Chapter 33: Spatial Risk

As mentioned in the overview of human health risk chapter, risk is based on exposure scenarios. An exposure unit is a geographically defined area where exposure will occur. Exposure is usually statistically summarized by a representative concentration that reflects the exposure experiecned within the unit over time. This unit is based on some geographically defined area or a predefined, reasonable size (e.g. $1/8^{th}$ acre for residential). The tabular risk models discussed in previous chapters allow you to spatially define exposure units and automatically aggregate data found within the units into the representative concentration. This results in single risk value for any given scenario.

In this chapter we discuss contouring risk over space. SADA will convert any geospatial estimation map into a geospatial risk map. This conversion is performed by using each modeled block concentration value as the exposure concentration in the risk models. From a risk standpoint, individual block risk may not provide useful information on its own, especially for small block sizes. The scenario parameters often assume the receptor will be exposed to the contaminant over a number of years. This translates into an assumption that the individual will be exposed to a single block for a number of years and/or a large portion of the day. For small block sizes (e.g., 1ft x 1ft), this is not reasonable. However, for block sizes that are equivalent to the exposure area, block sizes can give an accurate perspective on the potential areas of concern at the site.

The spatial risk map does, however, provide useful information from a decision standpoint as it identifies the geographic areas that are driving the risk seen when exposed over the entire unit. With the risk map visible, this geographic risk drivers are more easily identified. This has important implications when deciding on a remedial course of action. Removal of higher risk areas may sufficiently reduce exposure for certain activities. There are a couple of decision analsysis frameworks discussed shortly that address this very issue.

In this chapter, we will simply discuss how to convert an estimation map into a risk map and leave the discussion regarding decision analysis until later.

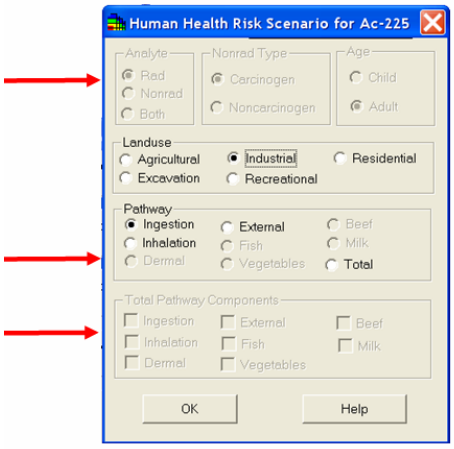
Human Health Risk Maps

This discussion assumes you have read Chapters 17-21 on human health risk in SADA. We will begin where the tabular risk assessment and spatial risk screening tools left off. Open up the file SpatialRiskModeling.sda. Change the analysis from General to Human Health. Make sure you have selected Soil and Ac-225.

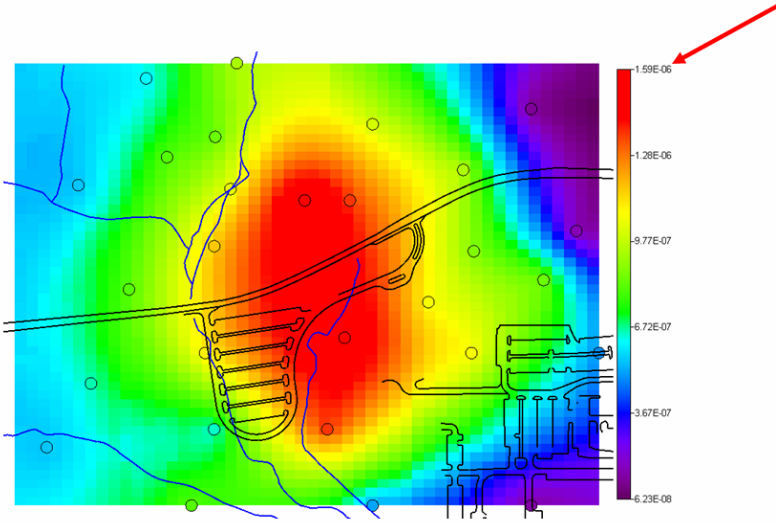
In a spatial risk model, you have complete control over the calibration of the toxicity and scenario parameters. These are still acceHowever, the exposure concentration statistics have no meaning here. Each modeled block value will become an individual exposure concentration. This is necessary to identify the geographic risk drivers contributing to the total risk experienced on the site.

Switch the interview to Draw a contoured risk map. You will notice that the same steps appear as when you are simply contouring the site. The risk component is introduced after you press the Show the Results button. SADA will then ask for a specific scenario. An ordinary kriging model has been established already for Ac-225. In practice, you would need to explore the spatial variation in your data and derive your own geospatial model (Chapters 29-32). In the

interest of simplicity, we have already taken care of this part. All you will need to do now is press Show the Results button. SADA then presents you with a set of valid risk choices given your current contaminant and media type. Notice that all irrelevant options or "no choice" options have been grayed out.



