

SADA General Information

Windows--based freeware designed to integrate scientific models with decision and cost analysis frameworks in a seamless, easy to use environment.

- Visualization/GIS
- Statistical Analysis
- Geospatial Interpolation
- Geospatial Uncertainty Analysis
- Human Health Risk Assessment
- Ecological Risk Assessment
- Custom Analysis
- MARSSIM Module
- Area of Concern Frameworks
- Cost Benefit Analysis
- Sampling Designs
- Export to Arcview/Earthvision

SADA has been supported by DOE, EPA, and the NRC. SADA Version 3.0 had about 11000 downloads. Version 4.0/4.1 has had 7000+ since January, 2005.



SADA General Information (cont.)

Free stand-alone package for Windows 98, 98SE, NT SP4 or higher, 2000, ME, and XP.

Contact information, updates, documentation, and downloads are available on-line at <http://www.tiem.utk.edu/~sada/>

A SADA user's group, email, annual conferences, and 3-4 training sessions performed a few times a year.

A substantial help file is included.

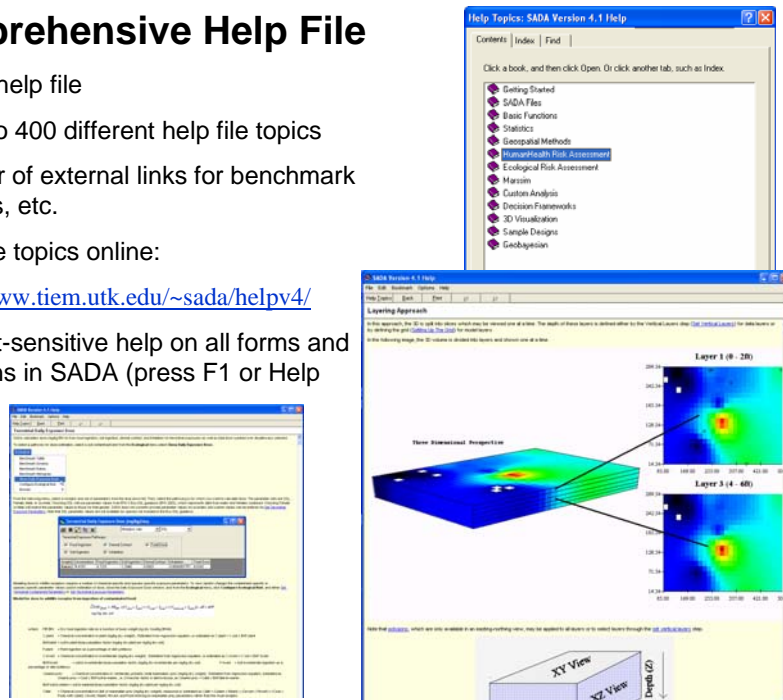
Conduct "black and white box" testing internally as well as an external beta release period.

Verification/quality assurance documents on the website.

Strong international presence (over 50% of downloads outside USA)

Comprehensive Help File

- 14 MB help file
- Close to 400 different help file topics
- Number of external links for benchmark sources, etc.
- Help file topics online:
<http://www.tiem.utk.edu/~sada/helpv4/>
- Context-sensitive help on all forms and functions in SADA (press F1 or Help button)




- 320 page user guide available from:
http://www.tiem.utk.edu/~sada/SADA_4_1_Usersguide.pdf

SADA Overview

Educational Use of SADA

- SADA used by many universities in computer laboratories for teaching undergraduate environmental sciences courses
- Actively creating curriculum for use by instructors for teaching both GIS and environmental assessment concepts
- Developing an education resource web site for SADA

<http://www.tiem.utk.edu/~sada/education>



SADA
Spatial Analysis and Decision Assistance (SADA): Freeware for GIS and Environmental Assessment in the Classroom
S.T. Purucker, R.N. Stewart, C.J.E. Webb

The Institute for Environmental Modeling, U. Tennessee

Background
SADA was developed by the Environmental Sciences Center, University of Tennessee, Knoxville, Tennessee. It is a freeware, user-friendly, and easy-to-use GIS-based software package that can be used in an undergraduate computer laboratory setting to analyze contaminated media data using GIS and statistical analysis methods. Using the software and available practice exercises, undergraduate students are able to make decisions concerning how to sample a contaminated site, estimate exposure and characterize potential risks to ecological populations in a spatial context, and determine appropriate cleanup measures at a site. SADA contains Geographical Information Systems (GIS) capabilities, ecological exposure and toxicological information, and spatial statistical methods for estimating the location of pollution in contaminated media.

Biological Risk Assessment
SADA contains a large database of ecological toxicological information, including chemical, physical, and biological data. This database can be used to assess the potential risks to ecological populations from contaminated media. The database includes information on the toxicity of chemicals, the sensitivity of various species, and the distribution of species in the environment. This information can be used to estimate the potential risks to ecological populations from contaminated media. The database also includes information on the distribution of species in the environment, which can be used to estimate the potential risks to ecological populations from contaminated media.

