



**UNIVERSITÉ
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INSTITUT DES SCIENCES
DE L'ENVIRONNEMENT

GICHD | CIDHG



Cartographic Methods for Visualizing the Explosive Remnants of War

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The problem of landmines

- > Dozens of millions of landmines worldwide. 70 affected countries
- > 2010: 4'191 victims of landmines. 1'155 killed (ICBL 2011)
- > 13 states are still potential producer of anti-personnel mines





IMSMA

- > Information Management System for Mine Action
- > Relational database management system + reporting
- > 60 countries
- > Data stored as XY pairs + estimated/calculated area
- > IMSMA is not a global repository of data

The screenshot shows the IMSMA Navigation software interface. The top menu includes File, Accounts, Map, Data Entry, Reports, Search, Customisation, and Tools. The main window displays a map of South and Southeast Asia with labels for countries like India, Bangladesh, Myanmar, Laos, Thailand, Cambodia, Vietnam, Philippines, and Malaysia. A sidebar on the left shows a tree view of locations under 'Somaliland'. Below the map, there is a status bar showing 'Longitude: 75.951126 Latitude: 07.627104'. At the bottom, a data table is visible with the following columns: Location ID, Location Name, Location Description, Entry Date, and Last Updated Date.

Location ID	Location Name	Location Description	Entry Date	Last Updated Date
LOC-SL-34	Dacar Budoq		2003-02-13 09:31:21.0	2009-04-14 17:31:05.0
LOC-SL-7	Boodhlay		2003-01-26 14:07:39.0	2009-04-14 17:31:05.0
LOC-SL-16	Qadlika yegoika		2003-03-03 13:34:15.0	2009-04-14 17:31:05.0
LOC-SL-13	Boodhlay		2003-02-08 15:33:29.0	2009-04-14 17:31:05.0
LOC-SL-35	Caal Baxay		2003-03-04 07:47:11.0	2009-04-14 17:31:05.0
LOC-SL-55	Taar shiid		2006-12-07 12:29:01.0	2009-04-14 17:31:05.0
LOC-SL-9	Qocon dhaxte		2003-01-23 13:51:51.0	2009-04-14 17:31:05.0
LOC-SL-7	Reytab khaatumo		2003-02-01 08:13:46.0	2009-04-14 17:31:05.0
LOC-SL-34	Haramaal dhaxte		2003-02-19 21:24:03.0	2009-04-14 17:31:05.0
LOC-SL-39	Balti caraat		2003-02-13 13:27:05.0	2009-04-14 17:31:05.0
LOC-SL-6	Ryo xirho		2003-02-01 10:44:53.0	2009-04-14 17:31:05.0
LOC-SL-8	Carro weyn		2003-01-20 09:11:39.0	2009-04-14 17:31:05.0



Who are the end users of this research?

1. Donors and the general public

- > \$480 in 2009
- > Need a global overview of the contamination to decide which country/area to fund as well as which activity (e.g. landmine clearance, mine risk education etc.)

2. Directors of national MA authorities

- > Need a reliable indicator of the progress of mine action activities to show e.g. to donors
- > Are asking for advanced information technology that is 'too complex to include in the regular IMSMA'



Who are the end users of this research?

3. Operations officers

- > Small to large prioritization process
 1. Refer to national-regional impact surveys results to decide where to clear
 2. Refer to other data (infrastructures, landcover, slope) to decide how to access the areas