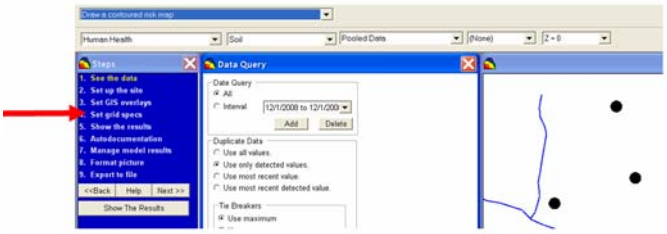
From the remaining enabled options, you can customize your own scenario. In this case, we'll just choose an industrial ingestion scenario. Select industrial as the landuse and press the OK button. SADA produces a risk map.



In most situations, the conversion of concentration or activity to risk will yield a similar looking map. This is because at most concentration ranges risk is roughly a linear transformation. Notice however the legend has changed to reflect the application of the industrial ingestion risk model.

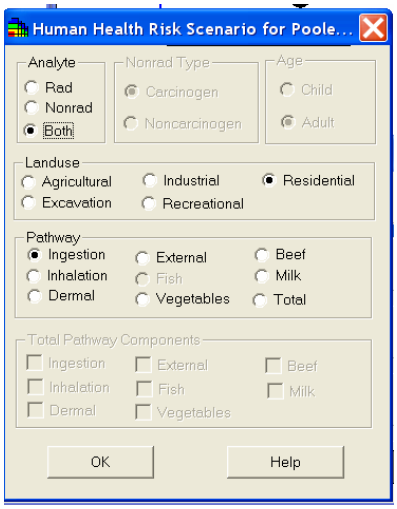
It is also possible to create a pooled risk map. In a pooled risk map, SADA will convert all relevant contaminants (depends on your scenario and toxicological choices) into risk and then sum them up. You will need a geospatial model established for each contaminant you include. In this example, a geospatial model has been established for every contaminant found in the soil. In practice, you would need to do this yourself.

Choose pooled data from the list of available contaminants and make sure you still have the interview Draw a contoured risk map selected.

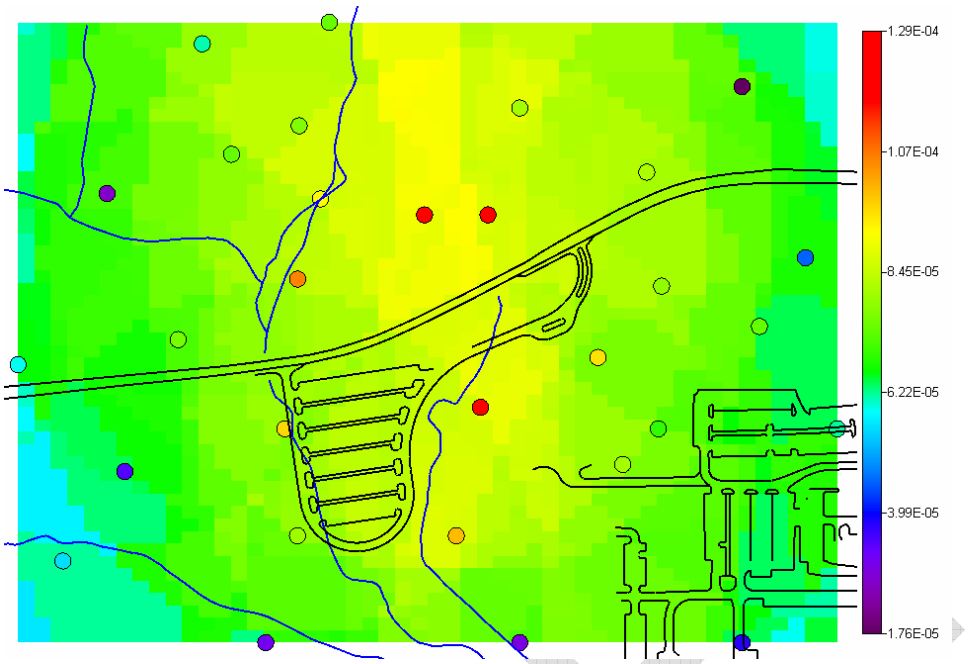


Notice that in the list of steps, there is no longer any steps specific to geospatial modeling other than Set grid specs. For pooled risk maps, these parameters must be calibrated for each contaminant individually. You would first need to visit each contaminant and establish a geospatial model and then return to this location. Fortunately, this has been taken care of for this example.

