

Міністерство освіти і науки України
Вінницький національний технічний університет

Кафедра комп'ютерного еколого-економічного
моніторингу та інженерної графіки



Геоінформаційні системи в екології

ВНТУ 2014

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5.1		151
5.2	,		GPS ..162
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1.2

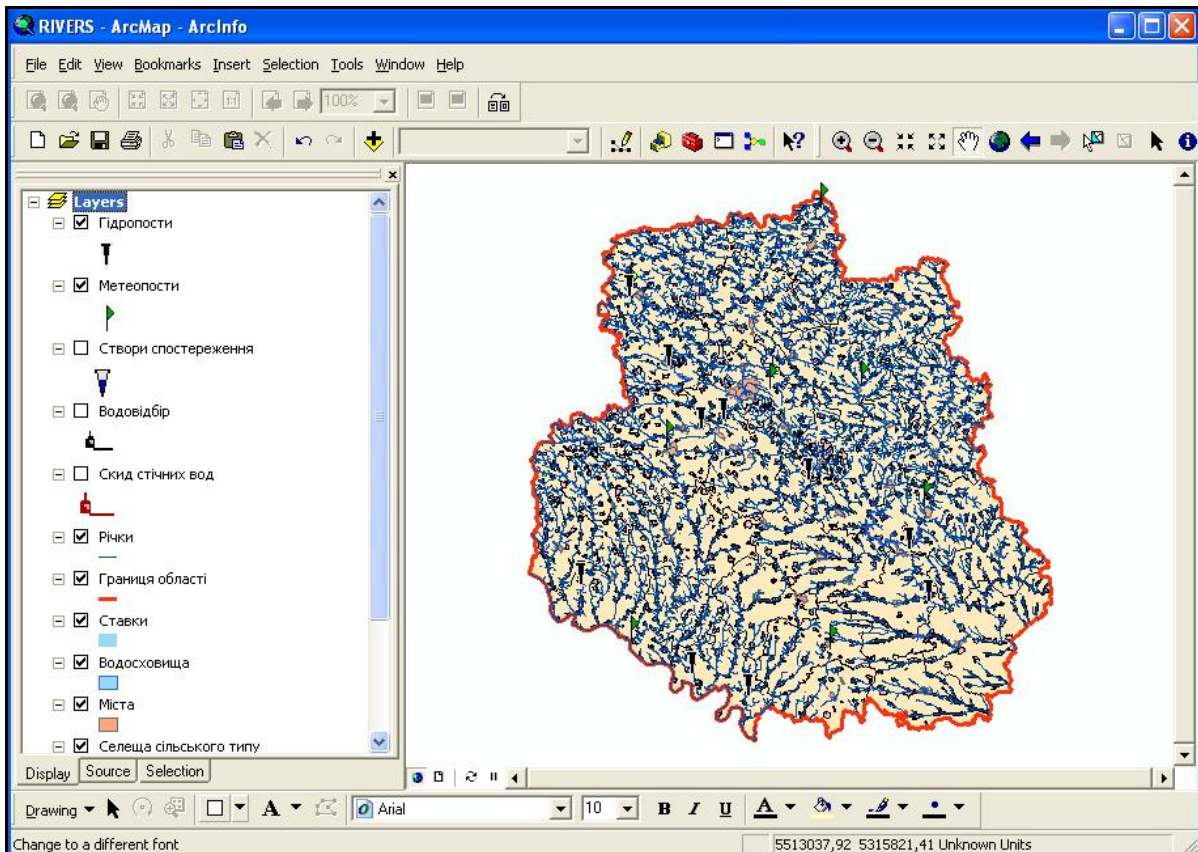
- "ArcGIS" ().
ArcGIS
:
:

- ArcCatalog ;
- ArcMap -
- ArcToolbox -
- ArcView ,
- ArcEditor, ArcView, -
- ArcInfo, ArcEditor, -
- ArcGIS; -
- ArcGIS Spatial Analyst , , -
- ArcGIS 3D Analyst, , ArcGIS 3D Analyst, , “ ” ArcGIS 3D Analyst ArcScene, ;
- ArcGIS Geostatistical Analyst , ;

- ArcGIS Schematics - -
- ' ArcGIS;
- ArcPress - -
- ;
- ArcGIS Publisher -
- MXD, (PMF) -
- ;
- ArcGIS Survey Analyst -
- ;
- ArcGIS Tracking Analyst -
- ' GPS;
- ArcGIS Maplex -
- ') ;
- ArcScan , , -
- ;
- ArcGlobe, ArcGIS 3D Analyst, -
- (-
-) , -
- ArcGIS Desktop - ;
- ArcGIS StreetMap - -
- ;
- MrSID Encoder for ArcGIS -
- (500) ArcGIS;

- ArcGIS Seagate Crystal Reports — -
- ;
- ArcGIS Business Analyst — -
- ;
- ArcGIS Network Analyst — -
- ;
- ArcGIS Military Analyst — , ;
- ArcWeb Services —
- Web- , -
- , , , , -
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- ArcGIS Data Interoperability — -
- , 70
- , — 50 ;
- ArcGIS Server — ,
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- ArcIMS (Arc Internet Map Server) -
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 - ArcSDE (Arc Spatial Database Engine) -
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 Oracle8i, Oracle9i, MS SQL Server, Informix i DB2;
 - ArcGIS Engine , -
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 (, Microsoft Excel) « -
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 - ArcPad - , -
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 Windows , -
 , GPS- — -
 .
 , ArcGIS (. 1.2) -
 -
 Internet (ArcIMS);
 Intranet (
 ArcSDE); (ArcGIS
 Engine, ArcObjects, MapObjects).
 (ArcGIS -
) .
 , ArcGIS MS Office [9].



. 1.2.

rcGIS

ArcGIS

ArcGIS

ESRI

ArcGIS)

(<http://www.ecomm.kiev.ua>).

“MapInfo Professional” ().

“MapInfo Professional”

. MapInfo

Excel, Access, dBASE, Lotus 1-2-3, Oracle 8

“MapInfo Professional”

ODBC [9].

“MapInfo Professional”

Delphi, Visual

Basic, C++, PowerBuilder.

“MapInfo Professional” (. 1.3)

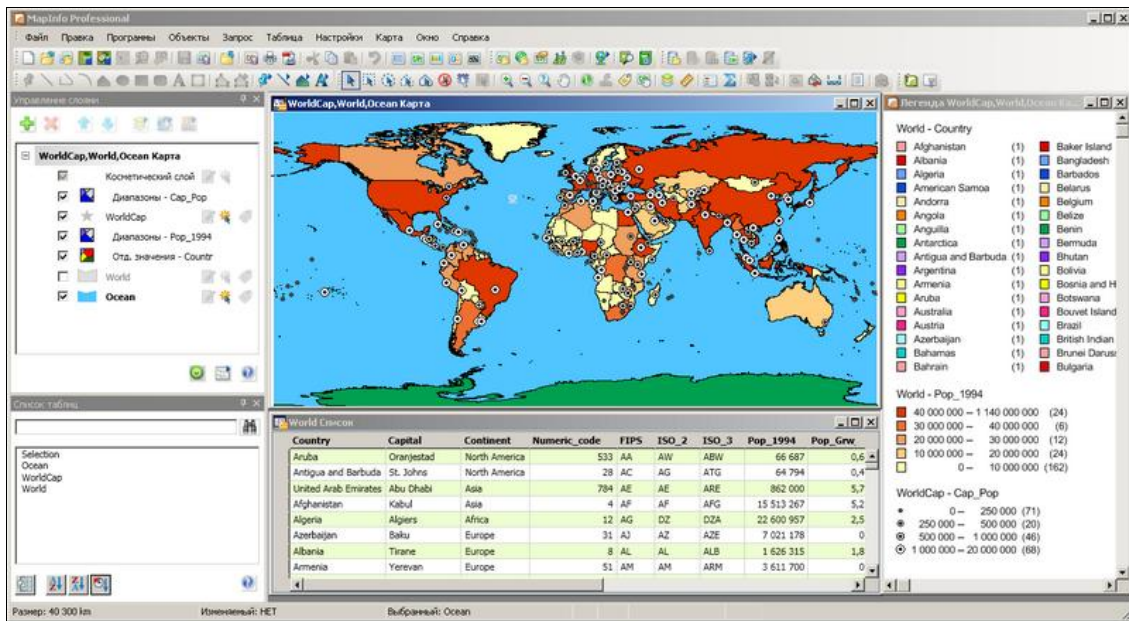
ArcGIS,

“MapInfo Professional”

ArcGIS,

MapInfo

(<http://www.isgeo.kiev.ua>).