4. Database administrators

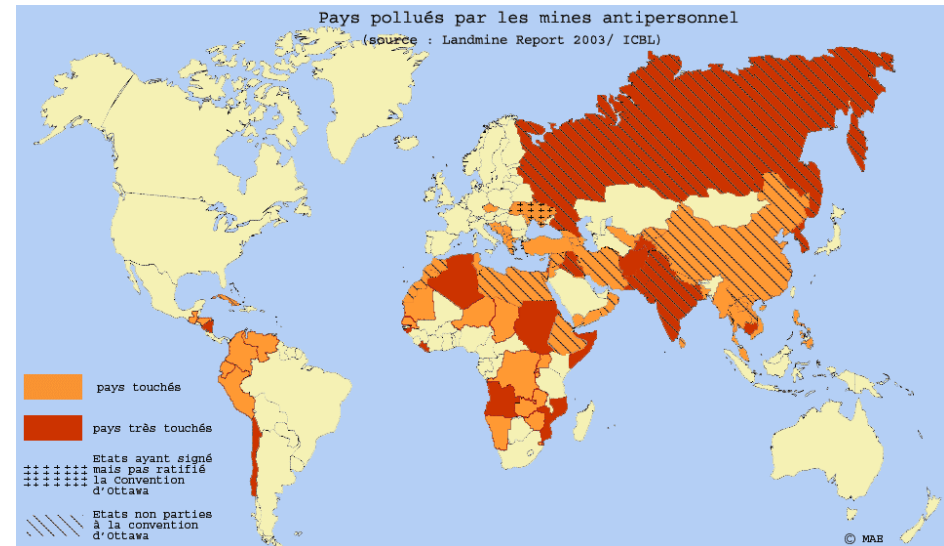
- > Probing the database for inaccuracy or incompleteness
- > Work at large scales

> **GIS expertise of these users is quite low**



State of the art: cartography and GIS in mine action

- > Few attempts
- > Few contamination maps available on the Web. Not up-to-date, not always interactive, sometimes hardly legible
- > One paper on the use of KDE to analyse and cartography landmine risk
 - > Single scale
 - > Points only





Scientific question

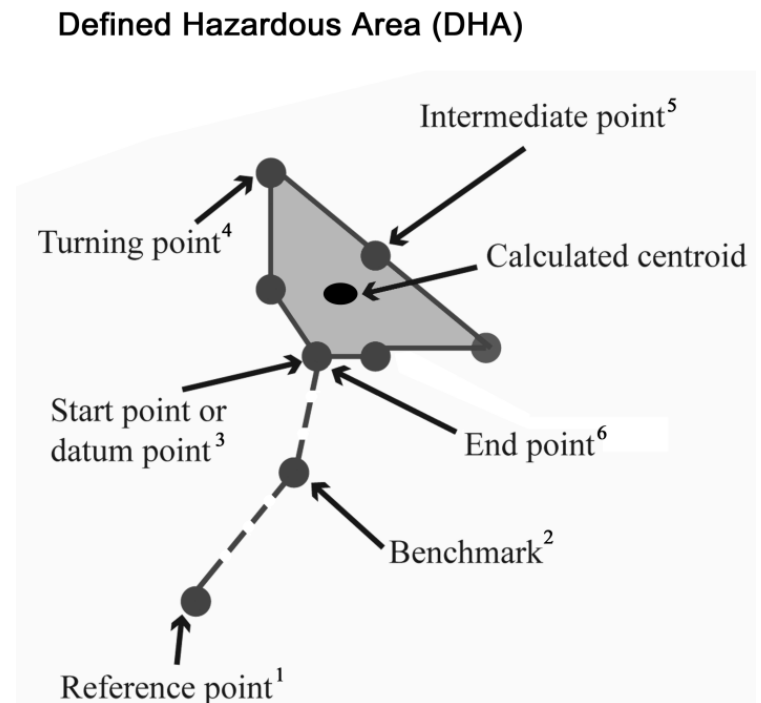
To what extent can GIS improve visualization of contamination ?



Data related specificities

> Heterogeneity:

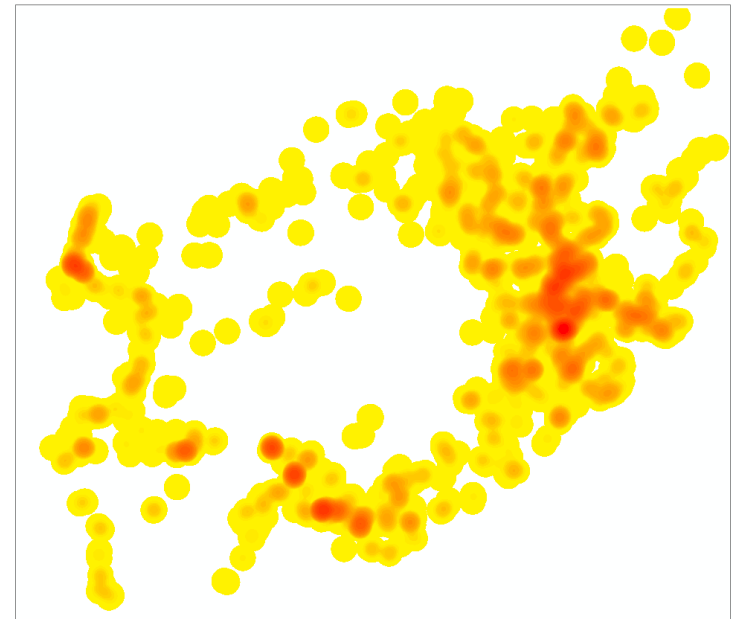
- > **Updates: few/year** (Nicaragua, Zambia) **vs thousands/year** (Afghanistan)
- > **Geometry: points > polygons**
- > **Reliability depending on the type**
- > **Few polygons in some programmes**
- > **Completeness of database**
- > **Positional accuracy**



