Using The Technique of Spatial Interpolation In Geographic Information Systems to Analyze And Monitor Dust And Sand storm Events

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Agenda

Introduction
An overview of the Spatial Analyst toolbox
An overview of the Interpolation toolset
Understanding interpolation analysis
IDW Method
Applied IDW in Case Study
What is ArcGIS? A Guide to ArcMap

ArcGIS is geospatial software to view, edit, manage and analyze geographic data. Esri develops ArcGIS for mapping on desktop, mobile, and web. Their motto is "See what others can’t". As such, the focus for ArcGIS is on location intelligence and analytics.

Who develops ArcGIS software?

• Esri (Environmental Systems Research Institute) develops ArcGIS software. The company’s headquarters is in Redlands, California.

• In 1969, the company was first founded primarily for land use development. With over 40% of the market share, ArcGIS is the leading GIS software in the market today.

• GIS integrates many different subjects using geography as its common framework. Esri is the global leader in the development of GIS, location intelligence, and mapping.
Who uses ArcGIS?

• ArcGIS users are in a wide range of fields and industries. For example, government, education, and commercial industries use ArcGIS. But the largest user base is in the environment, military, and land planning. Because most colleges use ArcGIS, graduates are usually somewhat familiar with it.

• What software is part of ArcGIS?

ArcGIS is a set of software consisting of:

• ArcMap
• ArcCatalog
• ArcGIS Pro
• ArcScene
• ArcGlobe
• ArcGIS Online
“ArcGIS Extensions” are additional modules or add-ons to the core ArcGIS software that provide specialized tools and functionalities for specific tasks or industries. By using ArcGIS extensions and add-ons, you can boost the capabilities of the stand-alone product.

These extensions expand the capabilities of ArcGIS to cater to various needs such as spatial analysis, geostatistics, network analysis, 3D modeling, and more.
ArcToolbox

• “ArcToolbox” is a part of the ArcGIS software that contains a collection of geoprocessing tools and functions. These tools cover a wide range of spatial analysis tasks, data conversion, manipulation, and geoprocessing workflows.

• ArcToolbox allows users to access, manage, and execute these tools to perform complex spatial tasks within the ArcGIS environment. For example, there are extensions for GPS tracking, geostatistics, and more. Each add-on has a toolset that you can use as part of an ArcToolbox.
An Overview Of The Spatial Analyst Toolbox
An overview of the Spatial Analyst toolbox:

- The Spatial Analyst toolbox provides a set of spatial analysis and modeling tools for raster (cell-based) and feature (vector) data.
- The capabilities of Spatial Analyst are broken down into categories or groups of related functionality. Knowing the categories will help you identify which particular tool to use.
An overview of the Spatial Analyst toolbox

• There are several ways to access Spatial Analyst functionality. With geoprocessing, operations in the Spatial Analyst toolbox can be performed through a Tool dialog box, Python (either at an interactive command line interface or with a script), or a Model. Traditional operations and workflows using Map Algebra can also be performed in the Python environment. There is also a Raster Calculator available for entering simple Map Algebra expressions that generate an output raster.

• For most tools, when the output is a raster, the location and name you specify for the output raster determines the format in which it is created. When not saving to a geodatabase, specify .tif for a TIFF file format, .crf for a CRF file format, .img for an ERDAS IMAGINE file format, or no extension for an Esri Grid raster format. See Output raster formats and names for more information.
An Overview Of The Interpolation Toolset
Spatial Analyst toolsets

One of that tools is most important in our work about Interpolation tools

- The Interpolation tools create a continuous (or prediction) surface from sampled point values.
- The continuous surface representation of a raster dataset represents some measure, such as the height, concentration, or magnitude (for example, elevation, acidity, or noise level).
- Surface interpolation tools make predictions from sample measurements for all locations in an output raster dataset, whether or not a measurement has been taken at the location.
An overview of the Interpolation toolset:

• Visiting every location in a study area to measure the height, concentration, or magnitude of a phenomenon is usually difficult or expensive. Instead, you can measure the phenomenon at strategically dispersed sample locations, and predicted values can be assigned to all other locations. Input points can be either randomly or regularly spaced or based on a sampling scheme.

