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™
Spatial Analysis and Decision Assistance

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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)

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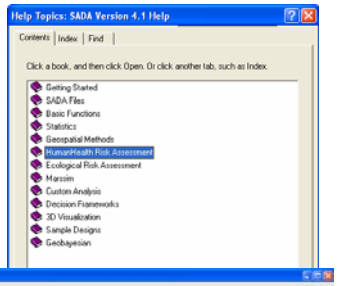
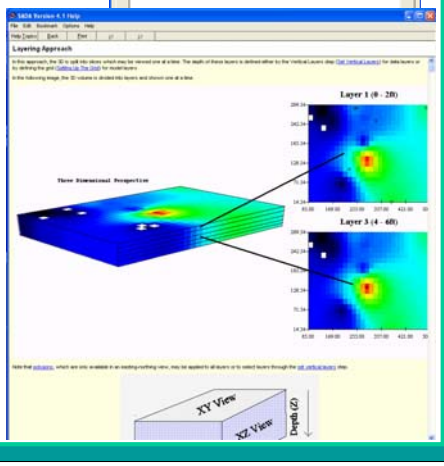
Comprehensive Help File

- 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)





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SADA Users Guide

- 320 page user guide available from:

http://www.tiem.utk.edu/~sada/SADA_4_1_Usersguide.pdf

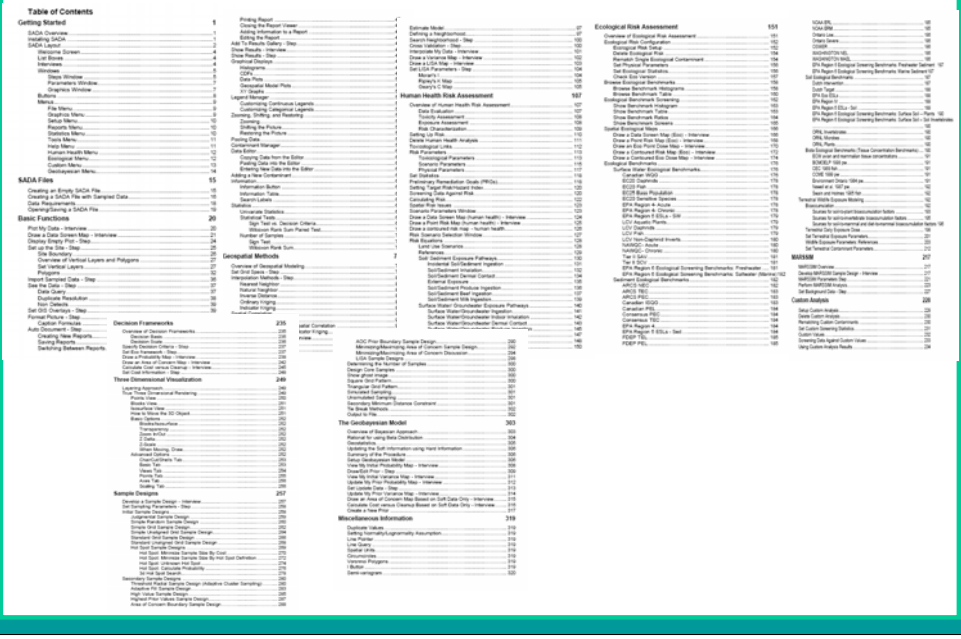
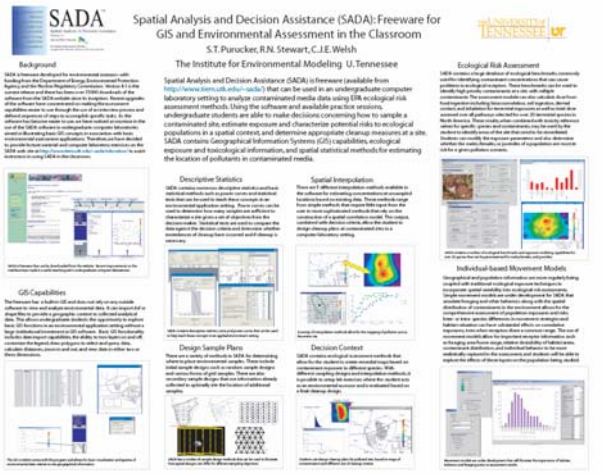


Table of Contents

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



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What exactly can you do in SADA?