Descriptive Statistics
SADA contains a large database of descriptive statistics, including mean, standard deviation, and variance. These statistics can be used to describe the distribution of data in a spatial context. The database also includes information on the distribution of species in the environment, which can be used to estimate the potential risks to ecological populations from contaminated media.

Spatial Interpolation
SADA contains a large database of spatial interpolation methods, including kriging, inverse distance weighting, and nearest neighbor. These methods can be used to estimate the values of data at locations where no data are available. The database also includes information on the distribution of species in the environment, which can be used to estimate the potential risks to ecological populations from contaminated media.

Individual-based Movement Models
SADA contains a large database of individual-based movement models, including random walk, correlated random walk, and Lévy flight. These models can be used to estimate the movement of individuals in a spatial context. The database also includes information on the distribution of species in the environment, which can be used to estimate the potential risks to ecological populations from contaminated media.

Decision Context
SADA contains a large database of decision context information, including information on the distribution of species in the environment, the sensitivity of various species, and the toxicity of chemicals. This information can be used to estimate the potential risks to ecological populations from contaminated media. The database also includes information on the distribution of species in the environment, which can be used to estimate the potential risks to ecological populations from contaminated media.

GIS Capabilities
SADA contains a large database of GIS capabilities, including map creation, data manipulation, and spatial analysis. These capabilities can be used to analyze data in a spatial context. The database also includes information on the distribution of species in the environment, which can be used to estimate the potential risks to ecological populations from contaminated media.

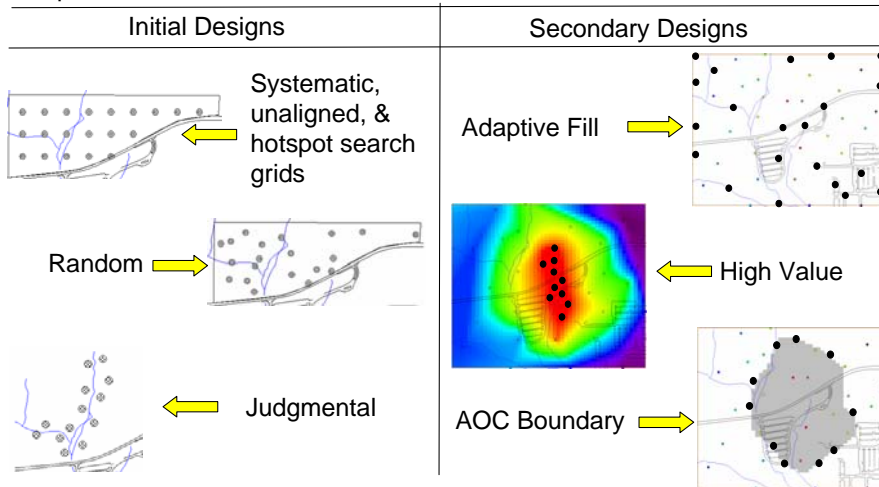
Design Sample Plans
SADA contains a large database of design sample plans, including random sampling, systematic sampling, and stratified sampling. These plans can be used to estimate the values of data at locations where no data are available. The database also includes information on the distribution of species in the environment, which can be used to estimate the potential risks to ecological populations from contaminated media.

What exactly can you do in SADA?

Create initial sample designs	Create probability maps
Import data	Define areas of concern
Plot data	Calculate cost vs cleanup
Import GIS layers	Draw a LISA Map
Aggregate sections of the site	Develop secondary sample designs
Calculate statistics (univariate)	Perform a MARSSIM data analysis
Model spatial correlation	Detect and Define MARSSIM elevated area
Create contour maps	Visualize results in 3d
Create a kriging variance map	Autodocument results
Perform traditional HH and Eco risk assessments (tabular risk, screens, prgs, benchmarks)	Create a geobayesian site conceptual model
Create a HH or Eco contoured risk map	Draw area of concern maps based on conceptual model
Create a HH or Eco point risk map	Calculate cost vs cleanup based on conceptual model
Create a data screen map for HH, Eco, Custom	Update the site conceptual model
Create an eco point dose map	Export to ESRI or Earthvision or common window applications
Create an contoured eco dose map	

Sample Designs

SADA has a number of sample design strategies in Version 4. These strategies include initial and secondary designs. Some are based on data alone while others are based on modeling results. With the exception of a couple of exclusively 2d designs all are available in 3d dimensions. Below are a few examples of each.