• The continuous surface representation of a raster dataset represents some measure, such as the height, concentration, or magnitude (for example, elevation, acidity, or noise level).

• Surface interpolation tools make predictions from sample measurements for all locations in an output raster dataset, whether or not a measurement has been taken at the location.

• There are a variety of ways to derive a prediction for each location; each method is referred to as a model. With each model, there are different assumptions made of the data, and certain models are more applicable for specific data—for example, one model may account for local variation better than another. Each model produces predictions using different calculations.
The interpolation tools are generally divided into deterministic and geostatistical methods.

- The deterministic interpolation methods assign values to locations based on the surrounding measured values and on specified mathematical formulas that determine the smoothness of the resulting surface.

- The deterministic methods include IDW (inverse distance weighting), Natural Neighbor, Trend, and Spline.

- The geostatistical methods are based on statistical models that include autocorrelation (the statistical relationship among the measured points). Because of this, geostatistical techniques not only have the capability of producing a prediction surface but also provide some measure of the certainty or accuracy of the predictions.
The following table lists the available tools and provides a brief description of each.

<table>
<thead>
<tr>
<th>Tool</th>
<th>Description</th>
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<tbody>
<tr>
<td>IDW</td>
<td>Interpolates a raster surface from points using an inverse distance weighted (IDW) technique.</td>
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<tr>
<td>Kriging</td>
<td>Interpolates a raster surface from points using kriging.</td>
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<tr>
<td>Natural Neighbor</td>
<td>Interpolates a raster surface from points using a natural neighbor technique.</td>
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<tr>
<td>Spline</td>
<td>Interpolates a raster surface from points using a two-dimensional minimum curvature spline technique.</td>
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<td></td>
<td>The resulting smooth surface passes exactly through the input points.</td>
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<tr>
<td>Spline with Barriers</td>
<td>Interpolates a raster surface, using barriers, from points using a minimum curvature spline technique. The barriers are entered as either polygon or polyline features.</td>
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<tr>
<td>Topo to Raster</td>
<td>Interpolates a hydrologically correct raster surface from point, line, and polygon data.</td>
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<td>Topo to Raster by File</td>
<td>Interpolates a hydrologically correct raster surface from point, line, and polygon data using parameters specified in a file.</td>
</tr>
<tr>
<td>Trend</td>
<td>Interpolates a raster surface from points using a trend technique.</td>
</tr>
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</table>
Understanding Interpolation Analysis
Understanding interpolation analysis

- Interpolation predicts values for cells in a raster from a limited number of sample data points. It can be used to predict unknown values for any geographic point data, such as elevation, rainfall, chemical concentrations, and noise levels.
Why interpolate to raster?

• The assumption that makes interpolation a viable option is that spatially distributed objects are spatially correlated; in other words, things that are close together tend to have similar characteristics. For instance, if it is raining on one side of the street, you can predict with a high level of confidence that it is raining on the other side of the street. You would be less certain if it was raining across town and less confident still about the state of the weather in the next county.

• Using the above analogy, it is easy to see that the values of points close to sampled points are more likely to be similar than those that are farther apart. This is the basis of interpolation. A typical use for point interpolation is to create an elevation surface from a set of sample measurements. Geostatistical Analyst also provides and extensive collection of interpolation methods.
Examples of interpolation applications

• Some typical examples of applications for the interpolation tools follow. The accompanying illustrations will show the distribution and values of sample points and the raster generated from them.

• Interpolating a rainfall surface

• The input here is a point dataset of known rainfall-level values, shown by the illustration on the left. The illustration on the right shows a raster interpolated from these points. The unknown values are predicted with a mathematical formula that uses the values of nearby known points.
Interpolating an elevation surface

- A typical use for point interpolation is to create an elevation surface from a set of sample measurements.
- In the following graphic, each symbol in the point layer represents a location where the elevation has been measured. By interpolating, the values for each cell between these input points will be predicted.
In the example below, the interpolation tools were used to study the correlation of the ozone concentration on lung disease in California.