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

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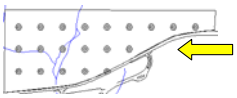
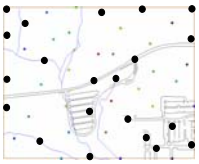
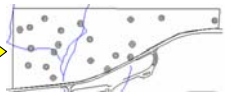
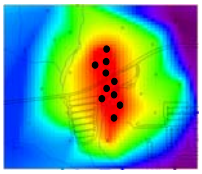
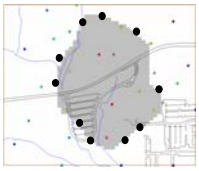
Sample Designs

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.

Initial Designs	Secondary Designs
 Systematic, unaligned, & hotspot search grids	Adaptive Fill 
Random 	 High Value
 Judgmental	AOC Boundary 

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Sample Laboratory Data

PROJECT NAME	PROJECT #	SAMPLEI	SAMPLE ID	DATE COLL	DATE RECD	ANALYZED	TAI LAB #	ANALYTE	RESULT	PQL	UNITS	METHOD
I-40/I-640 SINKHOLE	4969.013	BW/JO	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/JO	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/JO	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/JO	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/JO	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/JO	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/JO	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/JO	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/JO	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/JO	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/JO	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/JO	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/JO	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/JO	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/JO	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/JO	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/JO	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/JO	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/JO	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/JO	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/JO	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/JO	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/JO	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/JO	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/JO	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/JO	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/JO	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/JO	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/JO	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/JO	HSSW1	10/1/2002	10/3/2002	10/5/2002	02-A162603	Barium	0.08	0.01	mg/l	6010B

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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.

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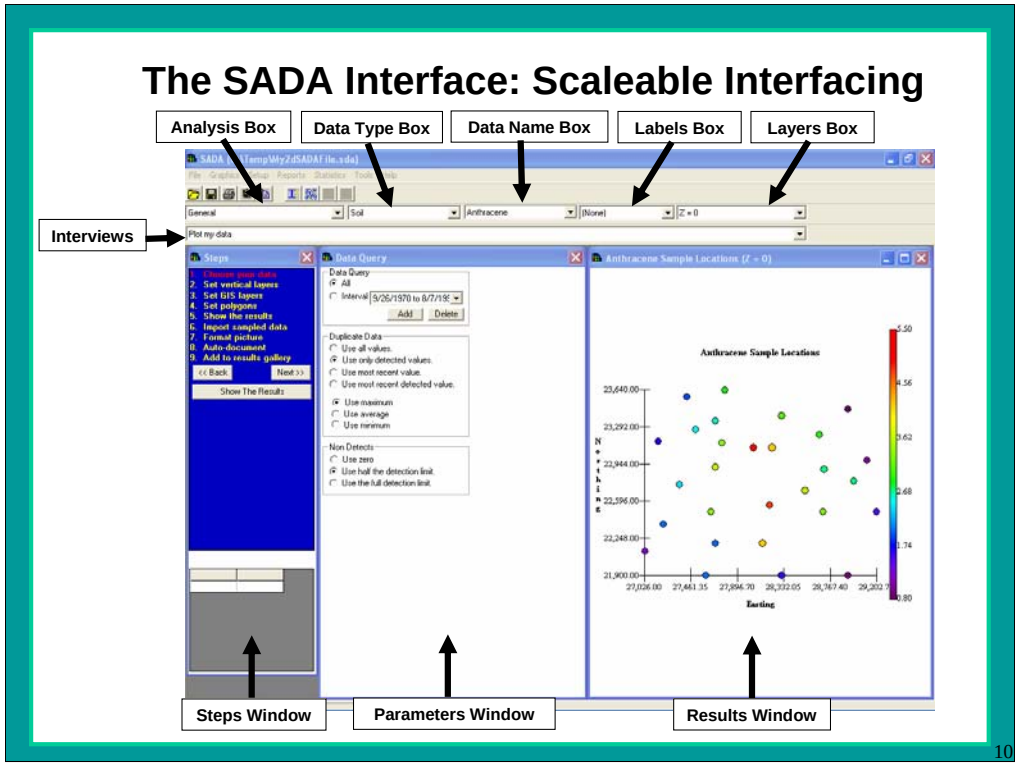
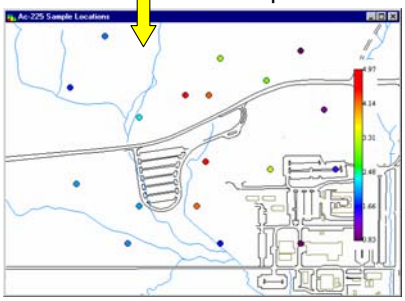
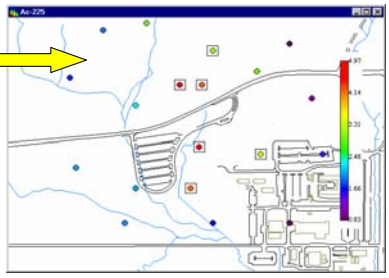