Sample Laboratory Data

PROJECT NAME	PROJECT #	SAMPLE I	SAMPLE ID	DATE COLL	DATE RECD	ANALYZED	TAI LAB #	ANALYTE	RESULT	POL	UNITS	METHOD
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/7/2002	02-A162603	Aldrin	< 0.00005	5E-05	mg/l	8081A
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/7/2002	02-A162603	a-BHC	< 0.00005	5E-05	mg/l	8081A
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/7/2002	02-A162603	b-BHC	< 0.00005	5E-05	mg/l	8081A
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/7/2002	02-A162603	d-BHC	< 0.00005	5E-05	mg/l	8081A
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/7/2002	02-A162603	g-BHC, Lindane	< 0.00005	5E-05	mg/l	8081A
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/7/2002	02-A162603	4,4'-DDD	< 0.00010	0.0001	mg/l	8081A
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/7/2002	02-A162603	4,4'-DDE	< 0.00010	0.0001	mg/l	8081A
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/7/2002	02-A162603	4,4'-DDT	< 0.00010	0.0001	mg/l	8081A
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/7/2002	02-A162603	Dieldrin	< 0.00010	0.0001	mg/l	8081A
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/7/2002	02-A162603	Endosulfan I	< 0.00005	5E-05	mg/l	8081A
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/7/2002	02-A162603	Endosulfan II	< 0.00010	0.0001	mg/l	8081A
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/7/2002	02-A162603	Endosulfan Sulfate	< 0.00010	0.0001	mg/l	8081A
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/7/2002	02-A162603	Endrin	< 0.00010	0.0001	mg/l	8081A
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/7/2002	02-A162603	Endrin Aldehyde	< 0.00010	0.0001	mg/l	8081A
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/7/2002	02-A162603	Endrin Ketone	< 0.00010	0.0001	mg/l	8081A
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/7/2002	02-A162603	Heptachlor	< 0.00005	5E-05	mg/l	8081A
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/7/2002	02-A162603	Heptachlor Epoxide	< 0.00005	5E-05	mg/l	8081A
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/7/2002	02-A162603	Methoxychlor	< 0.00010	0.0001	mg/l	8081A
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/7/2002	02-A162603	Toxaphene	< 0.00500	0.005	mg/l	8081A
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/7/2002	02-A162603	alpha-Chlordane	< 0.00005	5E-05	mg/l	8081A
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/7/2002	02-A162603	gamma-Chlordane	< 0.00005	5E-05	mg/l	8081A
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/6/2002	02-A162603	Aroclor 1016	< 0.00050	0.0005	mg/l	8082
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/6/2002	02-A162603	Aroclor 1221	< 0.00100	0.001	mg/l	8082
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/6/2002	02-A162603	Aroclor 1232	< 0.00050	0.0005	mg/l	8082
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/6/2002	02-A162603	Aroclor 1242	< 0.00050	0.0005	mg/l	8082
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/6/2002	02-A162603	Aroclor 1248	< 0.00050	0.0005	mg/l	8082
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/6/2002	02-A162603	Aroclor 1254	< 0.00050	0.0005	mg/l	8082
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/6/2002	02-A162603	Aroclor 1260	< 0.00050	0.0005	mg/l	8082
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/5/2002	02-A162603	Arsenic	< 0.0050	0.005	mg/l	6010B
I-40/I-640 SINKHOLE	4969 013	BW/JJO	HSSW1	10/1/2002	10/3/2002	10/5/2002	02-A162603	Barium	0.08	0.01	mg/l	6010B

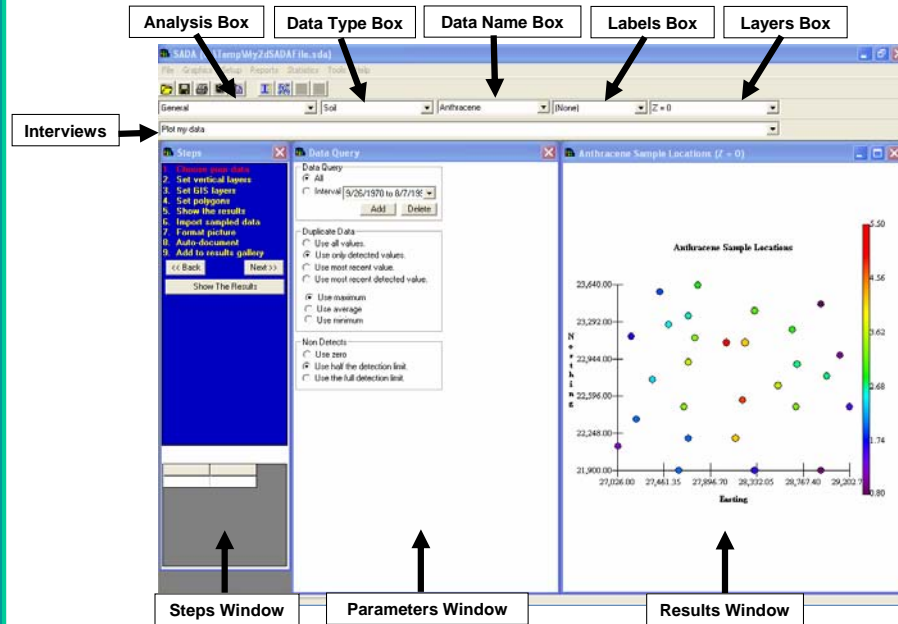
SADATM
Special Analysis and Decision Assistance