The image on the left shows the locations of the ozone monitoring stations. The image on the right displays the interpolated surface, providing predictions for each location in California. The surface was derived using kriging.
The IDW (Inverse Distance Weighted) tool uses a method of interpolation that estimates cell values by averaging the values of sample data points in the neighborhood of each processing cell. The closer a point is to the center of the cell being estimated, the more influence, or weight, it has in the averaging process.
Usage:

• The output value for a cell using inverse distance weighting (IDW) is limited to the range of the values used to interpolate. Because IDW is a weighted distance average, the average cannot be greater than the highest or less than the lowest input. Therefore, it cannot create ridges or valleys if these extremes have not already been sampled (Watson and Philip 1985).

• The best results from IDW are obtained when sampling is sufficiently dense with regard to the local variation you are attempting to simulate. If the sampling of input points is sparse or uneven, the results may not sufficiently represent the desired surface (Watson and Philip 1985).

• The influence of an input point on an interpolated value is isotropic. Since the influence of an input point on an interpolated value is distance-related, IDW is not ridge preserving (Philip and Watson 1982).
IDW (Spatial Analyst)

• The Output cell size parameter can be defined by a numeric value or obtained from an existing raster dataset. If the cell size hasn’t been explicitly specified as the parameter value, it is derived from the Cell Size environment if it has been specified. If the parameter cell size or the environment cell size have not been specified, but the Snap Raster environment has been set, the cell size of the snap raster is used. If nothing is specified, the cell size is calculated from the shorter of the width or height of the extent divided by 250 in which the extent is in the output coordinate system specified in the environment.

• If the cell size is specified using a numeric value, the tool will use it directly for the output raster.

• If the cell size is specified using a raster dataset, the parameter will show the path of the raster dataset instead of the cell size value. The cell size of that raster dataset will be used directly in the analysis, provided the spatial reference of the dataset is the same as the output spatial reference. If the spatial reference of the dataset is different than the output spatial reference, it will be projected based on the selected Cell Size Projection Method value.

• Some input datasets may have several points with the same x,y coordinates. If the values of the points at the common location are the same, they are considered duplicates and have no effect on the output. If the values are different, they are considered coincident points.
The various interpolation tools may handle this data condition differently. For example, in some cases, the first coincident point encountered is used for the calculation; in other cases, the last point encountered is used. This may cause some locations in the output raster to have different values than what you might expect. The solution is to prepare your data by removing these coincident points. The Collect Events tool in the Spatial Statistics toolbox is useful for identifying any coincident points in your data.

The barriers option is used to specify the location of linear features known to interrupt the surface continuity. These features do not have z-values. Cliffs, faults, and embankments are typical examples of barriers. Barriers limit the selected set of the input sample points used to interpolate output z-values to those samples on the same side of the barrier as the current processing cell. Separation by a barrier is determined by line-of-sight analysis between each pair of points. This means that topological separation is not required for two points to be excluded from each other's region of influence. Input sample points that lie exactly on the barrier line will be included in the selected sample set for both sides of the barrier.
IDW (Spatial Analyst)

- Barrier features are input as polyline features. IDW only uses the x,y coordinates for the linear feature; therefore, it is not necessary to provide z-values for the left and right sides of the barrier. Any z-values provided will be ignored.
- Using barriers will significantly extend the processing time.
- This tool has a limit of approximately 45 million input points. If your input feature class contains more than 45 million points, the tool may fail to create a result. You can avoid this limit by interpolating your study area in several pieces, making sure there is some overlap in the edges, then mosaicking the results to create a single large raster dataset. Alternatively, you can use a terrain dataset to store and visualize points and surfaces comprised of billions of measurement points.
- If you have the Geostatistical Analyst extension, you may be able to process larger datasets with the version of the IDW tool available there.
- The input feature data must contain at least one valid field.
- For data formats that support Null values, such as file geodatabase feature classes, a Null value will be ignored when used as input.
Parameters - Python

\[
\text{Idw}(\text{in\_point\_features}, \text{z\_field}, \{\text{cell\_size}\}, \{\text{power}\}, \{\text{search\_radius}\}, \{\text{in\_barrier\_polyline\_features}\})
\]