. 1.3.

MapInfo

11” (“ 2011)” ().

2011”

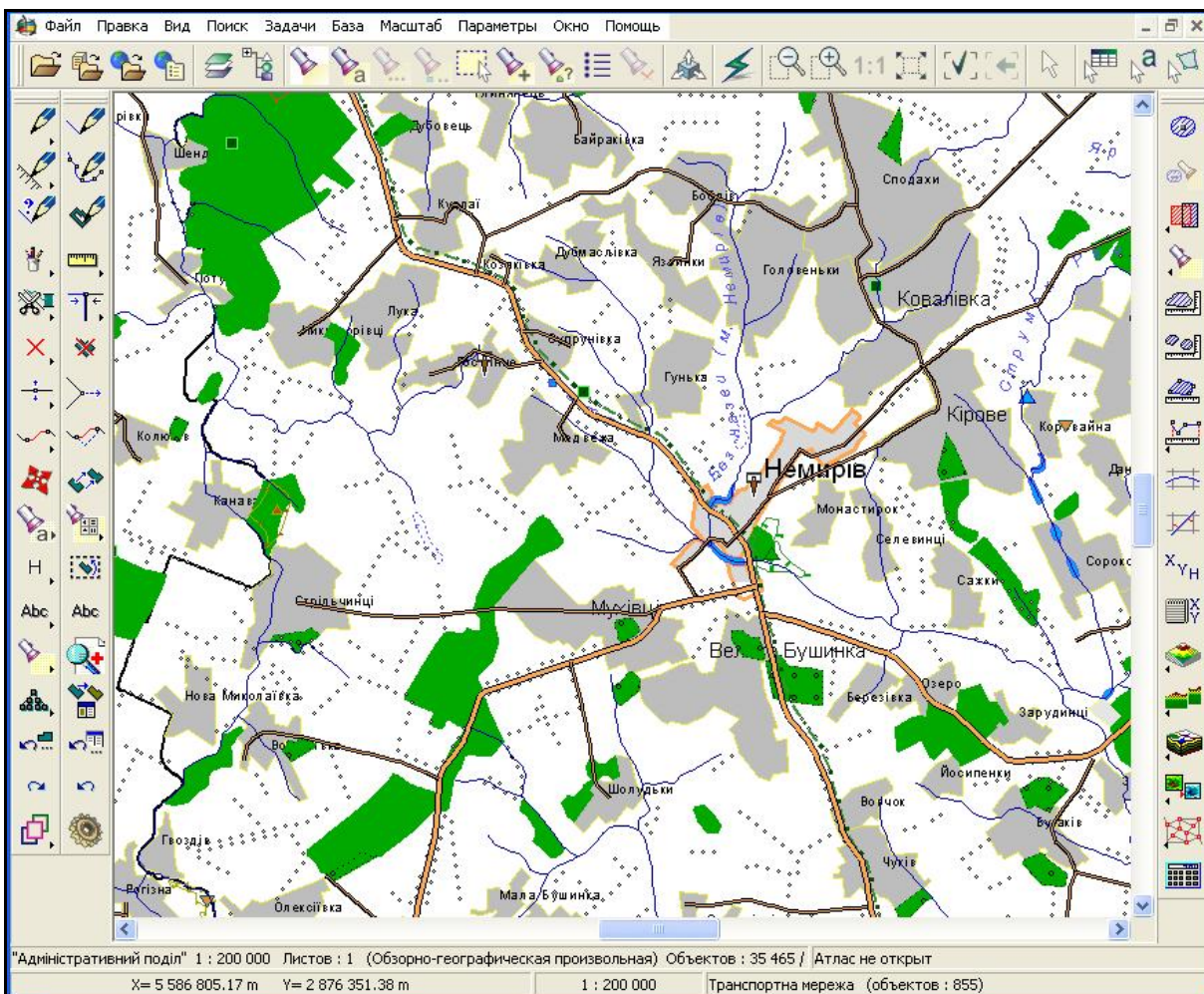
ArcGIS,

ArcGIS

2011” –

" 2011" (. 1.4)

[5, 9].



. 1.4.

« 11»

[5, 9].

DBF, MIF/MID, Shape, S57,
ArcGIS

Mapinfo,

70

ODBC BDE.

Word Excel

“ 2011”,

Delphi,

Visual C++, Visual Basic, C++ Builder

“ 2011” [5, 9].

: <http://www.gisinfo.ru> <http://www.panorama.vn.ua>).

- "Digitals" ().

- "Digitals"

(ArcGIS, Mapinfo,) (

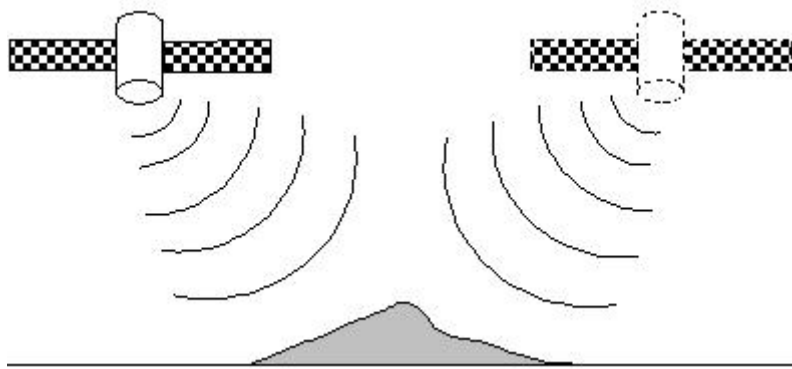
(,): <http://www.vingeo.com>).

Delphi Visual C++.

. 1.5).

GPS-

[9].



. 1.5.

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<http://www.vingeo.com>).

„GeoDraw” („Geograph”) ().

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ODBC, /

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„GeoDraw”: Geograph (), Geodraw (

) Geoconstructor ().

„GeoDraw”

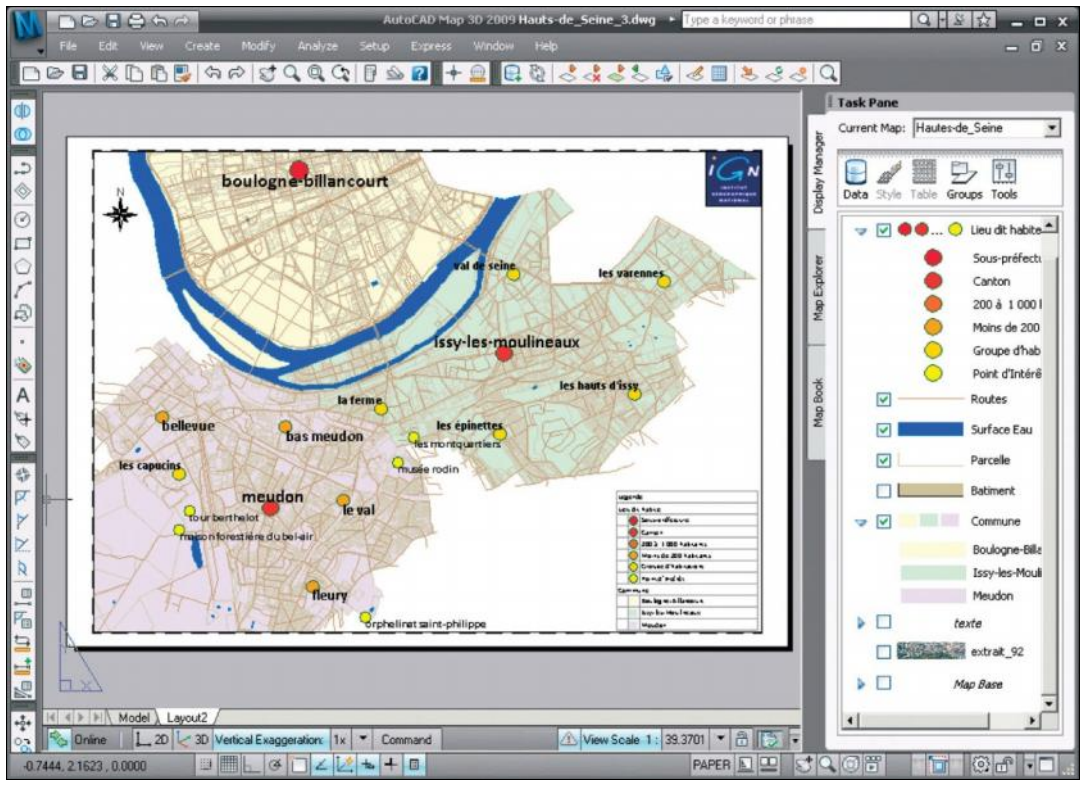
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. „GeoDraw”