Data Formats

- SADA can accept data in two formats: comma delimited files (csv) and Microsoft Access.
- SADA requires the presence of certain fields in the data set.
 - Easting
 - Northing
 - Depth
 - Value
 - Name
- SADA can use other forms of information as well
 - Media
 - Detection
 - Date
 - CAS Number
- Any other form of meta data can be imported as well. User can plot and retrieve this meta data during an analysis.
- SADA recognizes soil, sediment, surfacewater, groundwater, air, biota, and background, and the "basic" media type. Basic is assigned to data that have no media type.

SADATM
Spatial Analysis and Decision Assistance

The SADA Interface: Scaleable Interfacing

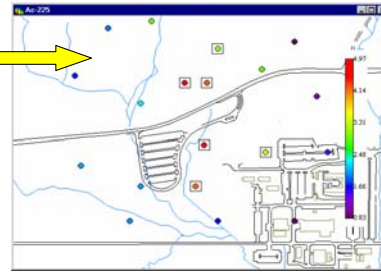
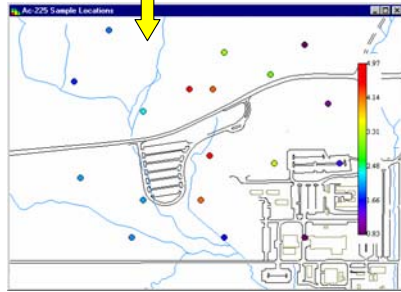


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Data Exploration

Data Plot/GIS Overlays

Spatial Data Screens

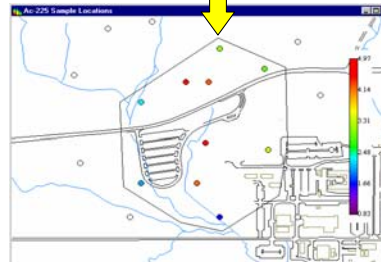


Polygon Selection/Cutaways

Statistics

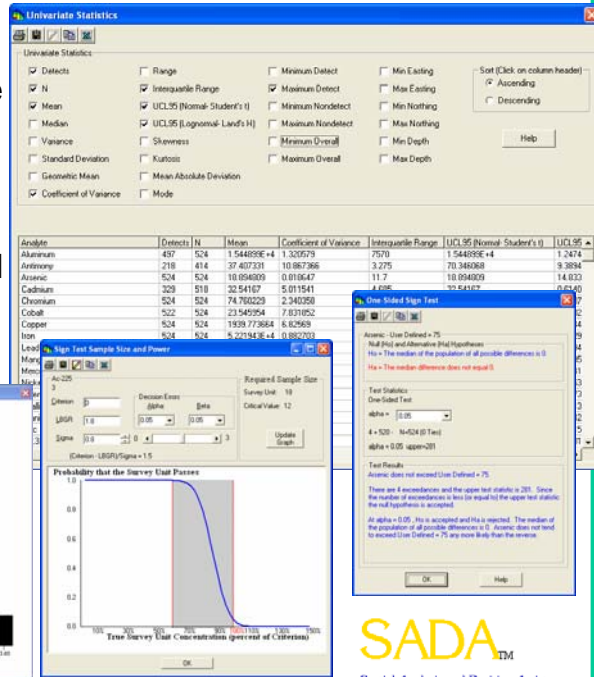
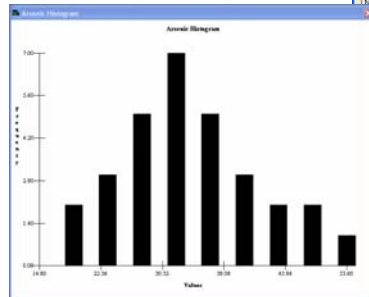
A screenshot of the 'Statistics' window in a GIS application. It displays a table with columns: 'Statistic', 'Value', 'Confidence Interval', 'Minimum Value', 'Maximum Value', and 'Standard Deviation'. The table lists various statistics for the 'Air 225 Sample Locations' dataset.