**Code sample:**
IDW example 1 (Python window)
This example inputs a point shapefile and interpolates the output surface as a TIFF raster.

```python
import arcpy from arcpy
import env from arcpy.sa import *
env.workspace = "C:/sapyexamples/data"
outIDW = Idw("ozone_pts.shp", "ozone", 2000, 2, RadiusVariable(10, 150000))
outIDW.save("C:/sapyexamples/output/idwout.tif")
```
Idw(in_point_features, z_field, {cell_size}, {power}, {search_radius}, {in_barrier_polyline_features})

IDW example 2 (stand-alone script)

This example inputs a point shapefile and interpolates the output surface as a Grid raster.

```python
# Name: IDW_Ex_02.py
# Description: Interpolate a series of point features onto a rectangular raster using Inverse Distance Weighting (IDW).
# Requirements: Spatial Analyst Extension
# Import system modules
import arcpy from arcpy
import env from arcpy.sa import *

# Set environment settings env.workspace = "C:/sapyexamples/data"

# Set local variables
inPointFeatures = "ca_ozone_pts.shp"
zField = "ozone" cellSize = 2000.0
power = 2
searchRadius = RadiusVariable(10, 150000)

# Execute IDW
outIDW = Idw(inPointFeatures, zField, cellSize, power, searchRadius)

# Save the output outIDW.save("C:/sapyexamples/output/idwout02")
```
Analyzing and Monitoring Dust and Sandstorm Events in Saudi Arabia for 2003 to 2022, and Comparing with 2023

Applied IDW in Case Study
Introduction

• Dust and sandstorms are climatic phenomena associated with strong winds blowing over dry and desert regions, and they occur widely in various regions around the world. These storms significantly reduce visibility, affecting daily life, economic activities, and public health in the affected areas. Dust and sandstorms are a major challenge for Saudi Arabia's environmental, economic, and social systems. Therefore, studying the analysis of dust and sandstorms is of great importance in understanding this phenomenon and dealing with its resulting impacts (WMO, 2022).

• Study aims to analyze SDS on Saudi Arabia, and the study aims to determine trends and changes in the occurrence of SDS over the years and analyze available data to elucidate the temporal and spatial patterns of this phenomenon.

• Data from monitoring stations in Saudi Arabia was analyzed the seasons of dust and sandstorms events for the period from March 2023 to August 2023 comparing with period of March 2003- 2022 to August 2003- 2022. The recorded cases were classified based on specific criteria such as wind speed, visibility reduction, and the type of event recorded in the station's report.
Data and Methodology

Dust and Sandstorms Classification Criteria:

- Taking data from the NCM (National Metrological Center). SDSs were delineated using methodology from Kelley and Ardon-Dryer (2021), comprising times when wind speed was >22 km/h, visibility was <5 km, and weather codes included dust (SS, DS, BLDU, BLSD, TSSS, TSDS, TSBLDU, TSBLSD).

- This study implemented objective criteria to identify and classify SDS based on observational data from ground meteorological stations. The criteria adhere to the World Meteorological Organization's (WMO) definition of a dust storm as horizontal visibility reduced to less than 1 km due to airborne dust.

- Data used for 28 metrological stations around Saudi Arabia, and data from 2003 to 2023.

- Using ArcGIS pro 3.3 for analyzing the data SDS events in 28 stations around Saudi Arabia by using the toolboxes spatial analysis tools- interpolations- IDW.
Metrological stations around Saudi Arabia
Dust and Sandstorms Events:

Trend SDS in KSA at 2023, and period of 2003 to 2022:

- The chart represents the totals of SDS in Saudi Arabia for 2023 and comparing with averages period of 2003 to 2022, specifying the number of hours in each month from March to August when SDS occurred. And we found that the hours of SDS events was decreased in 2023 around -82% comparing with periods of 2003-2022.
Result

<table>
<thead>
<tr>
<th>Month</th>
<th>Changing (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar</td>
<td>-79</td>
</tr>
<tr>
<td>Apr</td>
<td>-81</td>
</tr>
<tr>
<td>May</td>
<td>-80</td>
</tr>
<tr>
<td>Jun</td>
<td>-80</td>
</tr>
<tr>
<td>Jul</td>
<td>-87</td>
</tr>
<tr>
<td>Aug</td>
<td>-75</td>
</tr>
</tbody>
</table>
March: Comparing March 2023 with March during 2003 to 2022

- Comparison of SDS rating in March 2023 with the average SDS in March from 2003 to 2022.