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AutoCAD Map 3D 2011 ()
 AutoCAD Map 3D 2011 – - -
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 AutoCAD Map 3D 2011 (. 1.6) -
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 AutoCAD, -
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 . AutoCAD Map 3D 2011
 Autodesk MapGuide Enterprise
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 . . AutoCAD Map 3D
 2011
 (<http://www.cad.ru>).



. 1.6. AutoCAD Map 3D 2011

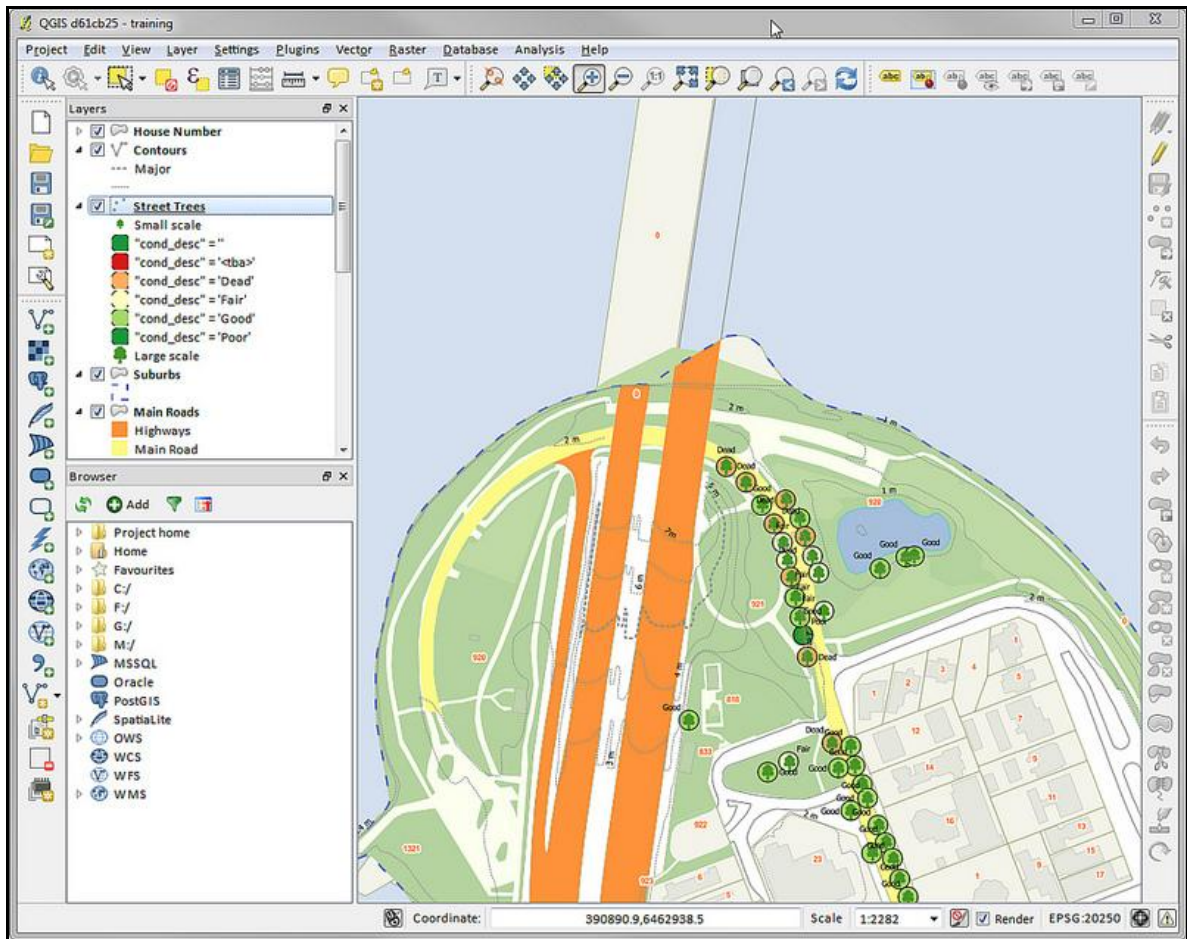
: QGIS (<http://www.qgis.org/>), GRASS GIS (<http://grass.osgeo.org/>), MapServer (<http://mapserver.org/>), VNetGIS (<http://vnetgis.com/>), R-GIS (<http://r-gis.net/>)

– QGIS.

QGIS – GNU (General Public License), Open Source Geospatial Foundation (OSGeo). QGIS Linux, Unix, Mac OSX, Windows Android, QGIS

- QGIS Desktop (.1.7):

Windows, Mac, Linux, BSD Android.



. 1.7. QGIS Desktop

- QGIS Browser:

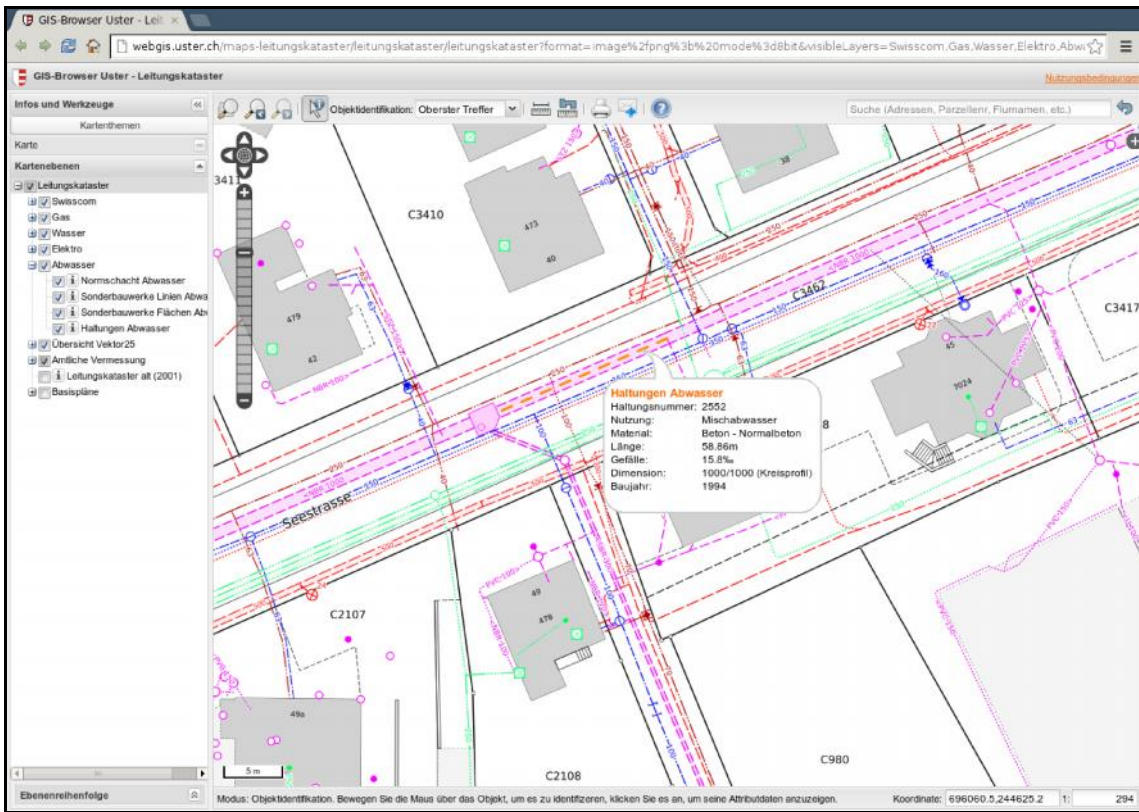
- QGIS Server:

WMS WFS

- QGIS Web Client:

QGIS

(.1.8).