User related requirements

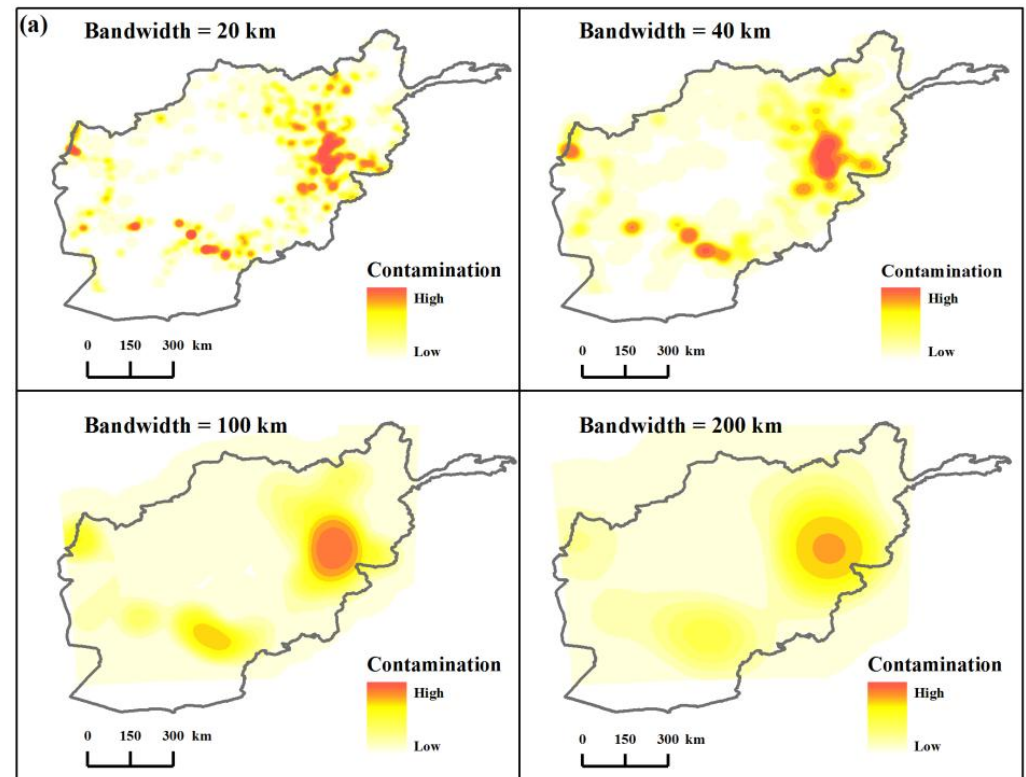
- > **Respecting data privacy**
 - > Disputed borders should not be visible
 - > Exact locations could be used to sell landmines on the black market
 - > Protection of civilians

- > **The method presented here does not address these requirements**
 - > Each mine \sim one circle



Requirements for visualising explosive remnants of war data

- > Requirements are sometimes contradictory
 - > Precise enough maps to show contamination
 - > Obfuscated enough not to show too much
 - Flexibility. Keep control over the level of detail that users want to show