Statistic	Value	Confidence Interval	Minimum Value	Maximum Value	Standard Deviation
Count	10	10	0	10	3.16
Sum	1.00000	0.99999	0.00000	1.00000	0.31623
Mean	0.10000	0.09999	0.00000	1.00000	0.31623
Median	0.00000	0.00000	0.00000	1.00000	0.31623
Mode	0.00000	0.00000	0.00000	1.00000	0.31623
Range	1.00000	0.99999	0.00000	1.00000	0.31623
Standard Deviation	0.31623	0.31623	0.00000	1.00000	0.31623
Variance	0.10000	0.10000	0.00000	1.00000	0.31623
Skewness	0.00000	0.00000	0.00000	1.00000	0.31623
Kurtosis	0.00000	0.00000	0.00000	1.00000	0.31623
Sum of Squares	1.00000	0.99999	0.00000	1.00000	0.31623
Sum of Cubes	0.10000	0.09999	0.00000	1.00000	0.31623
Sum of Fourth Powers	0.01000	0.00999	0.00000	1.00000	0.31623
Sum of Fifth Powers	0.00100	0.00099	0.00000	1.00000	0.31623
Sum of Sixth Powers	0.00010	0.00009	0.00000	1.00000	0.31623
Sum of Seventh Powers	0.00001	0.00000	0.00000	1.00000	0.31623
Sum of Eighth Powers	0.00000	0.00000	0.00000	1.00000	0.31623
Sum of Ninth Powers	0.00000	0.00000	0.00000	1.00000	0.31623
Sum of Tenth Powers	0.00000	0.00000	0.00000	1.00000	0.31623



Statistics

- Numerous univariate statistics
- Non-parametric hypothesis testing
- Power curve based sample sizes
- Histogram and cdf

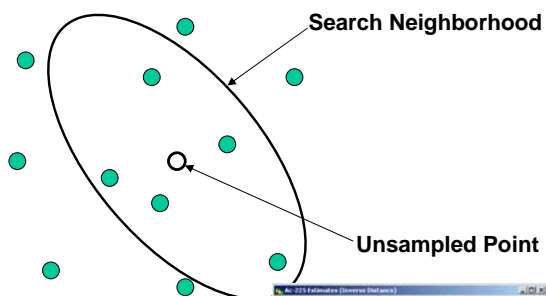


SADA
Spatial Analysis and Decision Assistance

Spatial Interpolation

The estimated value V_0 at an unsampled location is estimated as the weighted average of nearby values.

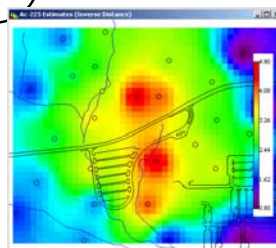
$$V_0 = \sum_{i=1}^N w_i V_i$$



Inverse Distance

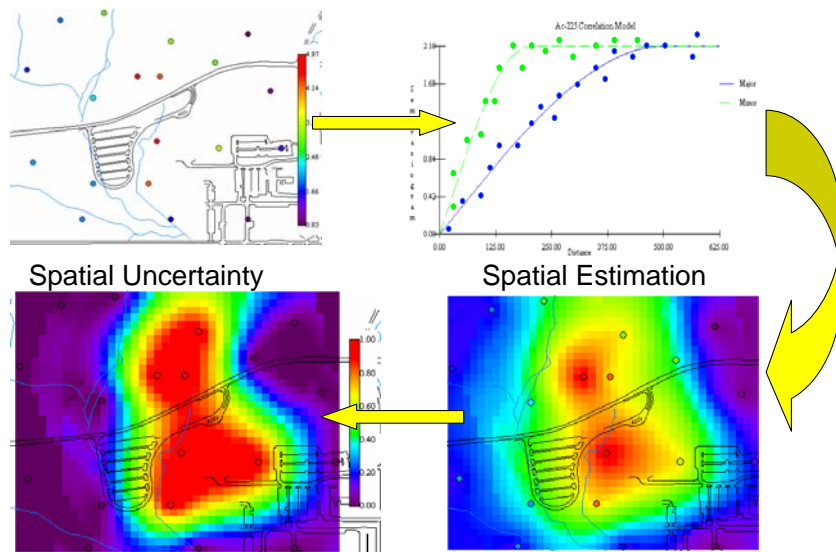
$$w_i = \frac{1}{d_i^p \sum_{j=1}^N d_j^{-p}}$$

w_i is the weight for the i th neighbor
 d_i is the distance of the i th neighbor
 p is the power
 N is the number of neighbors within the search neighborhood