. 1.8. QGIS Web Client

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 - : CorelDraw, MS Visio,
 “ ”.
 Adobe Photoshop,

- 1) ?
- 2) - ?
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[10, 11]:

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2. ()
3. (ArcInfo, ArcCatalog, ArcScan, ArcView, Mapinfo Professional, 11, Digitals .) , - (MS Access, Paradox, MySQL).
4. , , (-) .
5. ' , -
6. () , , , , , (.txt, .doc, .xls), (.avi, .mpeg), PowerPoint, ,
7. , .

2.2

1. [10, 11].
- [10, 11]:
2. CorelDraw, PhotoShop
3. Internet
- ArcSDE (Intranet-)
- ArcIMS (Internet).

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3.1)

ArcGIS,

WCS

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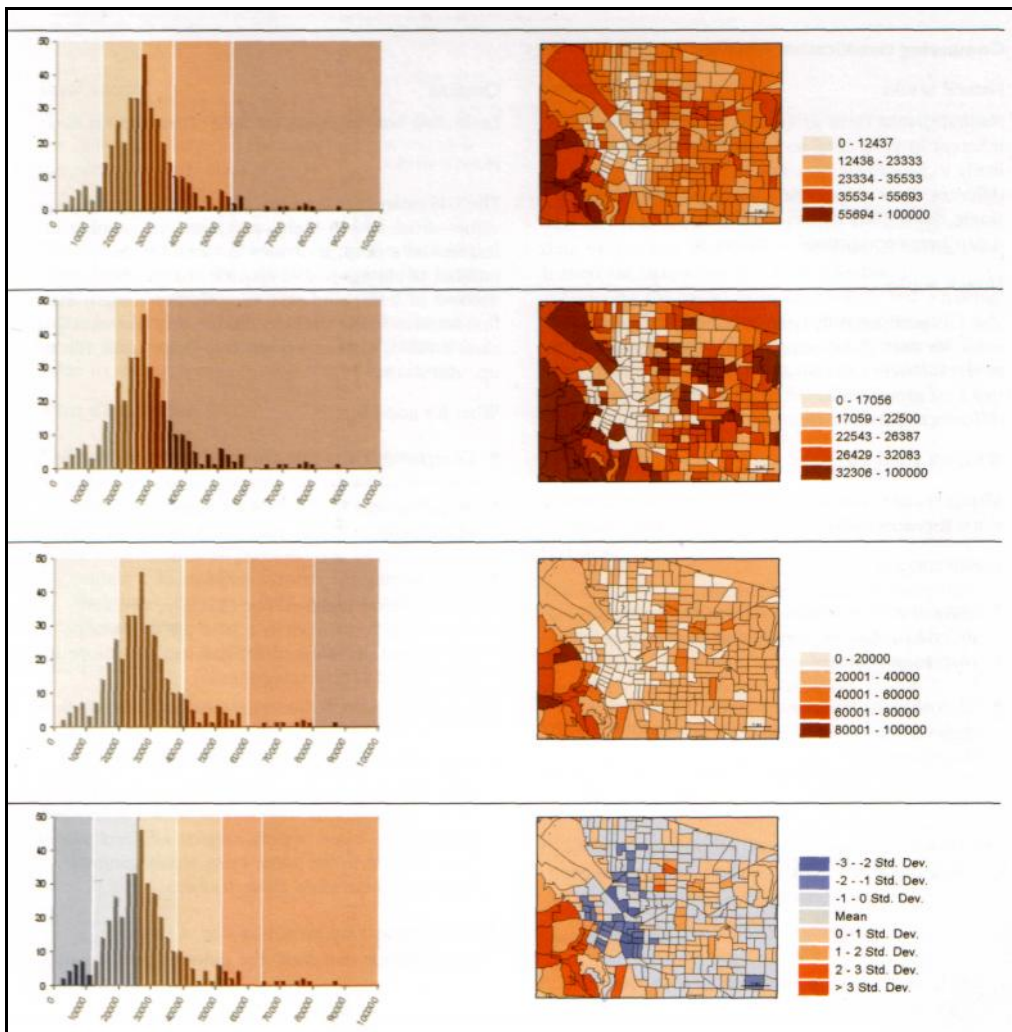
(. 3.2) [13].

. 3.3

2.

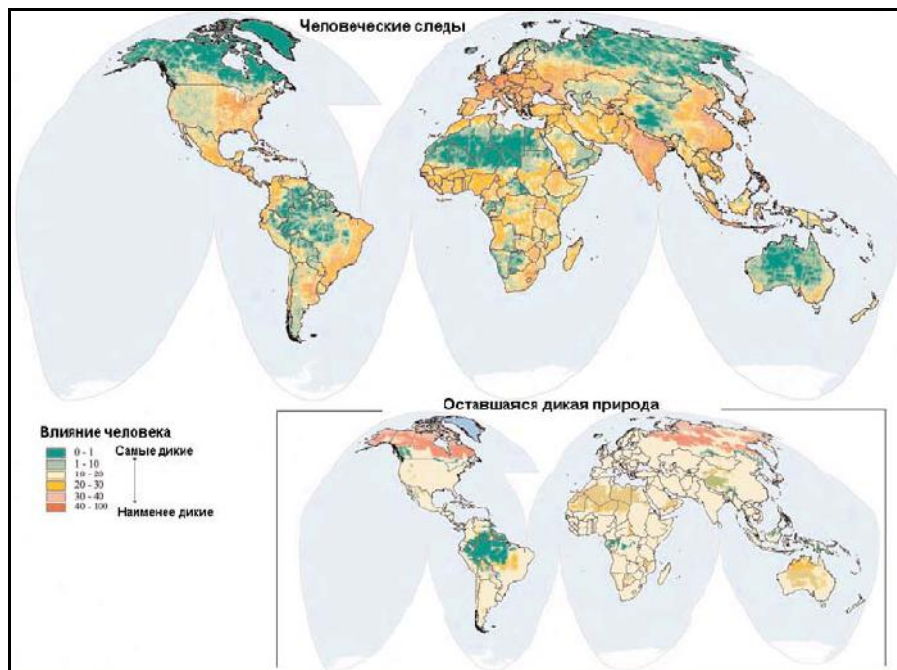
2004

()



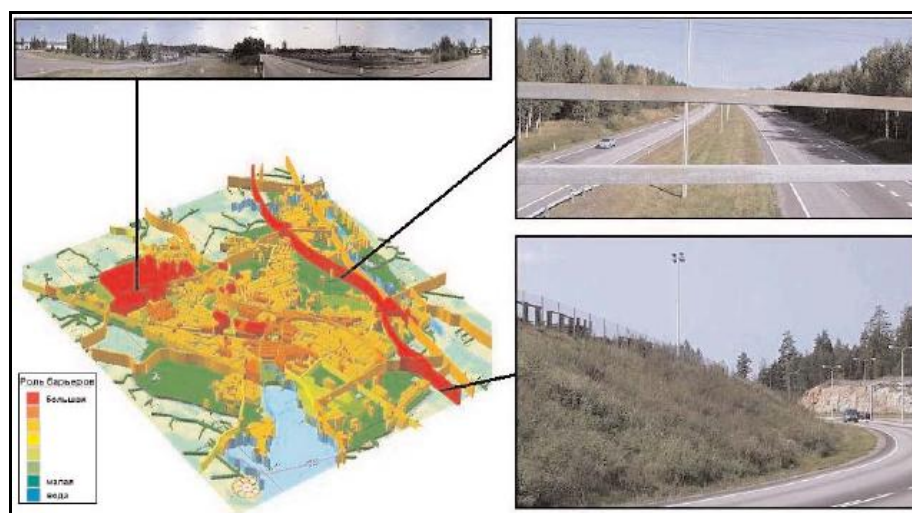
. 3.1.