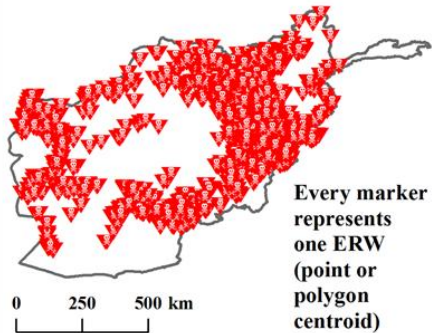
Methodology

> 6 mapping methods

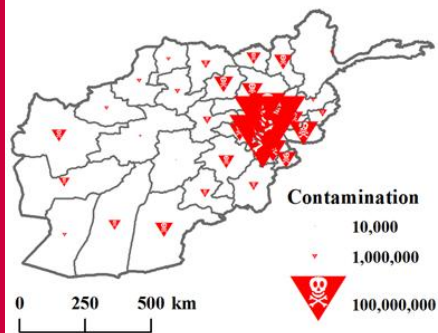
> Evaluation of each methods against previous requirements

> Validation by end-users

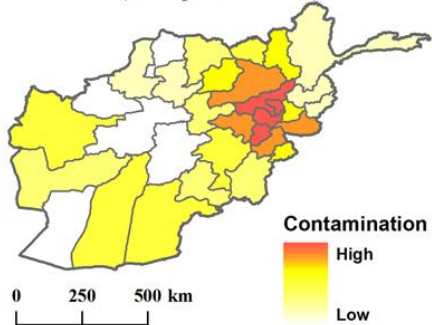
Method A: one-to-one dot maps



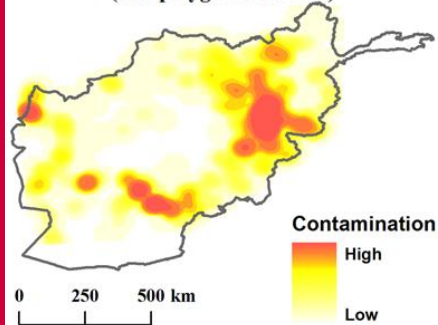
Method B: proportional symbols
(here: province level)



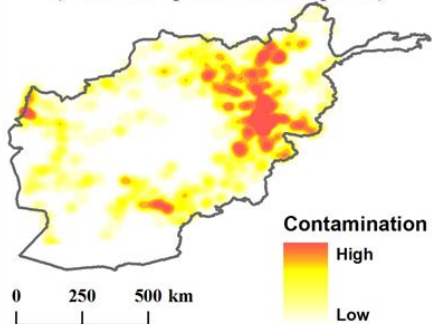
Method C: choropleth maps
(here: province level)



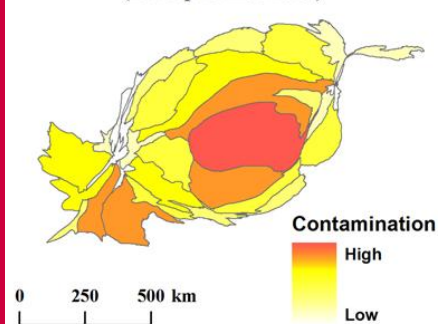
Method D: KDE applied to points
(and polygon centroids)



Method E: KDE applied to polygons
(first filled up with random points)

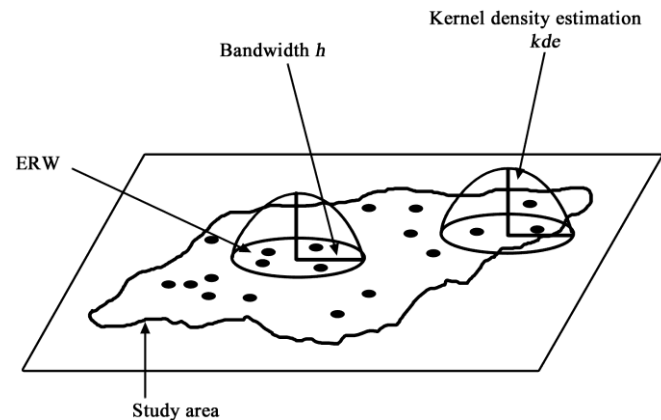


Method F: cartograms
(here: province level)



Focus on the two kernel methods

> Customization of kernel density estimation bandwidth: Average Distance to K-th Nearest Neighbour



