CHAPTER 10

Irrigation area characteristics

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Summary

Point data of an irrigation command area in Haryana has been collected on water depths (during dry and wet season) and electrical conductivity. Part of the area is negatively effected by salinity and waterlogging. The objective of the study is to analyze the causes for these common problems in command areas. First the outcome of various interpolation procedures of the point data has to be evaluated before relations between EC and distance from canal, EC and vegetation index, water table fluctuations and distance from canal can be analyzed. The findings of the study has to be put in output maps, graphs and tables. The case study is based on actual data collected by the Central Soil Salinity Research Institute in Karnal, Haryana, India.

Getting started

The data for this case study are stored on the ILWIS 2.1 CD-ROM in the directory d:\appguide\chap10. If you have already installed the data on your hard-disk, you should start up ILWIS and change to the subdirectory where the data files for this chapter are stored, c:\ilwis21\data\appguide\chap10. If you did not install the data for this case study yet, please run the ILWIS installation program (see ILWIS Installation Guide).

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- Double-click the ILWIS program icon in the ILWIS program group.

- Change the working drive and the working directory until you are in the directory c:\ilwis21\data\appguide\chap10.

Now you are ready to start the exercises of this case study.

10.1 Basic data

The area under investigation is located in Haryana State, India. Two main waterways can be distinguished: the main irrigation canal running from North to South and the main drain running from West to East. A radial road pattern branches from each village center. The first crop of the season is mainly rice, which is harvested in October. This crop is mainly grown partly under rain-fed conditions, partly under irrigated conditions. The second crop, mainly sugarcane is grown under irrigated conditions.

A SPOT-image recorded 3rd January 1989 during the second crop in the agricultural year. Areas which remain bare due to waterlogging and/or salinity can be easily identified on the image. The dark spots indicate waterlogged areas, the white spots could indicate salt crystals at the soil surface.

In the pilot area an intensive measurement campaign has been executed. In a grid watertable levels, EC- values and elevations have been recorded.

Data overview

To get an overview of the available data browse through the directory where all the data for the exercise is. Open all maps, tables and images. The following maps are available:

Spab1gc	Geocorrected SPOT image band 1 .
Spab2gc	Geocorrected SPOT image band 2.
Spab3gc	Geocorrected SPOT image band 3.
Gohana	Polygon map with topographical data.
Data	Point map.
Data	Attribute table with the following columns:

	Village	village
	ph2	pH
	Elv	elevation in m.a.s.l.
	Wto	watertable October (meters below surface)
	Wtj	watertable June (meters below surface)
	Ece	electrical conductivity (mmhos/cm)

The available interpolated maps will be discussed in section 10.2.

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- Display the Spab3gc.

- Display, on top of the SPOT band, the polygon map Gohana with the topographical data.

> - Add the point map `Data` to the window, include the attribute `Ece` to the view. Adjust the point symbol size.
>
> - Remove the attribute `Ece` and display the elevations of each grid point.

❗ Note that at each point not all the components have been measured. If an item is not included a "?" is given.

10.2. Image processing

To analyze the surface processes some image processing has to be done. A false color image has to be created to improve the visual interpretation capabilities. The Normalized Difference Vegetation Index (NDVI) has to be created to get a better indication of the vegetation densities in the area.

The NDVI is calculated using the built in function NDVI(band1,band2). The NDVI is a bounded ratio ranging from -1 to + 1.

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>
> - Create a false color image of the area.
>
> - Create a NDVI of the area.
>
> - Overlay the outline of the command area over both images and identify various cover types and vegetation densities.

10.3 Interpolation

The available data is point data. To analyze the groundwater table fluctuations and EC values for the whole area the point data has to be interpolated. In ILWIS various interpolation functions are available, nearest point, moving average, trend surface and moving surface. Each method has its own specific procedure (see Reference guide). It is difficult to give strict rules about which interpolation method has to be used. The interpolation method selected should match the accuracy of the data measured. Although this "real-life" data set is not the most appropriate to demonstrate various interpolation methods, one exercise is given on the effect of various interpolation methods.