The SADA Interface: Scaleable Interfacing
Analysis Box
Data Type Box
Data Name Box
Labels Box
Layers Box
Interviews
Steps Window
Parameters Window
Results Window
10

Data Exploration

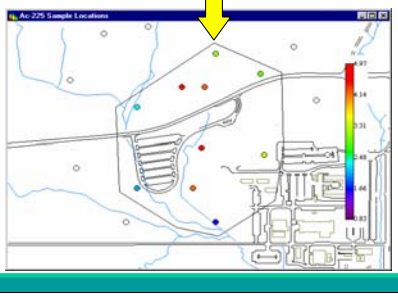
Data Plot/GIS Overlays



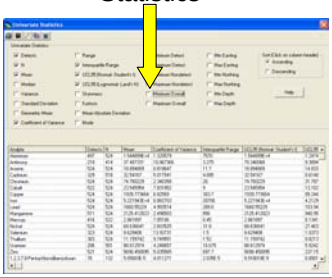
Spatial Data Screens



Polygon Selection/Cutaways



Statistics



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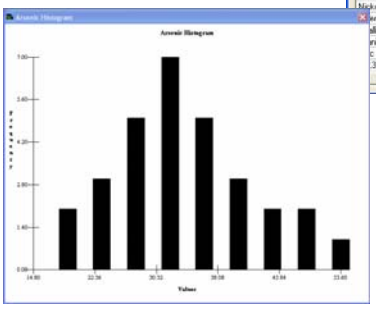
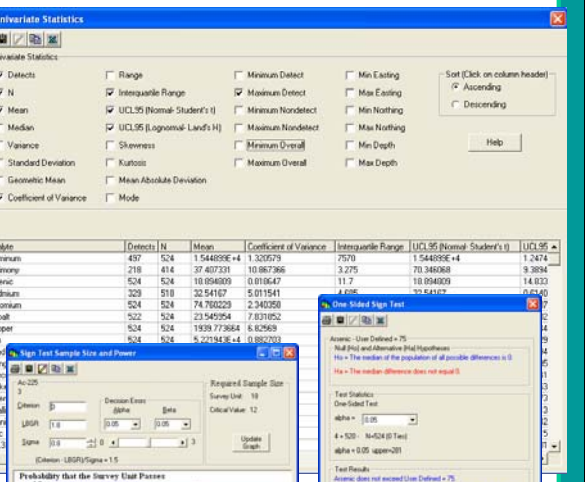
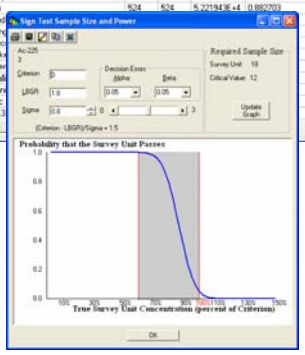
Statistics