(ArcGIS) [12]



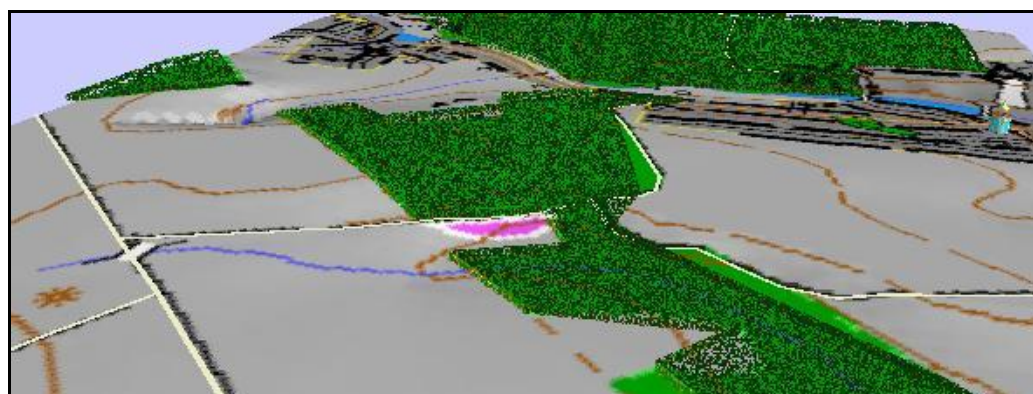
. 3.2.

(ArcGIS) [13]



. 3.3.

(ArcGIS) [13]



. 3.4.

() [6]



. 3.5.

ArcMap
 “Nuon” (ArcGIS) [14]

3.

“Nuon”

(. 3.5) [14].

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(.3.6) [15].

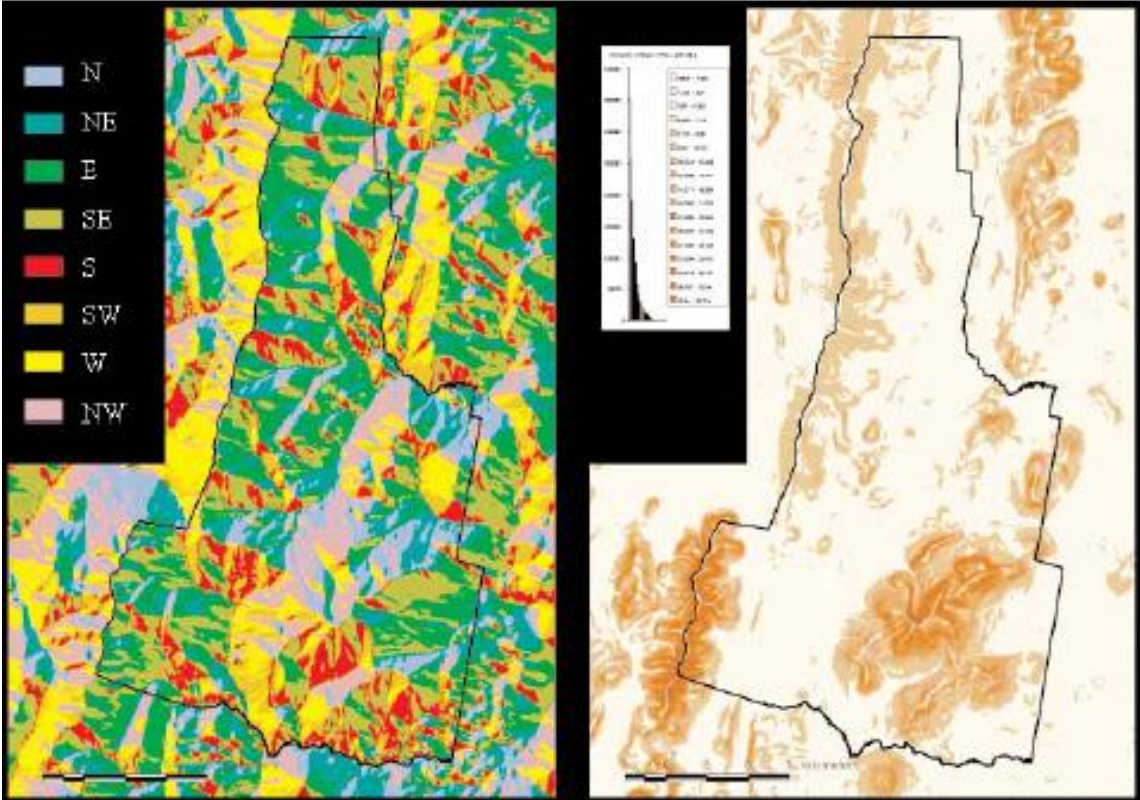
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(.3.7)，
(.3.8) [16].

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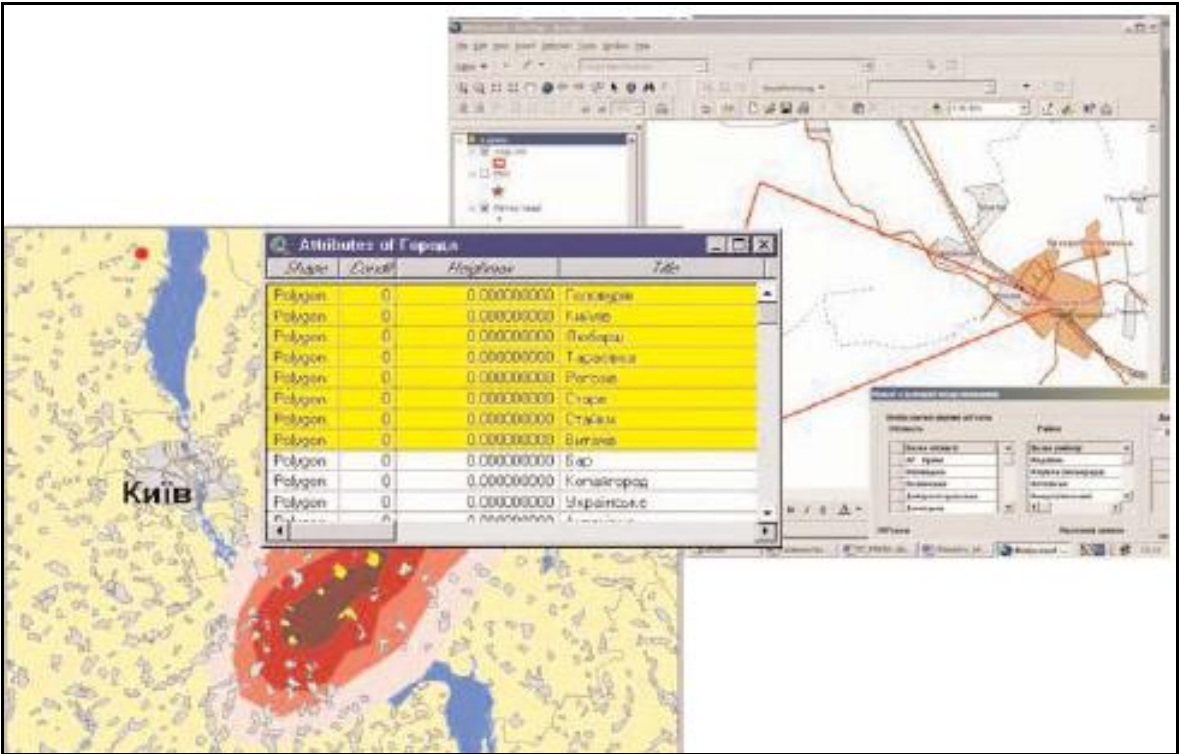
· · ·
ArcGIS
· .3.9
- 2002 ·
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[17].