- **The Eastern region of Saudi Arabia such as in Al-Ahsa station** had the highest occurrence of SDS in March 2023, this indicates a lower rating of SDS in March 2023, it recorded 20 hours and 4 days in March 2023 compared to an average of 74 hours and 10 days in 2003 to 2022, with anomaly -54 hours and -6 days.

- **The Central region of Saudi Arabia for instance in Al- Qassim station** experienced sharp decrease in SDS rating in March 2023, with 3 hours and 2 days, compared to an average of 51 hours and 11 days from 2003 to 2022, with anomaly -49 hours and -9 days during 2023 and the period 2003-2022. This indicates a sharp lower occurrence of SDS in March 2023 compared to the previous period.

- **The Northern region of Saudi Arabia for instance in Rafha station** witnessed a significant sharp decrease in SDS frequency in March 2023, with 2 hours and 1 day, compared to an average of 47 hours and 8 days from 2003 to 2022, with anomaly -45 hours and -7 days during 2023 and the period 2003-2022.

- **The Western region of Saudi Arabia for instance in Al-Madinah station** experienced a significant major decrease in SDS rating in March 2023, with 1 hour and 1 day, compared to an average of 12 hours and 3 days from 2003 to 2022, with anomaly -11 hours and -2 days during 2023 and the period 2003-2022.
Comparing March 2023 with March during 2003 to 2022:

Dust storms Frequency (Hours) in March 2023

Dust storms Frequency (Hours) in March during 2003-2022

Anomaly of dust storms March for hours 2023 and the period 2003-2022
April: Comparing April 2023 with April during 2003 to 2022

- Comparison of SDS rating in April 2023 with the average SDS frequency in April from 2003 to 2022.

- **Central region as Wadi Al-Dawasir station**, it increase in SDS occurrence in April 2023, with 53 hours and 16 days, compared to an average of 44 hours and 9 days from 2003 to 2022, with anomaly April for +9 hours and +7 days during 2023 and the period 2003-2022.

- **As for Eastern region of Saudi Arabia such as Hafar Al-Batin station** experienced a significant sharp decrease in SDS incidence in April 2023, with 3 hours and 2 days, compared to an average of 50 hours and 9 days from 2003 to 2022, with anomaly of SDS April for -41 hours and -6 days during 2023 and 2003-2022.

- **The Southern region such as Bisha station** experienced a significant increase in SDS occurrence in April 2023, with 39 hours and 13 days, compared to an average of 17 hours and 5 days from 2003 to 2022, with anomaly of SDS April for +22 hours and +8 days during 2023 and 2003-2022.

- **The Western region such as Jeddah station** recorded a notable increase in SDS rate in April 2023, with 12 hours and 3 days, compared to an average of 7 hours and 1 day from 2003 to 2022, with anomaly of SDS April for +5 hours and +2 days during 2023 and 2003-2022. Also, **Al-Madinah station** experienced a significant major decrease in SDS occurrence in April 2023, with 3 hours and 2 days, compared to an average of 12 hours and 4 days from 2003 to 2022, with anomaly of SDS April for -9 hours and -2 days during 2023 and 2003-2022. This indicates a higher and lower incidence of SDS in April 2023 compared to the previous period.
Comparing April 2023 with April during 2003 to 2022:

- Dust storms Frequency (Hours) in April 2023
- Dust storms Frequency (Hours) in April during 2003-2022
- Anomaly of dust storms April for hours 2023 and the period 2003-2022
May: Comparing May 2023 with May during 2003 to 2022

- Comparison of SDS occurrence in May 2023 with the average SDS rating in May from 2003 to 2022.