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







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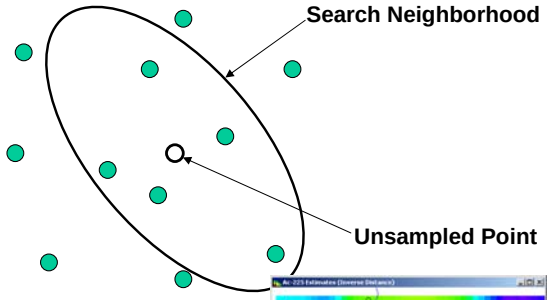
Spatial Interpolation

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

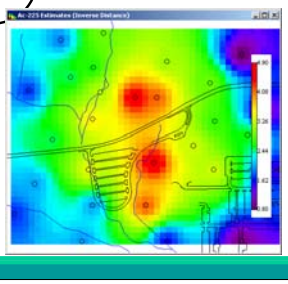
$$V_0 = \sum_{i=1}^{N} w_i V_i$$



Inverse Distance

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

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



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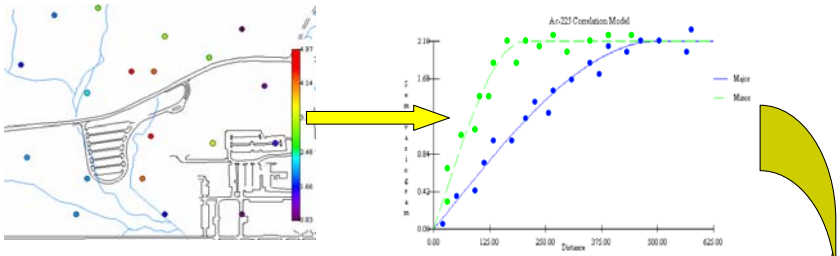
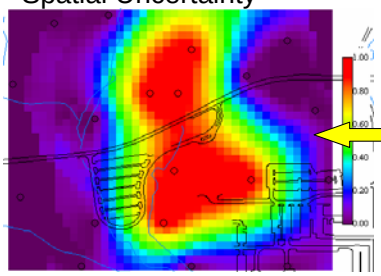
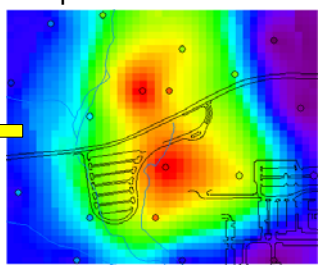
Spatial Analysis