. 3.6.

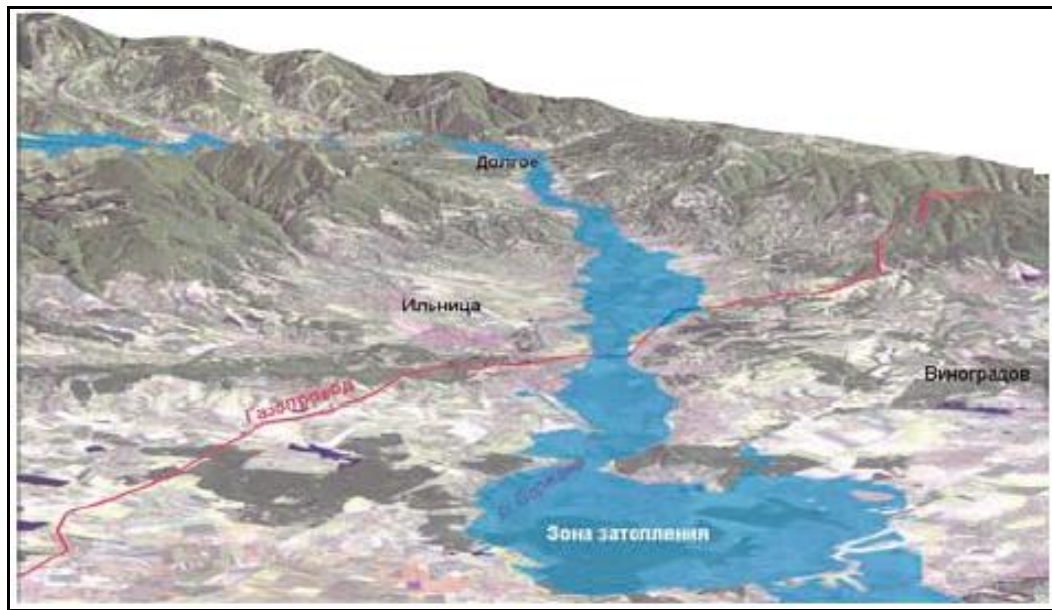
(ERDAS IMAGINE)



. 3.7.

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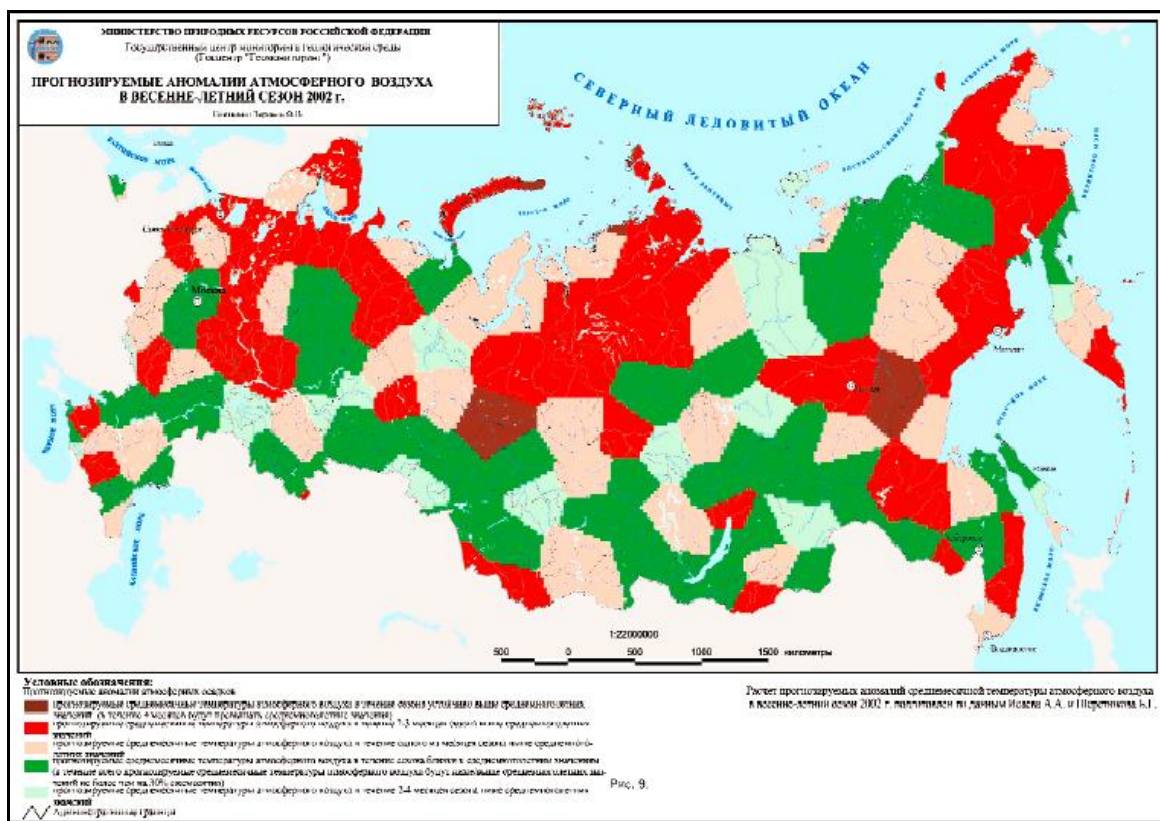
) (ArcGIS) [16]



. 3.8.

1%

(ArcGIS ArcScene) [16]



. 3.9.

2002

(ArcGIS) [17]

5. “ ” (.) -

- . 3.10 -

2000

(8 , -

,) [18].

6. -

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(. 3.11) [19]. -

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ArcGIS 3D Analyst (. 3.12). -

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(. 3.13) [21].

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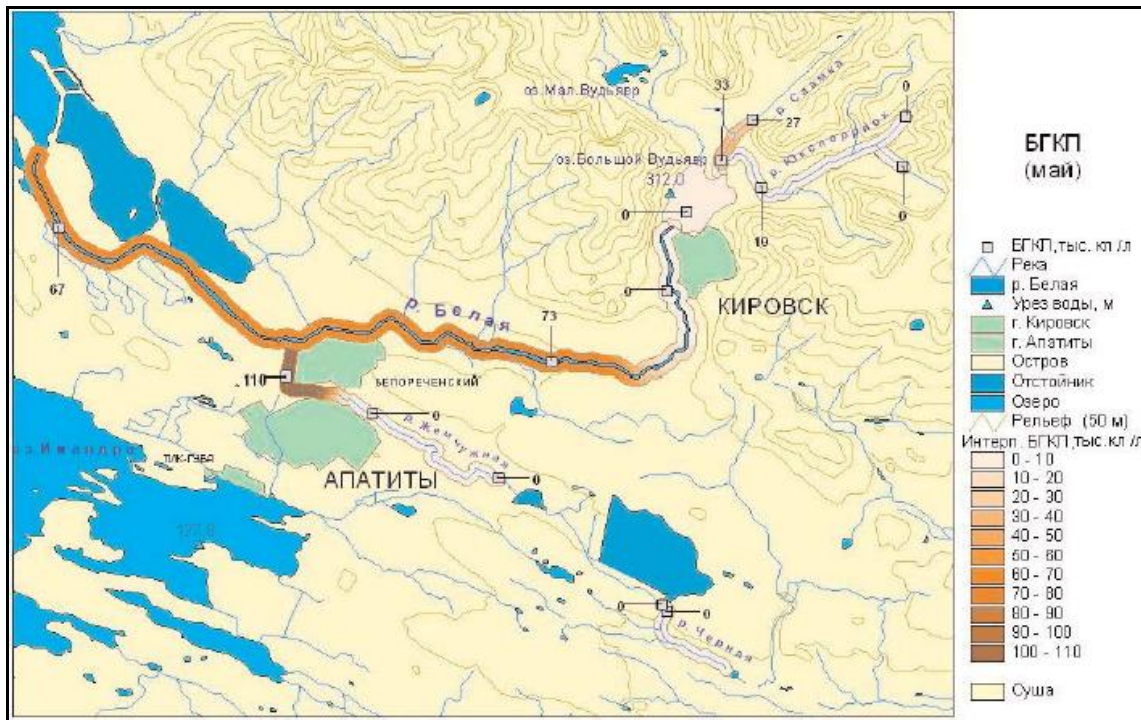
(. 3.2, 3.5, 3.7, 3.9 – 3.14).