Interpolating maps is time-consuming. For this reason some points maps have already been interpolated. Some other maps need to be interpolated.

The following interpolated maps have been created using *a moving average procedure with a limiting distance of 1400 meter*: (Points further away than 1400 meter are assigned the weight zero and not taken into account during the interpolation.)

Elma1400   Surface elevations in meters above sea level.

Wjma1400   Watertable levels in January (in meters below surface).

Ecma1400   EC values (mmhos/cm).

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- Display the map Ecma1400 with measured Ec values of the point map. Check the result of the interpolation.

- Interpolate the point observations of the water table for October. Use the moving average procedure with the *linear decrease* method and a limiting distance of 1400 meter and a weight exponent 1. Give the map the name Woma1400.

- Calculate the level of the watertable of both months in meters above see level.

- Create a map Grwfluc with the groundwater fluctuations.

Spatial correlation

The result of the interpolating procedure depends on the method and the values for weight and limiting distance. The next exercise looks into the effect of these factors.

Point statistics may help to get an impression of the nature of your point data. Spatial correlation measures dependence among nearby values in a spatial distribution. Variables may be correlated because they are affected by similar processes that extend over a larger region. In ILWIS distances between points are calculated and autocorrelation and (semi) variance are calculated for points that are more or less at the same distances from each other (for more details refer to the Help on Spatial correlation operations).

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- Calculate the spatial correlation between the values of the Ec. Do the same for the values of the water table in October.

- Analyze the autocorrelation of these two data sets.

! Note that correlations are not so high. The 1400 meter used as limiting
  distance is maybe too much.
  Why is the correlation for water table values higher compared to the EC
  values.

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- Interpolate the `Data` point map. Use `Wto` as attribute. The limiting
  distance is 700 m, linear decrease and a weight exponent of `1`. Give
  the map the name `Woma700`.

- Compare the result of this interpolation with map `Woma1400`.

Trend surface

Trend surface is another interpolation method. One polynomial surface is
calculated by a least square method approaching all point values in the map. A
trend surface is *fitted* through the points in such a way that the differences between
the measured and calculated points are minimized. A first order polynomial is an
inclined plane, a second order is a surface with one slope reversal, a third order
with two slope reversals, etc. The calculation of the interpolated surfaces is rather
quick compared to the moving average method.

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- Interpolate the `Wto` point data use plane, 2nd degree linear and 6th
  degree maps.

- Compare the result of these interpolations (also with the map
  `Woma1400`).

10.4 Data analyses

The base maps needed for the analyses were created in the previous chapters. In the
command area salinity and waterlogging can be observed (as discussed in chapter
1). Locally there are conveyance losses from the irrigation channel which base is
above the land surface. Most likely in areas with high water tables and poor
drainage where high ec-values occurs.

In the analyses the relations between canal and water table fluctuations, NDVI and
electrical conductivity, NDVI and watertable January have to be evaluated. As base
maps the maps interpolated with the moving average and limiting distance of 1400
meter will be used. A "distance from canal" map has to be created before relations

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can be analyzed between the location of the canal and the various water management problems.

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- The "distance from canal" map can not be made directly. Mask the polygon map Gohana using only the canal, rasterize the resulting map. Calculate the distance from the canal, use a step size of 10 meter.

- Cross the Distance map with the map Grwfluc (use also for Grwfluc a step size of 0.1 meter).

- Create a graph in which the relation between groundwater fluctuations and "distance to canal" can be observed.

From the graph can be concluded that there is some relation between the groundwater fluctuations and the distance from the canal: the further from the canal the higher the average fluctuations. Most likely low fluctuations near the canal are caused by seepage losses from the canal.

❗ Why is it advisable to select large step sizes for distance and the water table fluctuations?
Keep in mind you are working with real data. The correlation you find are in this case not very clear. Important though is that the methodology of this kind of analyses is clear to you.

The same kind of analyses can be done for: the NDVI and electrical conductivity; the Ec and distance from the canal.

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- Cross the maps NDVI and EC and EC and "Distance from canal". If the crossing does not give good results reduce the step sizes of the original maps.

- Create graphs which clarify the relations between the factors.

Acknowledgment