The SEDI interpolation method : how does it work.

Introduction

The SEDI interpolation method originates from the Harare based Regional Remote Sensing Project. It sought to assist the interpolation of rainfall data gathered at station level with the Meteosat cold cloud duration images received from the FAO Artemis Project. At a later stage the method was applied to other parameters as well (e.g. potential evapotranspiration and altitude, crop yields and NDVI).

The concepts of this interpolation method have been described at several places, although deviations exist from the basic idea. A comparable method called co-kriging is applied mainly to geology and ground water studies.

SEDI is a simple and straightforward method for 'assisted' interpolation. The method can be applied to any parameter of which the values are available for a number of geographical locations, as long as a 'background' field is available that has a negative or positive relation to the parameter that needs to be interpolated. Three requirements are a prerequisite for the successful application of the SEDI method:
1. The availability of the parameter to interpolate as *point data* at different geographical locations (e.g. rainfall, potential evapotranspiration, crop yields)
2. The availability of a background parameter in the form of a *regularly spaced grid* (or field) for the same geographical area (e.g. CCD, NDVI, altitude).
3. A relation between the two parameters (*negative of positive*; rainfall/CCD is positive, PET/altitude is negative). A Spearman rank correlation test can reveal whether a relation exists, and how strong this relation is.

The SEDI method yields the parameter mentioned under point 1 as a field. The calculation can be influenced by setting a number of input parameters.

A non-mathematical explanation using rainfall and CCD

Rainfall data are gathered on a dekadal (10-day) basis in most countries of the world. Plotted on a map this could give the following picture:
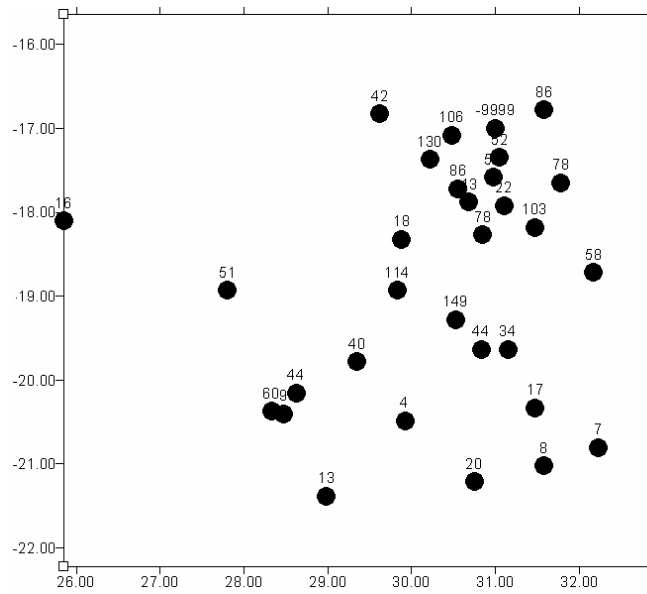
Figure 1. Rainfall (mm) for Zimbabwe second dekad of January 1991

The geostationary Meteosat satellite and its sister satellites make infrared temperature pictures of the earth every half hour. In tropical regions it can be assumed that areas with temperatures lower than about minus 40 degrees Celsius. are covered with rain clouds. The cumulated number of hours in a dekad with this low temperature is called 'Cold Cloud Duration' (CCD). It is represented as an image. An image is a regular structure with rows and columns, like a chessboard. The building blocks of the image are called 'pixels'. A pixel represents one data value. Pixels can be assigned a color depending on the value they represent. An example:
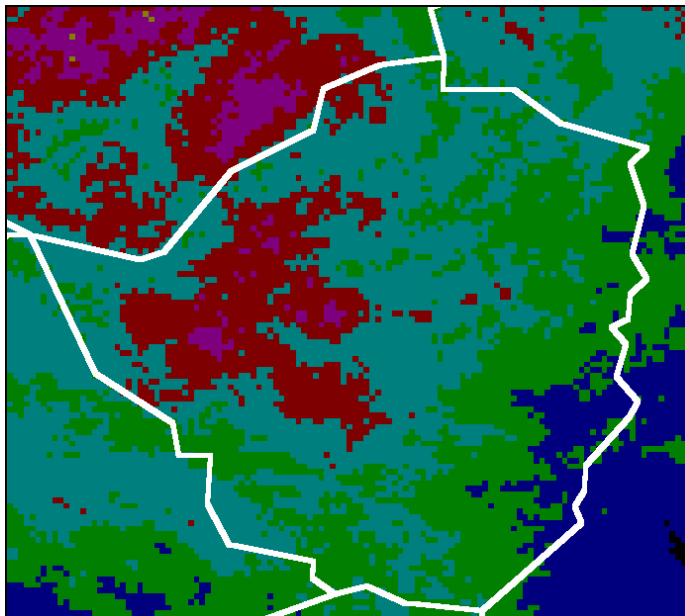