2. ()



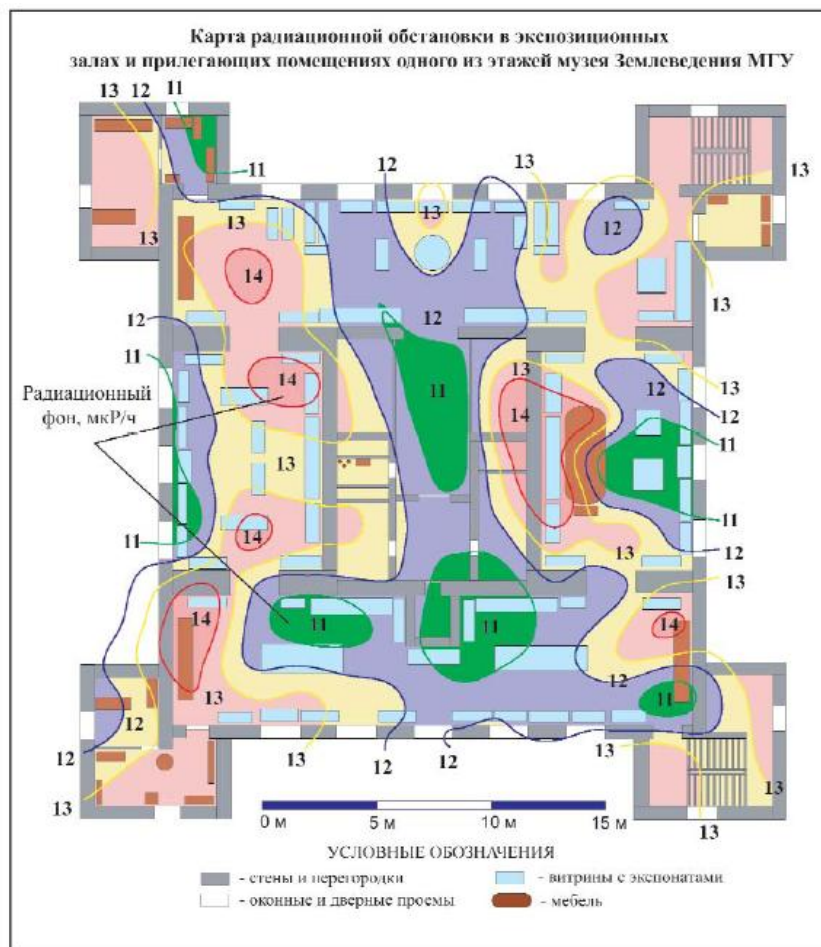
. 3.10.

2000 . (ArcGIS) [18]



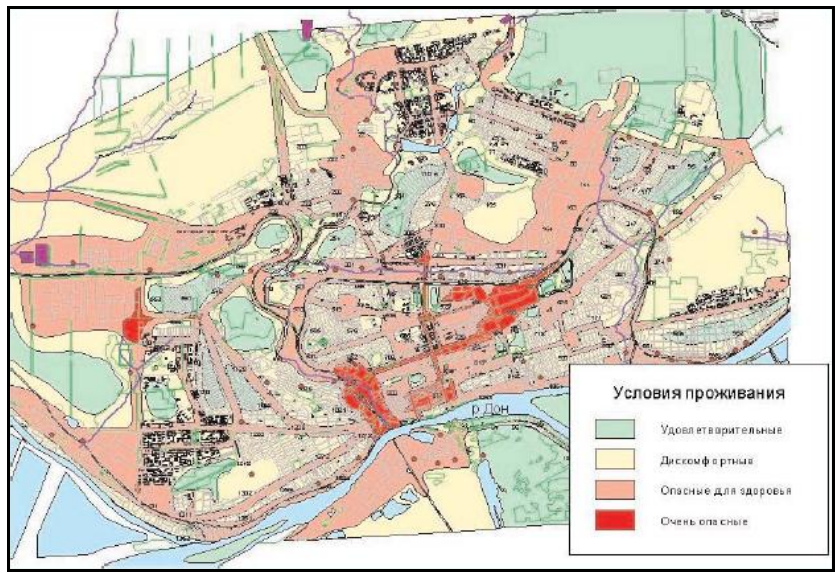
. 3.11.

(ArcGIS) [19]



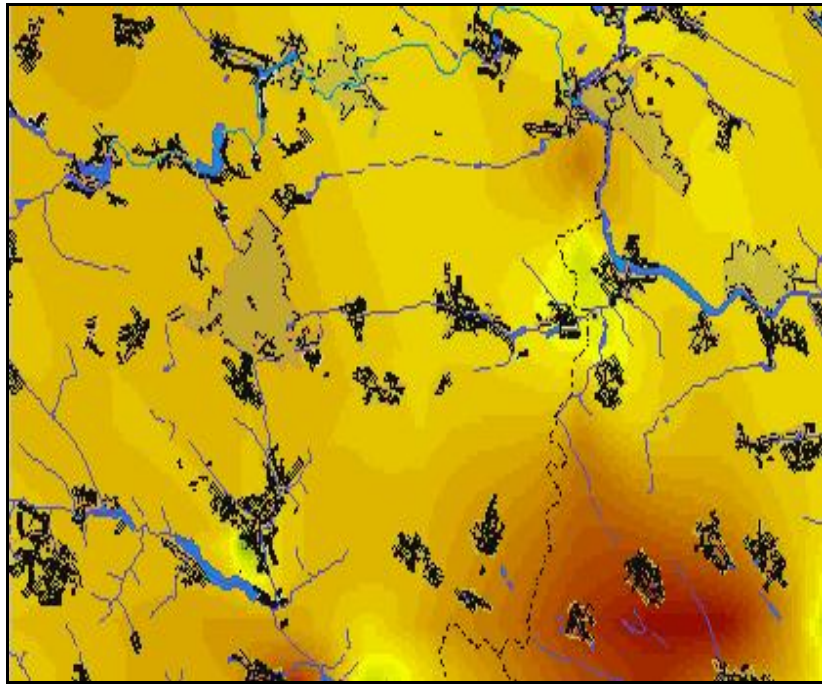
. 3.12.

(ArcGIS) [20]



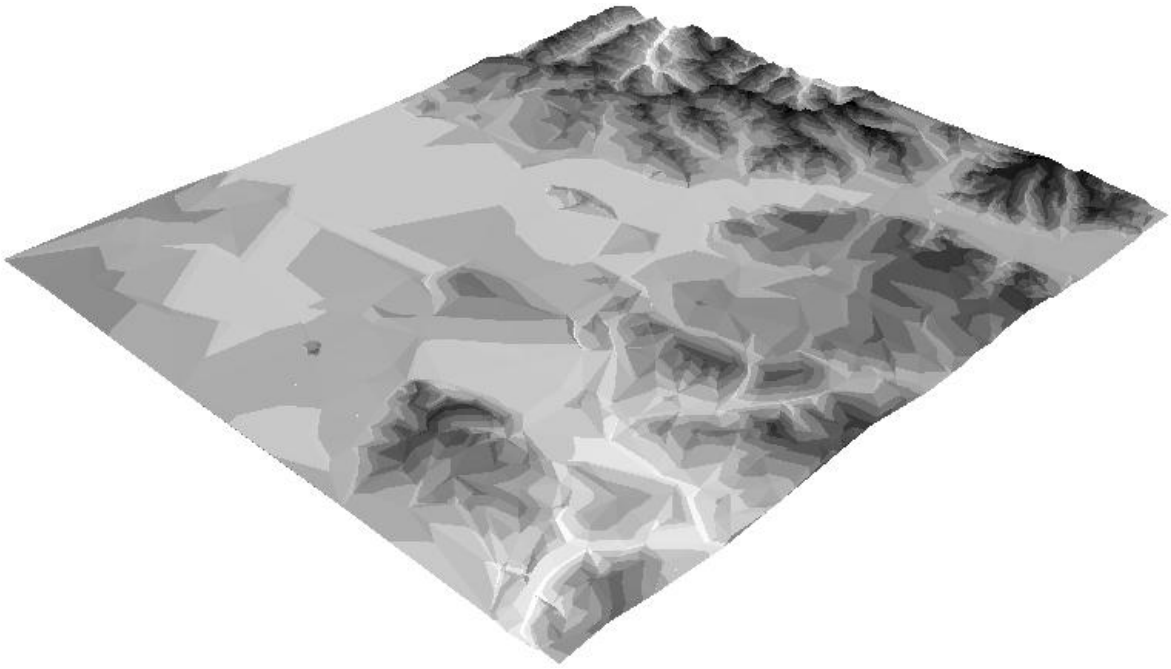
. 3.13.