Spatial Uncertainty



Spatial Estimation



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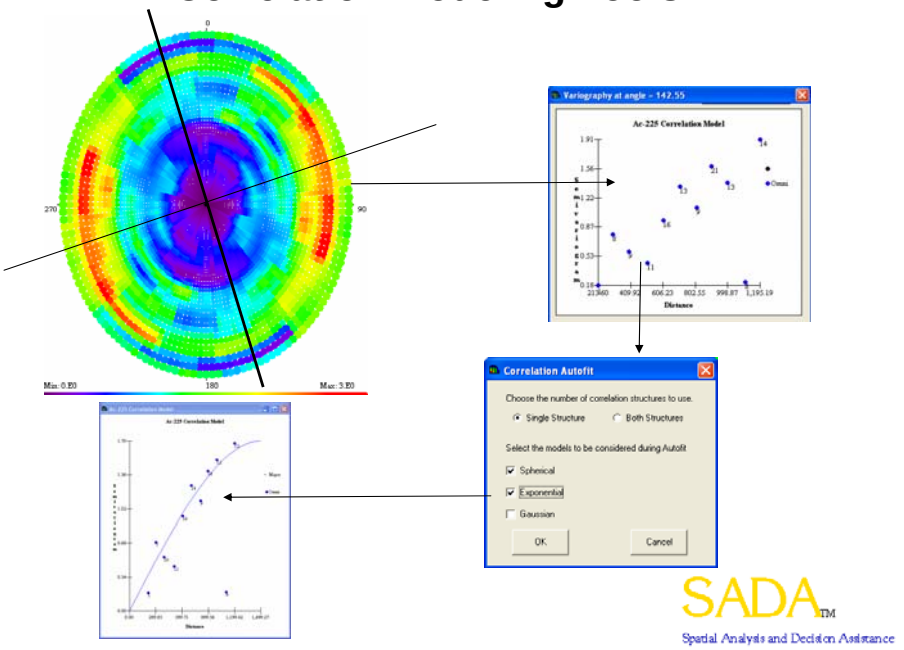
Correlation Modeling Tools



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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

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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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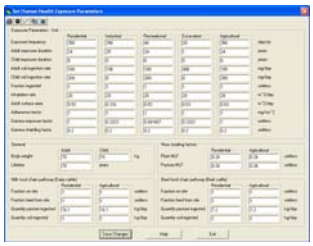
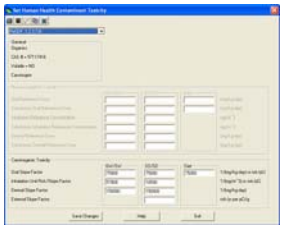
Human Health Risk Calculations

- 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





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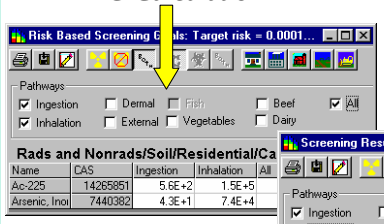
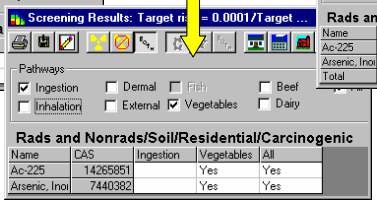
Human Health Risk

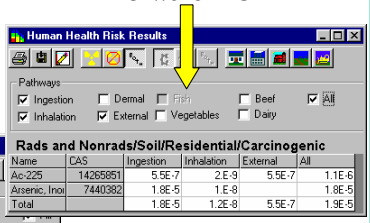
PRG Calculation

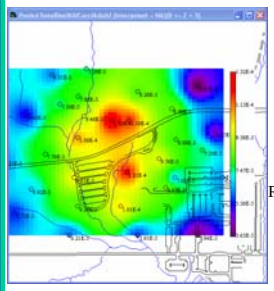
PRG Screens

Forward Risk



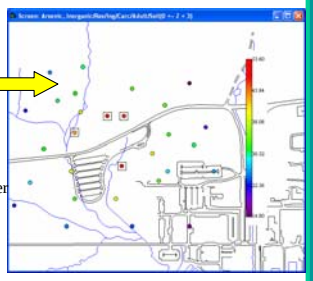






Risk Based Spatial Screens

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

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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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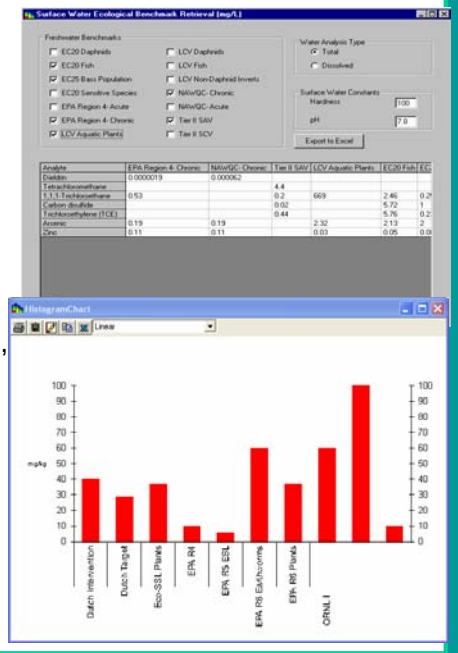
Ecological Benchmark Screening