Figure 2. Cold Cloud Duration image for Zimbabwe, second dekad of January 1991

The relation between rainfall and CCD is a positive one. In other words: high rainfall values generally coincide with high CCD values.

The SEDI process is done in three steps:
1.   Extracting values from the image and calculating the ratio of point and image values
2.   Gridding the ratio's to form a regularly spaced grid.
3.   Multiplying Grid with image to obtain estimated image.

Step 1 : Extracting values from the image and calculating the ratio's

For every point value in the input rainfall data, a value can be extracted from the CCD image. The SEDI method will find the pixel that coincides with a rainfall station and extract the pixel value. In some cases the value of one pixel does not give satisfactorily results. Therefore the SEDI software allows the user to extract the values of more than one pixel from the image, and take its average as image value for the station (see figure …).
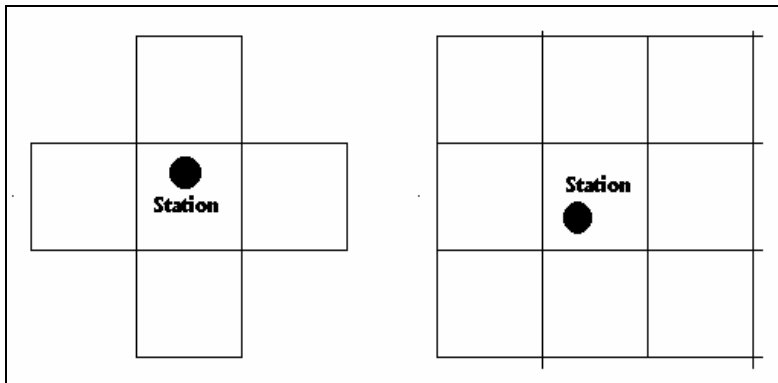

Figure 3. Extracting 5 or 9 pixels per point value

For every station we now have a rainfall value and a CCD value. The Spearman rank correlation coefficient (using the rainfall/CCD data pairs) yields a positive value. This means the relation between rainfall and CCD is positive (as to be expected).
The ratio between rainfall and CCD value is now calculated as showed in the following table:

Tabel 1. Calculating the ratios

Station Name	Rainfall (mm)	CCD value (hours)	Ratio
Station 1	23.4	56	0.42
Station 2	12.4	12	1.03
Station 3	54.3	96	0.57
Station 4	6.7	8	0.84

Should the relation have been negative, the ratio is calculated as follows:

$$\frac{StationValue}{HighestPossiblePixelValue - PixelValue}$$

Step 2: Creating a regularly spaced grid from the ratios

The second step constitutes of the creation of a grid from the irregularly spaced ratio's:
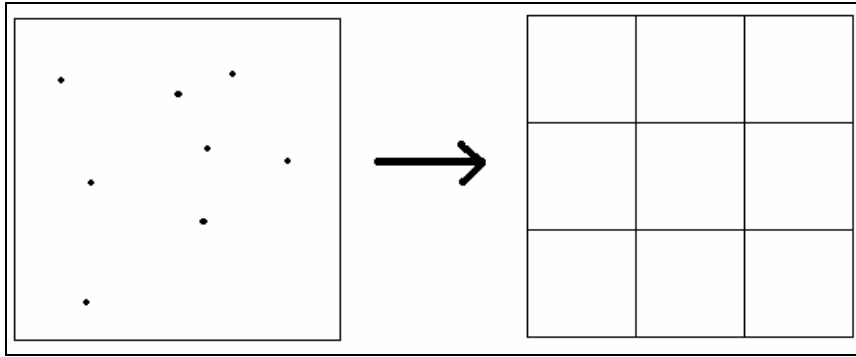
Figure 4. Creating the ratio grid