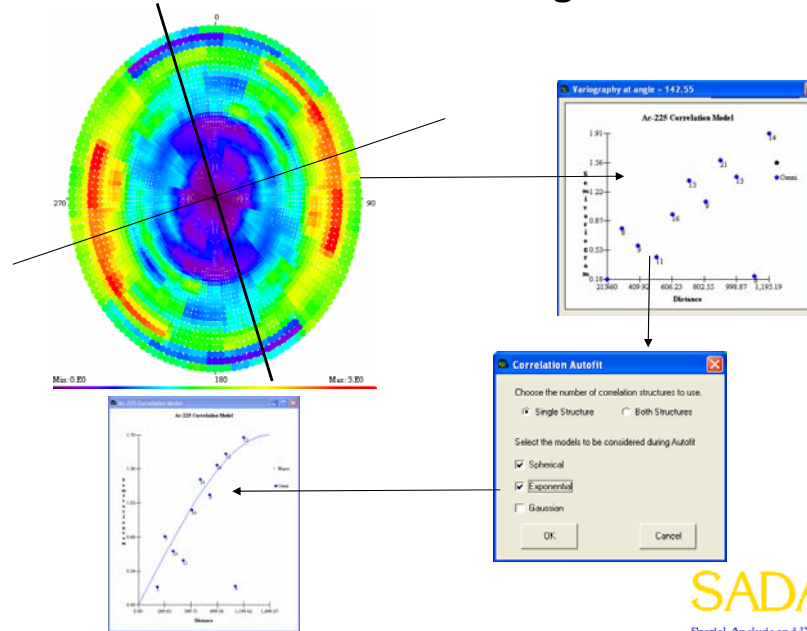
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Spatial Analysis



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Correlation Modeling Tools



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Spatial Analysis and Decision Assistance

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Geospatial References

- Applied Geostatistics, Isaaks and Srivastava
- Geostatistical Software Library (GSLIB), Deutsch and Journel
- Geostatistics for Natural Resources Evaluation, Pierre Goovaerts
- Geostatistics in Five Easy Lessons, Journel
- Spatial Data, Cressie

Spatial Implementation of Risk Assessment

- Conventional Risk Assessment Limitations
 - Typically regulatory exposure assessment guidance recommends a summary statistic for the exposure concentration
 - Spatial information is lost when a summary statistic is used in the RA-exposure is assumed to be continuous in space and time
 - Often this lost info not recovered in the rest of the remediation process
- Reasons for incorporating spatial statistics into risk assessment
 - Maximize the use of limited resources
 - Efficiently collect data
 - Retain collected spatial info in the risk assessment
 - Use all types of available data, including expert judgment
 - To more adequately characterize the exposure distribution
 - Extrapolate from known data to cover data gaps
 - Account for spatial processes related to exposure
 - Better understand uncertainties in the exposure assessment

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Ecological and Human Health Risk

- SADA implements EPA methods for conducting ecological and human health risk assessments
- Calculation of site-specific preliminary remediation goals
- Benchmark database for contaminant effects on ecological receptors
- Exposure modeling for humans and over 20 other terrestrial species
- Contains IRIS/HEAST toxicity databases for calculating risk from exposure
- Contains EPA default exposure parameters for the risk models
- Tabular screening and risk results
- Point screens
- Risk and dose mapping



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Human Health Risk Calculations

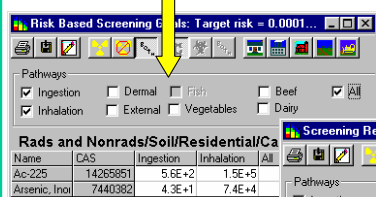
- For each media
 - Soil, Sediment, Surface Water, Groundwater
- Exposure Scenarios
 - Residential, Industrial, Recreational, Agricultural, Excavation
- Exposure Pathways
 - Ingestion, Inhalation, Dermal Contact, Food Chain (Beef, Milk, and Vegetable Ingestion)
- IRIS and HEAST Toxicity Databases for Carcinogenic and Noncarcinogenic Effects
- Physical Parameters for Modeling
 - Bioaccumulation Factors
 - Volatilization, Particulate Emission Factors
 - Permeability Constants, Absorption Factors
 - Saturation Coefficients, Radionuclide Half-Lives

SADA
Special Analysis and Decision Assistance

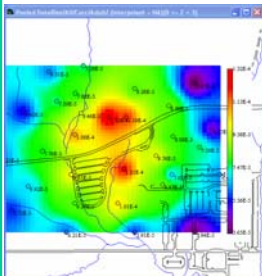
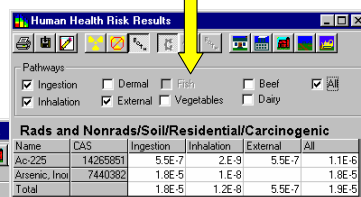
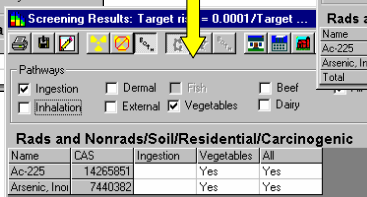
Human Health Risk

PRG Calculation

Forward Risk



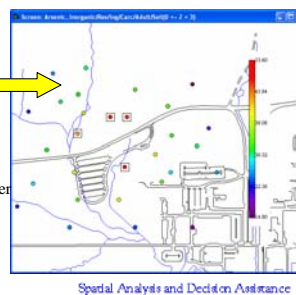
PRG Screens



Risk Based Spatial Screens

Risk Mapping

Residential, Industrial, Agricultural, Recreational, Worker
 Ingestion, Inhalation, Dermal, External, Food Chain
 Soil, Sediment, Surfacewater, Groundwater
 Packaged with Editable Scenario Parameters
 Packaged with IRIS and HEAST Database