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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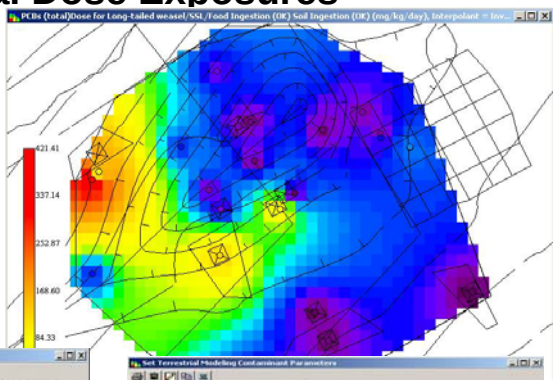
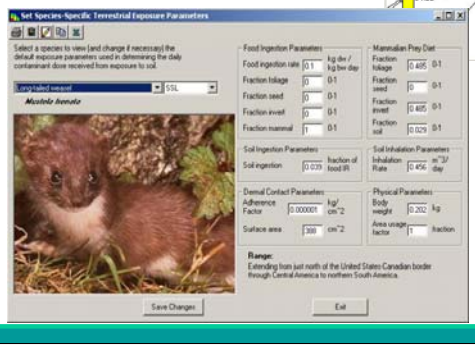
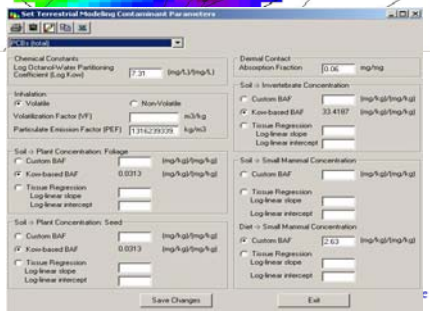
Ecological Dose Exposures

- 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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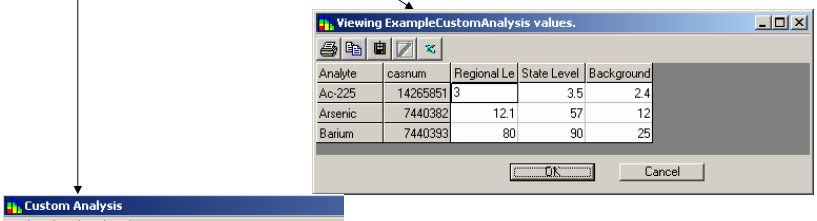
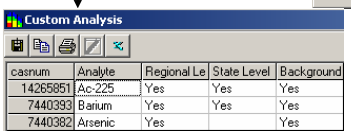
Custom Criteria

- View or Edit Criteria
- Data Screens





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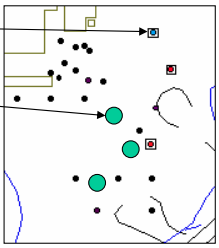
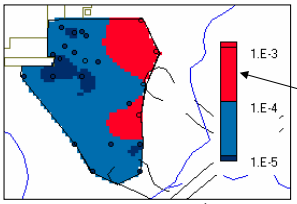
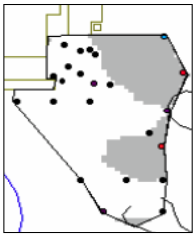
Decision Analysis