The ratio grid is created with the **inverse distance method with a weighting power of 2**. The software allows the user to set:
- **The distance between the grid lines**. A low distance creates a accurate, dense grid, while a high value creates a coarse, less accurate and more general grid.
- **The number of stations per gridpoint** determines the number of stations included in the calculation of a point in the grid matrix.
- **The maximum radius for interpolation** determines whether a value is calculated for a point in the grid matrix. If the number of stations around this gridpoint within this radius is higher than the specified number of stations, a value is calculated. Otherwise the gridpoint ia assigned a missing value, and the resulting image will be 'empty' at that particular point.

Step 3: Creating the SEDI image

The last step encompasses the creation of the SEDI image. The process is simple. By multiplying the grid (step 2) with the background image, an estimate for the value to interpolate is obtained. In terms of rainfall and CCD: a rainfall image is obtained by multiplying the ratio grid with the background image.
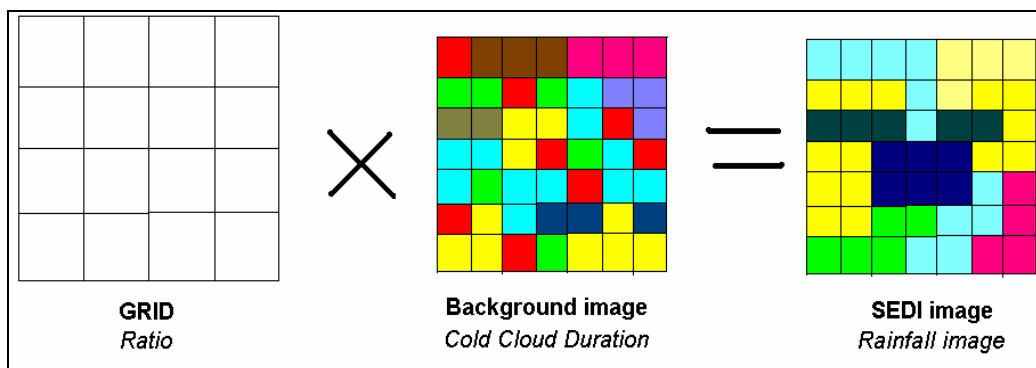

GRID
Ratio

Background image
Cold Cloud Duration

SEDI image
Rainfall image

Figure 5. Creating the SEDI image form ratio grid and background image

The SEDI software

The SEDI methods are incorporated in a DOS software package called DOS IGT (IDA GIS Tools). This package is freeware and can be downloaded from the FAO FTP site: **FTP://FTP.FAO.ORG/SDRN/IGT/**

It has been the initiative of FAO to incorporate the SEDI routines into the standard remote sensing package use by the GIEWS group, called **WINDISP version 3**. WINDISP is being developed at the University of Arizona in the U.S.A and runs under Windows. It can be downloaded freely from **http://ag.arizona.edu/~epfirman/windisp3.html.**

IGT implemented the routines in the three separate steps described in the previous chapter. The WINDISP version of the SEDI routines contains two extra functions:
1. A function that performs all three steps at once. This is especially handy in case the user is not interested in the intermediate results (function *PROCESS-SEDI-AUTOMATIC*)
2. A function that, like the previous one, performs all steps at once, while taking estimated values for most of the settings (function *PROCESS-SEDI-ASSISTED*). The estimated values are save in a file, to serve as a starting point for more refined calculation.

Should any question arise, please contact:

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