Ecological Capabilities in SADA

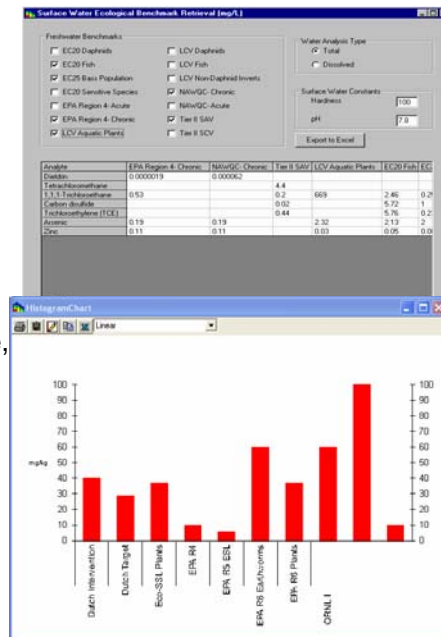
- SADA implements EPA methods for conducting ecological risk assessments
- Benchmark database for contaminant effects on ecological receptors, tabular and histogram access
- Exposure modeling for over 20 terrestrial species
- Contains EPA default exposure parameters for the risk models where available
- Tabular screening and risk result output
- Sample by sample screens displayed on maps
- Risk and dose mapping
- Areas of Concern based on exceedances of ecological benchmarks or TRVs
- Suggest additional sample locations based on uncertain areas of exceedance

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Ecological Benchmark Screening

Ecological Benchmarks

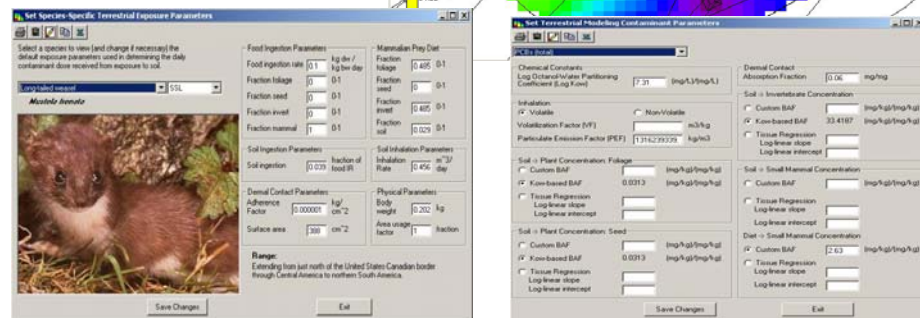
- Suitable for screening ERAs
- Compilation of ecological benchmarks for surface water, soil, sediment, and biota
- Benchmarks a function of environmental variables where appropriate
- Choice of statistics (max, percentile, UCL95, etc.)
- Hierarchy of media-specific benchmarks for screening
- Spatial and tabular display of ratios



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Ecological Dose Exposures

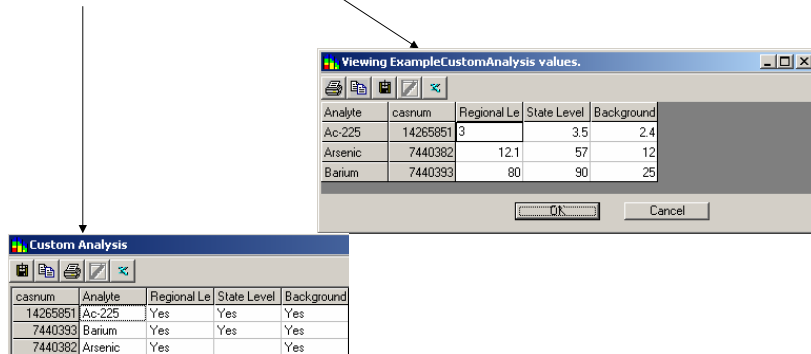
- SADA calculates dose (mg/kg BW d) from food ingestion, soil ingestion, dermal contact, and inhalation for terrestrial exposures
- SSL, Female, Male, or Juvenile
- Over 20 different species



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Custom Criteria

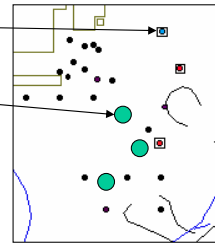
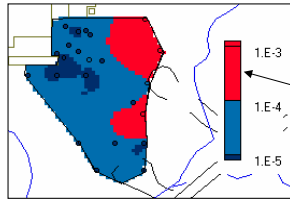
- View or Edit Criteria
- Data Screens