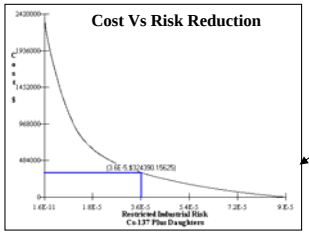
- Spatial Screens
- Sampling Strategies





- Spatial Risk
- Area of Concern
- Cost Benefit





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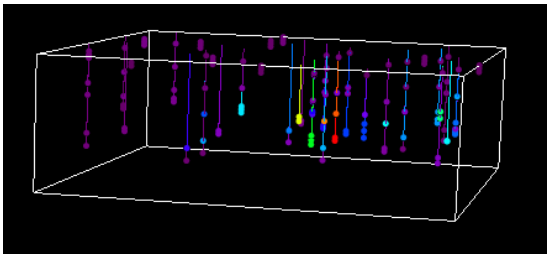
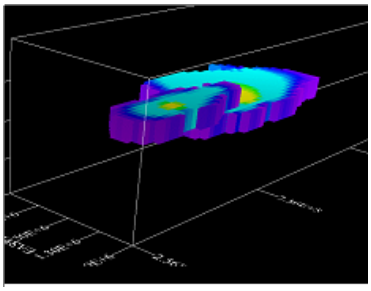
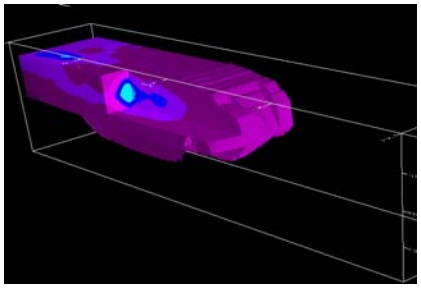
3D Visualization

True 3d Views: Points, Blocks, and Isosurfaces







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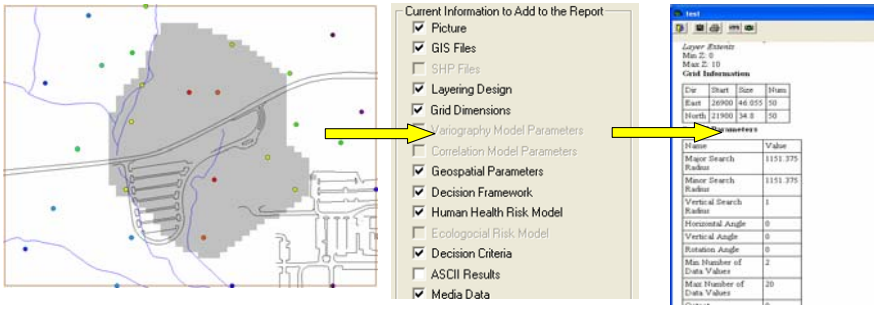
SADA Overview: Autodocumentation

- 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)



AOC Map

(Based on HH, IDW, Block Design)

"Ingredients"

Report

(Word, WordPerfect, HTML)

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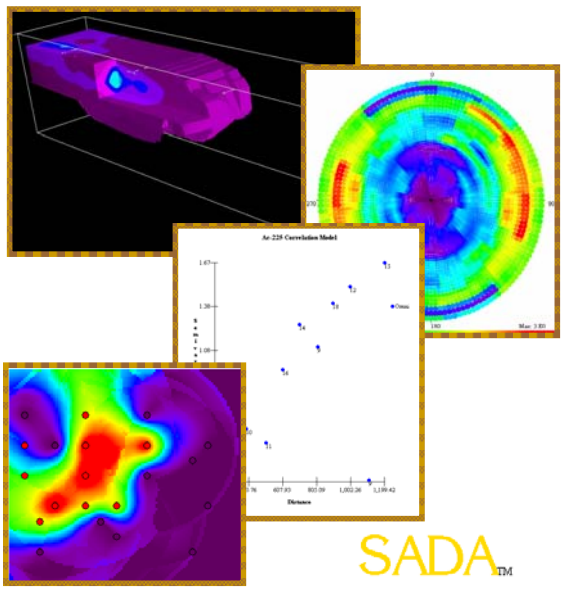
Results Gallery

- 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



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

Thank You

Links to Additional Resources

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