Press Show the Results and a risk/scenario options window appears. This time, many of the options are enabled. You will first need to choose the class of analytes you want to work with: rad, nonrad, both. Depending on your selection, the rest of the window adjusts itself disabling and enabling various options accordingly. With Both selected, you must choose carcinogens as a noncarcinogenic evaluation would not make sense when you are including radionuclides in the analysis. If you switch to nonrads, then the carc/noncarc options now becomes enabled. Spend some time clicking on the various options. When you are finished, make sure your options look like the following and press OK.

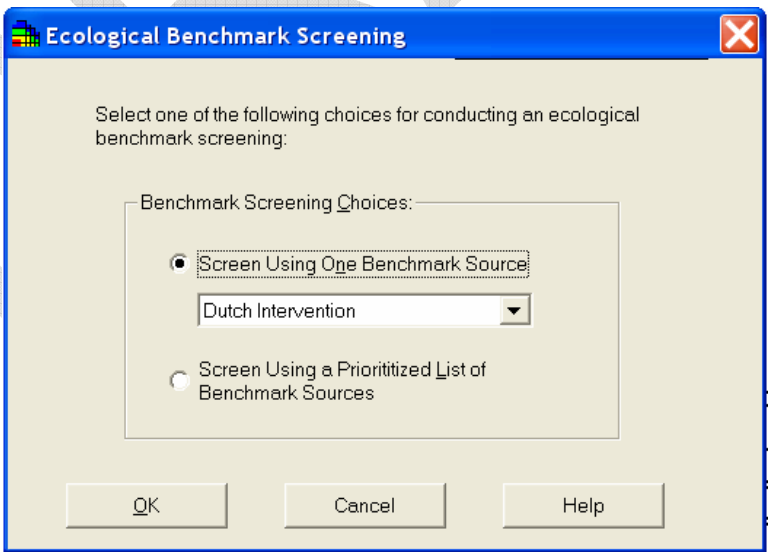


SADA responds with a summed risk map.



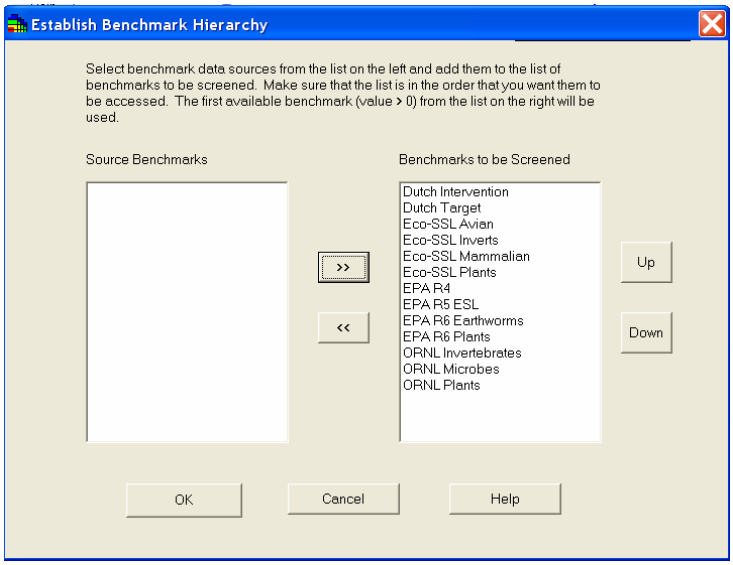
Ecological Risk Maps

The same kind of mapping can be conducted for ecological risk. This discussion assumes you have read the chapters pertaining to Ecological risk assessment (chapters 22-25). Switch to Arsenic, Inorganic and then switch the analysis type to Ecological. The first step in creating an ecological risk map is to calibrate the underlying geospatial model. In this case, for Arsenic, this has been done already. If you click on the Interpolation Methods step you can see that Ordinary Kriging has been selected. Press Show The Results and a benchmark selection window is presented.

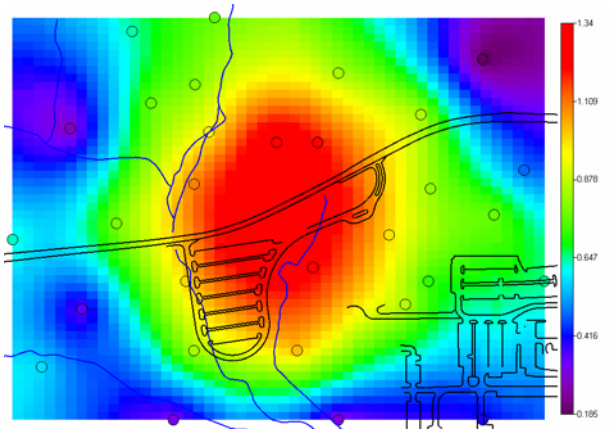


You may recognize this from the ecological point risk or ecological data screen map. Select Screen Using a Prioritized List of Benchmark Sources and press OK.