- **The Eastern region such as Al-Ahsa station** experienced a significant sharp decrease in SDS in May with 32 hours and 5 days in May 2023 compared to an average of 61 hours and 10 days in 2003 to 2022, with anomaly -29 hours and -5 days during 2023 and 2003-2022.

- **The Central region as Wadi Al-Dawasir station**, it recorded a significant increase in SDS frequency in May 2023, with 58 hours and 14 days, compared to an average of 30 hours and 7 days from 2003 to 2022, with anomaly for +28 hours and +7 days during 2023 and the period 2003-2022. Also, **Riyadh station** experienced a significant decrease in SDS occurrence in May 2023, with 16 hours and 4 days, compared to an average of 31 hours and 9 days from 2003 to 2022, with anomaly -15 hours and -5 days during 2023 and 2003-2022. This indicates a higher rate of dust rate in May 2023 compared to the previous period.

- **The Northen region such as Arar station** recorded a notable decrease in SDS frequency in May 2023, with 10 hours and 3 days, compared to an average of 42 hours and 8 days from 2003 to 2022, with anomaly -32 hours and -5 days during 2023 and 2003-2022.
Comparing May 2023 with May during 2003 to 2022:

Dust storms Frequency (Hours) in May 2023

Dust storms Frequency (Hours) in May during 2003-2022

Anomaly of dust storms May for hours 2023 and the period 2003-2022
June: Comparing June 2023 with June during 2003 to 2022

- This study illustrate a comparison of SDS rate in June 2023 with the average SDS incidence in June from 2003 to 2022.

- **The Eastern region as Al-Ahsa station** experienced a significant sharp decrease in SDS, with 45 hours and 9 days in June 2023 compared to an average of 92 hours and 11 days in 2003 to 2022, with anomaly -47 hours and -2 days. And, **Dammam station** recorded a SDS incidence of around 21 hours and 4 days in June 2023, compared to an average of 64 hours and 8 days from 2003 to 2022, indicating a major decrease in the number of hours, with anomaly of dust storms June for -43 hours and -4 days.

- **The Central region such as Riyadh station** experienced a significant sharp decrease in SDS rate in June 2023, with 0 hour and 0 day, compared to an average of 41 hours and 6 days from 2003 to 2022, with anomaly -41 hours and -6 days. And, **Wadi Al-Dawasir station**, it recorded a sharp decrease in SDS frequency in June 2023, with 1 hour and 1 day, compared to an average of 15 hours and 5 days from 2003 to 2022, with anomaly -14 hours and -1.

- **The Northern region such as Al- Qurayyat station** experienced increase in SDS frequency in June 2023, with 7 hours and 1 day, compared to an average of 2 hours and 1 day from 2003 to 2022, with anomaly +5 hours and +1 day.
Comparing June 2023 with June during 2003 to 2022:

Dust storms Frequency (Hours) in June 2023

Dust storms Frequency (Hours) in June during 2003-2022

Anomaly of dust storms June for hours 2023 and the period 2003-2022
July: Comparing June 2023 with July during 2003 to 2022

- Comparison of SDS incidence in July 2023 with the average SDS rate in July from 2003 to 2022.

- The Eastern region as that Al-Ahsa station experienced a significant sharp decrease in SDS, with 14 hours and 2 days in July 2023 compared to an average of 60 hours and 9 days in the period from 2003 to 2022, with anomaly -46 hours and -7 days. Hafar Al-Batin station experienced a significant sharp decrease in SDS rate in July 2023, with 0 hour and 0 day, compared to an average of 22 hours and 4 days from 2003 to 2022, with anomaly -22 hours and -5 days. This indicates a lower incidence of SDS in July 2023 compared to the previous period.

- As Central region such as Riyadh station experienced a significant sharp decrease in SDS rate in July 2023, with 0 hour and 0 day, compared to an average of 28 hours and 5 days from 2003 to 2022, with anomaly -28 hours and -5 days. As Wadi Al-Dawasir station, it recorded a sharp decrease in SDS incidence in July 2023, with 0 hour and 0 day, compared to an average of 15 hours and 5 days from 2003 to 2022, with anomaly -15 hours and -5 days.