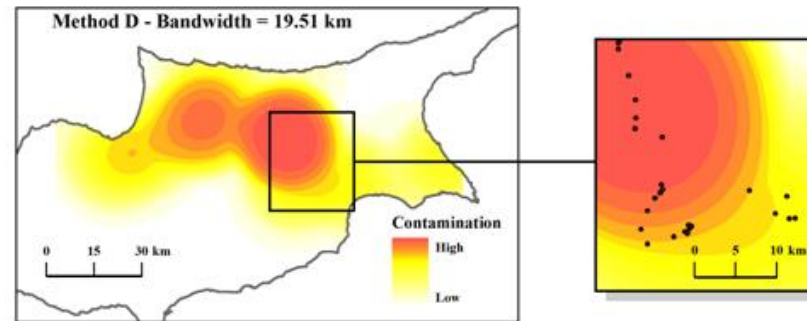
> ... K is adjustable by the end user = parameter allowing users to keep control over the level of detail of maps

Results with the two kernel-based methods

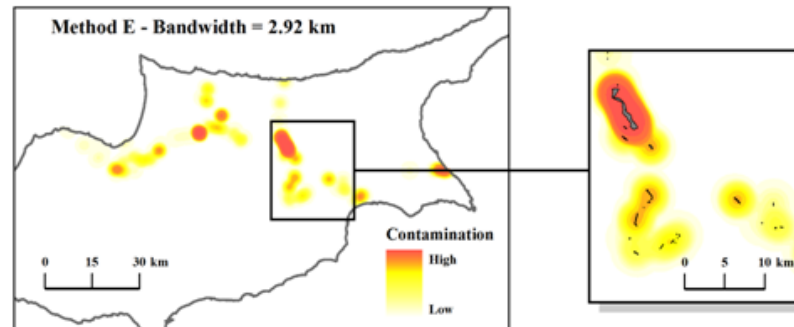
Non customized KDE



Customized KDE (applied to points) fits better the original patterns



Customized KDE (applied to polygons) even better. Local hotspots are shown



Prototype for the KDE-based methods

SERWIS RASTER GENERATOR
Generates a smoothed image showing Open, Active and Current Hazards

1. Choose Hazard Status

Choose one field for status

Confirmed Status

State which status current hazards have:

Type	Include
Active	<input checked="" type="radio"/> No <input type="radio"/> Yes
Closed	<input checked="" type="radio"/> No <input type="radio"/> Yes
Ongoing	<input checked="" type="radio"/> No <input type="radio"/> Yes
Open	<input checked="" type="radio"/> No <input type="radio"/> Yes

2. Choose Hazard Area Size

Choose one field for size

Area Size
Calculated Area
Calculated Size

3. Choose and state Hazard Type

Choose one field for type

Intended Land Use
Mine Action AreaType
Type of Hazardous Area

State hazard type:

Type	Include
AP	<input checked="" type="radio"/> No <input type="radio"/> Yes
AT	<input checked="" type="radio"/> No <input type="radio"/> Yes
BAC	<input checked="" type="radio"/> No <input type="radio"/> Yes
CHA	<input checked="" type="radio"/> No <input type="radio"/> Yes
DA	<input checked="" type="radio"/> No <input type="radio"/> Yes
DHA	<input checked="" type="radio"/> No <input type="radio"/> Yes
Mine Field	<input checked="" type="radio"/> No <input type="radio"/> Yes
SHA	<input checked="" type="radio"/> No <input type="radio"/> Yes

4. Adjust level of Detail for the Map

Little detailed Much detailed

5. Enter Additional Information

Hazard as Vector data

Country/Region:
Date of creation:
Name of the contact:
Organization:
Address:
E-mail:

6. Generate Raster File

Run Help

Selection of data to be visualized

Cursor for end users to define the level of detail of the kernel map

To what extent can GIS improve visualization of contamination?

- > **To a large extent, provided that a complete cartographic framework be supplied**
- > **Different methods - Different scales - Different user groups**
- > **We explained pros and cons of each method**
- > **Recommendations (can be extended/adjusted to users' specific needs)**
- > **Lacroix, Herzog, Eriksson, Weibel (2013). *Methods for Visualizing the Explosive Remnants of War* – Applied Geography, 41:179-194**

Target audience	Global level	Sub-continental level	National level	Sub-national level	Municipality level
Users outside the core MA domain	Method E (polygons)	Method E (polygons) Clusters			
Directors of national MA authorities			Method D (points) Choropleth maps	Method D (points) Choropleth maps	
Operations officers			Method D (points) Clusters	Method D (points) (Clusters)	One-to-one dot maps
Database administrators					One-to-one dot maps



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Thank you