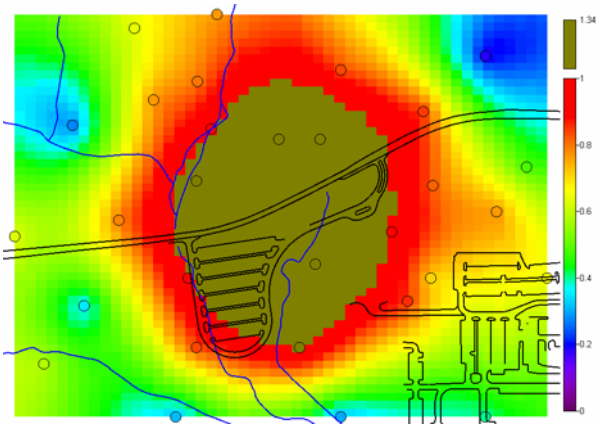
In the next window, you will create a prioritized list of benchmarks to choose from. Make sure your window looks like the following and press Ok.



SADA will respond by converting geospatial model values into a a risk ratio map.



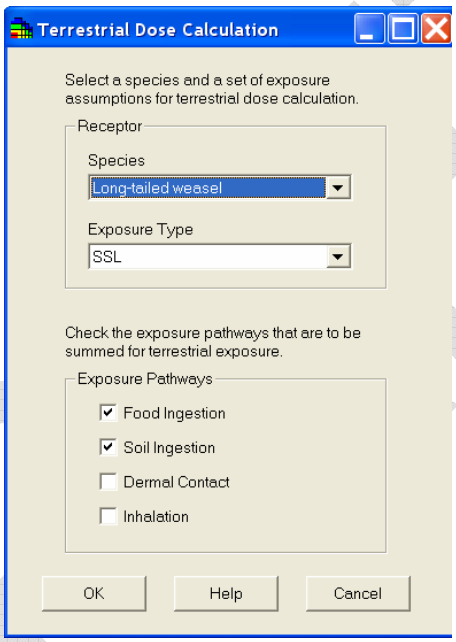
Try your hand at creating a new fixed continuous legend that is fixed from 0 to 1 (hint: Graphics→Legend Manager). Anything greater than 1 will receive a brown color. See if you can get this picture.



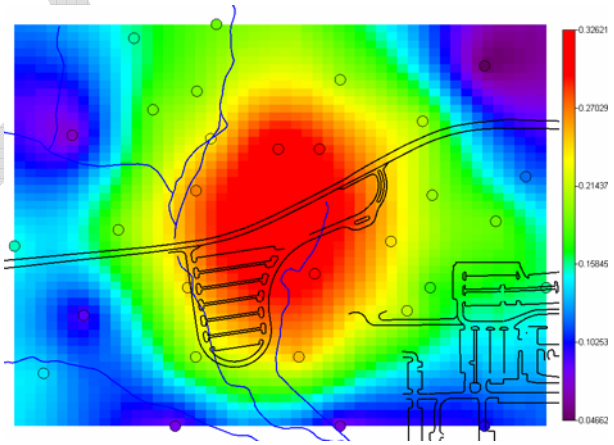
If you switch now to Pooled Data under the Ecological Analysis you will notice that virtually all interviews including Draw a Contoured Risk map are now missing. This is because under ecological risk there is no equivalent to pooled risk.

Ecological Dose

The same kind of mapping can be conducted for ecological dose. This discussion assumes you have read the chapters pertaining to Ecological dose assessment (chapters 26-27). Switch back to Arsenic and choose the interview Draw a contoured eco dose map. As previously mentioned, the first step in creating a dose map from scratch is to establish a geospatial model. This has already been done for you in this example (ordinary kriging). SADA will then convert these model values into dose values allowing you to see the areas of the site that are driving dose. Press Show The Results and you will be presented with receptor and exposure options.



You may recognize this from earlier chapters on point dose. If you are not familiar with these terms or options please refer to the introductory chapters on ecological risk. Select Long-tailed weasel, SSL, Food Ingestion, and Soil Ingestions and press OK.



The dose map for this receptor is produced. Recall that you can control the behavior of the Long-tail weasel (and other receptors) by going to Ecological→Configure Ecological Risk→Set Terrestrial Exposure Parameters. Other parameters are found in Ecological→Configure Ecological Risk→Set Terrestrial Contaminant Parameters. Please return to the introductory ecological risk chapters for more information on these screens.

We are now ready to move on to the decision analysis frameworks which can integrate risk, geospatial models, and uncertainty together to quanity how each may affects a final decision outcome