- The Southern region as Jizan station experienced increase in SDS occurrence in July 2023, with 57 hours and 13 days, compared to an average of 36 hours and 10 days from 2003 to 2022, with anomaly +21 hours and +3 days. And, Najran station experienced a sharp decrease in SDS rate in July 2023, with 2 hours and 2 days, compared to an average of 13 hours and 6 days from 2003 to 2022, with anomaly -11 hours and -4 day.
Comparing July 2023 with July during 2003 to 2022:

Dust storms Frequency (Hours) in July 2023

Dust storms Frequency (Hours) in July during 2003-2022

Anomaly of dust storms July for hours 2023 and the period 2003-2022
August: Comparing June 2023 with August during 2003 to 2022

- Comparison of SDS incidence in August 2023 with the average SDS rate in August from 2003 to 2022.

- The Eastern region Al-Ahsa station experienced a significant sharp decrease in SDS, with 0 hour and 0 day in August 2023 compared to an average of 24 hours and 5 days in the period from 2003 to 2022, with anomaly -24 hours and -5 days. Similarly, Dammam station recorded a SDS rate of around 0 hour and day in August 2023, compared to an average of 10 hours and 2 days from 2003 to 2022, indicating a major decrease in the number of hours, with anomaly -10 hours and -2 days.

- The Central region as Riyadh station experienced a significant sharp decrease in SDS rate in August 2023, with 1 hour and 1 day, compared to an average of 18 hours and 4 days from 2003 to 2022, with anomaly -17 hours and -3 days. And, Wadi Al-Dawasir station, it recorded a sharp decrease in SDS occurrence in August 2023, with 1 hour and 1 day, compared to an average of 13 hours and 4 days from 2003 to 2022, with anomaly -12 hours and -3 days.

- As Northern Al-Jawf station experienced increase in SDS rate in August 2023, with 13 hours and 6 days, compared to an average of 3 hours and 1 day from 2003 to 2022, with anomaly +10 hours and +5 days.

- And Al-Madinah station experienced increase in SDS rate in August 2023, with 10 hours and 2 days, compared to an average of 4 hours and 2 days from 2003 to 2022, with anomaly +6 hours and 0 day.

- As Southern region such as Jizan station experienced decrease in SDS occurrence in August 2023, with 0 hour and 0 day, compared to an average of 11 hours and 5 day from 2003 to 2022, with anomaly -11 hours and -5 days.
Comparing August 2023 with August during 2003 to 2022:

Dust storms Frequency (Hours) in August 2023

Dust storms Frequency (Hours) in August during 2003-2022

Anomaly of dust storms August for hours 2023 and the period 2003-2022
Conclusion

- Interpolation is a method used to estimate values between known points based on their spatial correlation. It assumes that points close to each other will have similar values.
- Interpolation is commonly used to create elevation surfaces, estimate values between sampled points, and generate continuous surfaces that represent a particular attribute across an entire area.
- When creating a rainfall surface or an elevation surface, interpolation predicts the unknown values between known points using mathematical formulas that take into account the values of nearby known points.
- Different interpolation methods, such as kriging and inverse distance weighting (IDW), can be used depending on the specific requirements of the analysis.
- The "Output cell size" parameter in interpolation can be specified numerically or obtained from an existing raster dataset. If not explicitly provided, the cell size is derived from the environment settings or calculated based on the extent of the data.
Conclusion

- Coincident points, where multiple points have the same x, y coordinates, can affect the interpolation process. Depending on the interpolation tool, the first or last coincident point encountered may be used for the calculation. It is recommended to remove coincident points to ensure accurate results.

- Barriers, such as linear features that interrupt the continuity of the surface, can be used in interpolation to limit the selected set of input sample points. Barriers are specified as polyline features, and their presence can significantly increase processing time.

- There is a limit of approximately 45 million input points for the interpolation tool. If the input exceeds this limit, alternative approaches such as dividing the study area into smaller parts or using a terrain dataset can be considered.

- The Geostatistical Analyst extension provides additional capabilities for processing larger datasets using the IDW tool.

- The input feature data used for interpolation must contain at least one valid field, and Null values may be ignored depending on the data format used.
Thank you!

Any Questions?

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