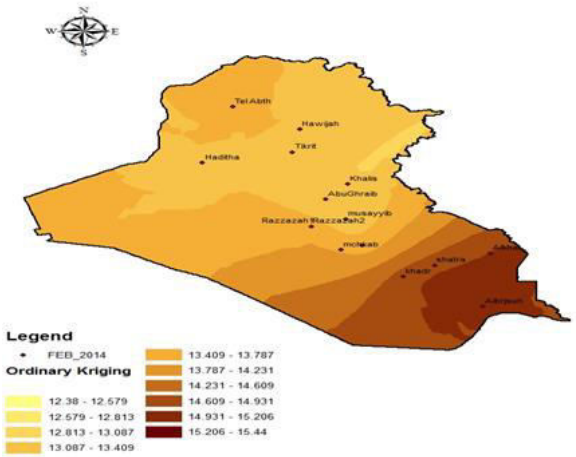

Figure (2): Solar Radiation Map, February 2014

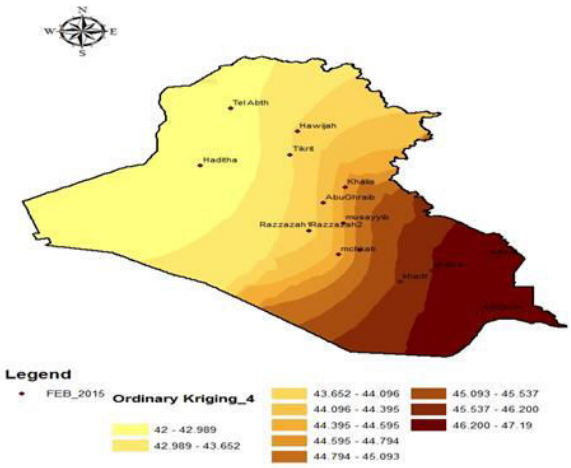

Figure (3): Solar Radiation Map, February 2015

The cross-validation procedure provides measures of accuracy for the predictions made using the ordinary kriging method. The measures produced include Mean Error(MPE), Root Mean Square Error (RMSPE), Average Standard Error (ASE), Mean Standardized Error (MSPE), Root Mean Square Standardized Error (RMSSPE). As example figure(4) explains as example for accepted criteria of February 2015 .

The model that provides accurate predictions should report MPE values close to zero when the predictions are unbiased, RMSPE values should be close to one when the standard errors are accurate, If ASE values are greater than RMSPE values, the model overestimates variance in the predicted values. Whereas ASE values are lower than RMSPE values indicated that the model underestimates variance in the predicted values, And the cross validation allows determining how good model is when RMSSPE values close to zero.

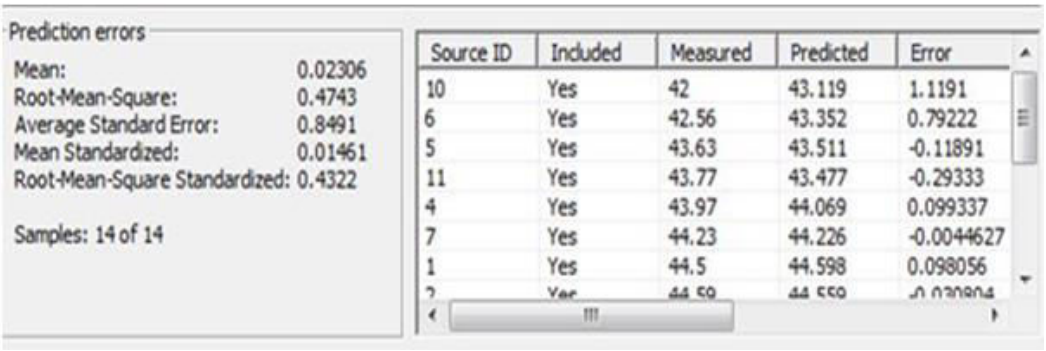

Figure (4): Example for accepted criteria of February 2015

Values calculated for RMSSE for some months from years 2013-2015 are documented in Table (1) below.

Table (1): Cross Validation Values

Month/Year	Model	Method	RMSE
February/2013	**Spherical**	**Ordinary Kriging**	0.9945
February/2014	**Spherical**	**Ordinary Kriging**	0.8674
February/2015	**Spherical**	**Ordinary Kriging**	0.4322
January/2013	**Spherical**	**Ordinary Kriging**	0.9687
January/2014	**Spherical**	**Ordinary Kriging**	1.023
January/2015	**Spherical**	**Ordinary Kriging**	0.8639
July/2013	**Spherical**	**Ordinary Kriging**	1.348
July/2014	**Spherical**	**Ordinary Kriging**	0.9772
July/2015	**Spherical**	**Simple Kriging**	1.0000
October/2013	**Circular**	**Ordinary Kriging**	0.9271
October/2014	**Gaussian**	**Ordinary Kriging**	0.8837
October/2015	**Circular**	**Ordinary Kriging**	0.9326

It was found that the Spherical model gives best results except for October, where the Gaussian and Circular models were better than the Spherical model.

4. CONCLUSION:

GIS techniques for modeling universal sun beams has been offered. The Cross Validation parameters such as RMSE has been presented for the three types. The estimated values are in perfect agreement with the known values. Based on GIS platform, we present an efficient creation of digital grid maps makes it possible to obtain climatic information at any point, whether there is a weather station or not. Multiple factors condition the difficulty of map creation, such as the location of the site samples, spatial density, spatial variability etc. For specific set of meteorological datum, it can use a variety of stochastic and deterministic interpolation methods to estimate meteorological variables at unknown sites. Solar energy is an important renewable energy source for the country, both in the generation of PV electricity and as heat. Therefore, it is necessary to quantify the solar potential of an area.

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