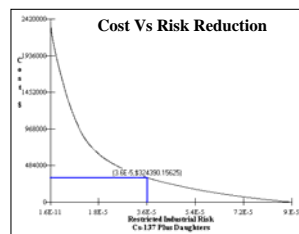
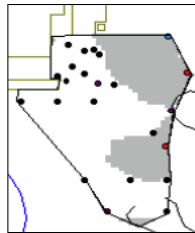
SADATM
Spatial Analysis and Decision Assistance

Decision Analysis

- Spatial Screens
- Sampling Strategies



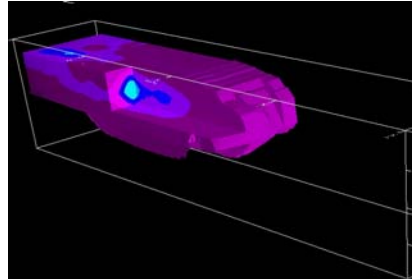
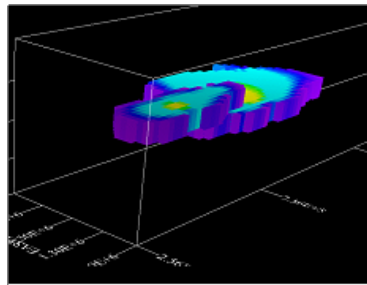
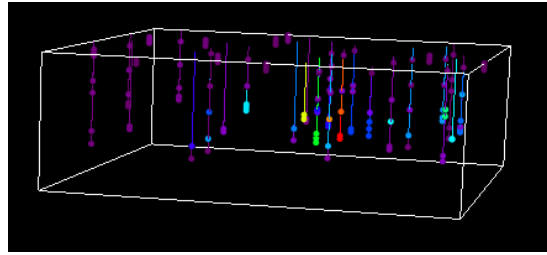
- Spatial Risk
- Area of Concern
- Cost Benefit



SADA
Spatial Analysis and Decision Assistance

3D Visualization

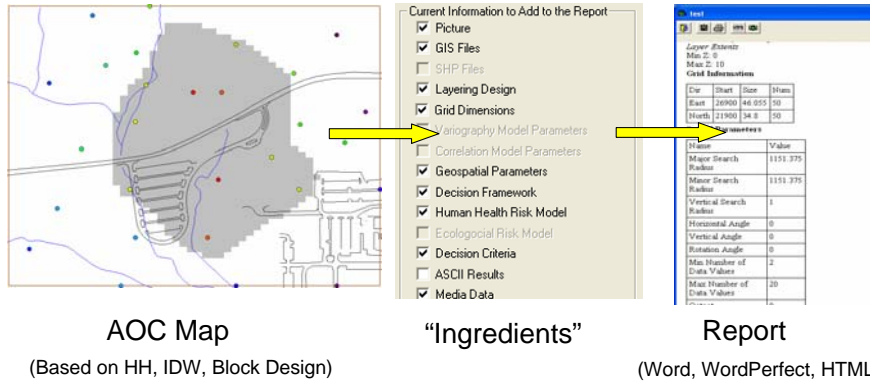
True 3d Views: Points,
Blocks, and Isosurfaces



SADATM
Spatial Analysis and Decision Assistance

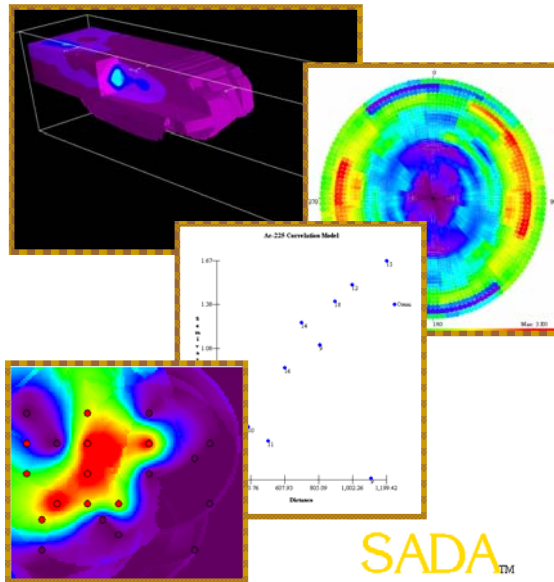
SADA Overview: Autodocumentation

- Provides transparency in the modeling process and facilitates reproducibility of results.
- Self-documentation of all parameters, models, and other relevant information (e.g. exposure concentrations, risk models, exposure variables, geospatial parameters, toxicity data, images etc)



Results Gallery

- Users can now save “static” results to the results gallery
- Users can view them, format them, and change various viewing properties
- Prevents users from having to regenerate a picture each time they want to see it
- Version 5.0 will allow dynamic results to be saved for further modeling



SADATM
Spatial Analysis and Decision Assistance

After viewing the links to additional resources, please
complete our online feedback form.

Thank You

[Links to Additional Resources](#)

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