(ArcGIS) [21]

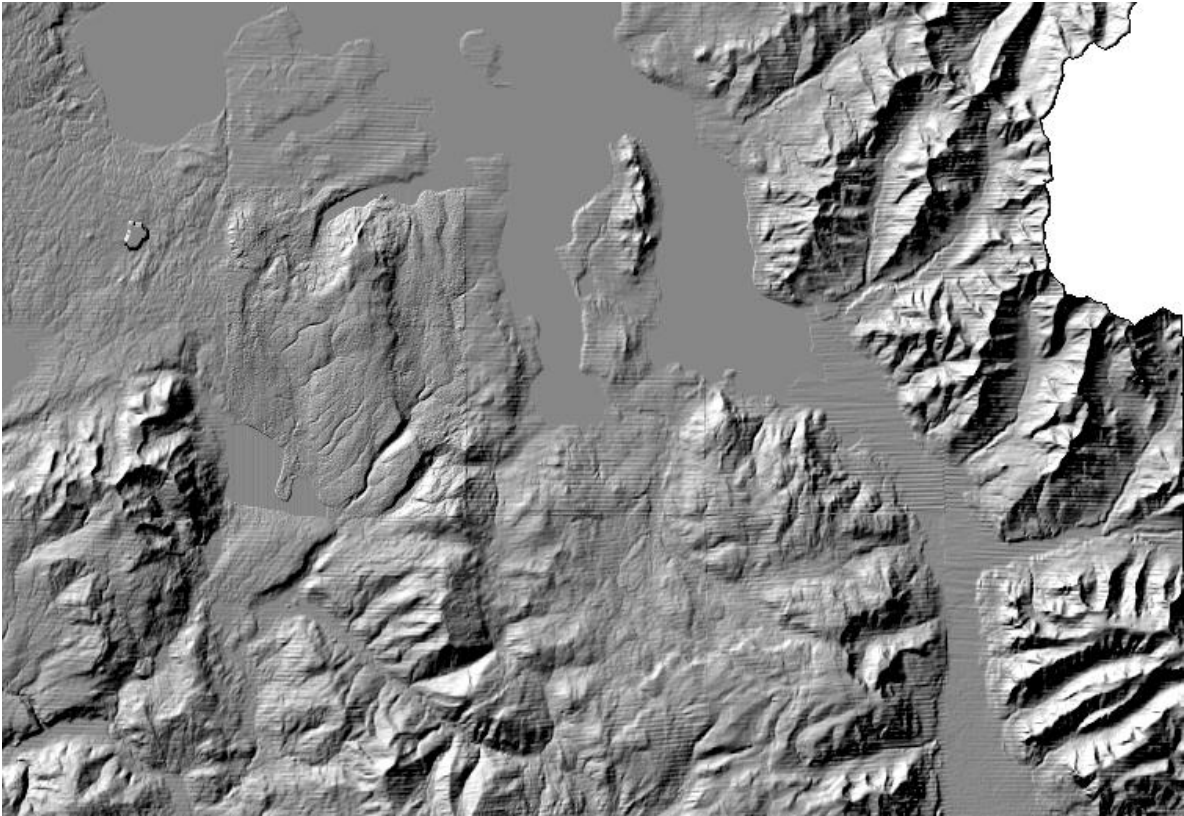


. 3.14.

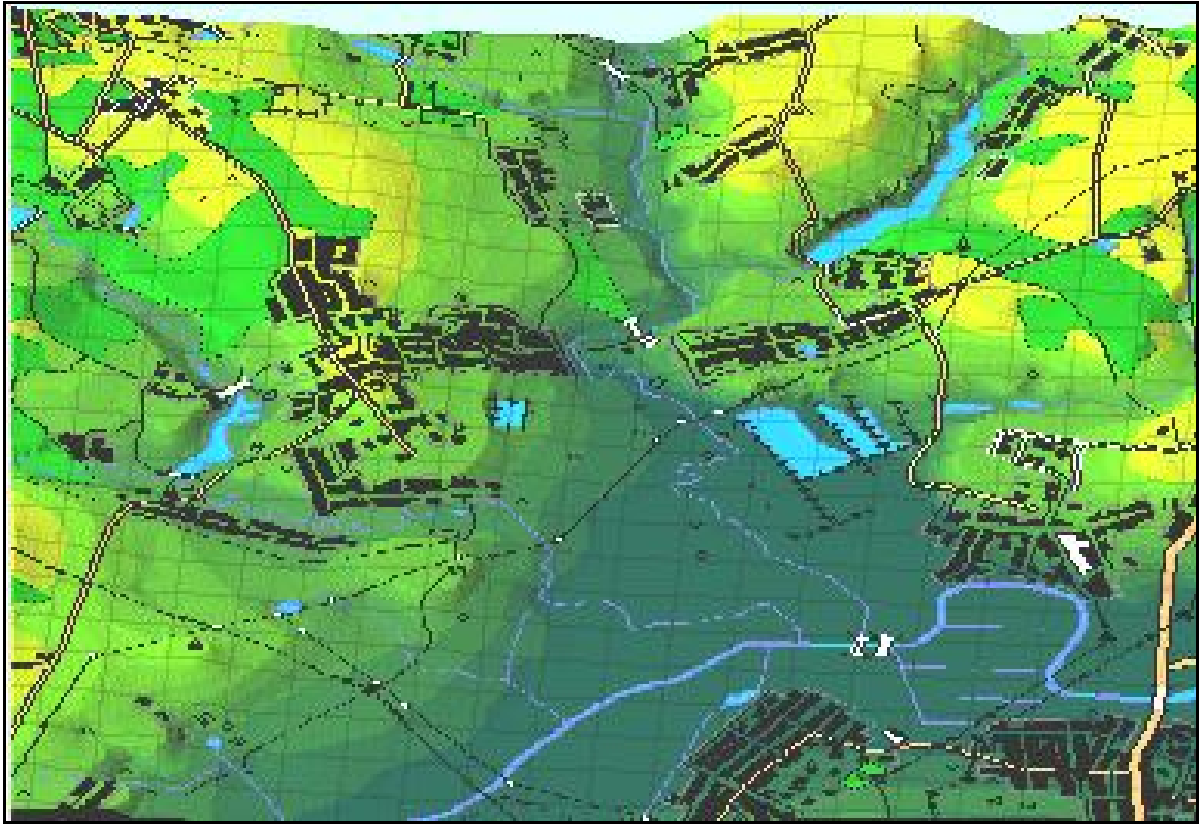
) [6]



. 3.15. TIN (') (ArcGIS)



. 3.16. (ArcGIS)



.3.17. (« »)

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3.18
ArcGIS GeoStatistical Analyst

30 1986

4. ()

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TERRA AQUA

12 20

“ - ”. . 3.19

18.07.2002 .,

- ArcView 3.x [22].

160 , 180 250 . 3.20

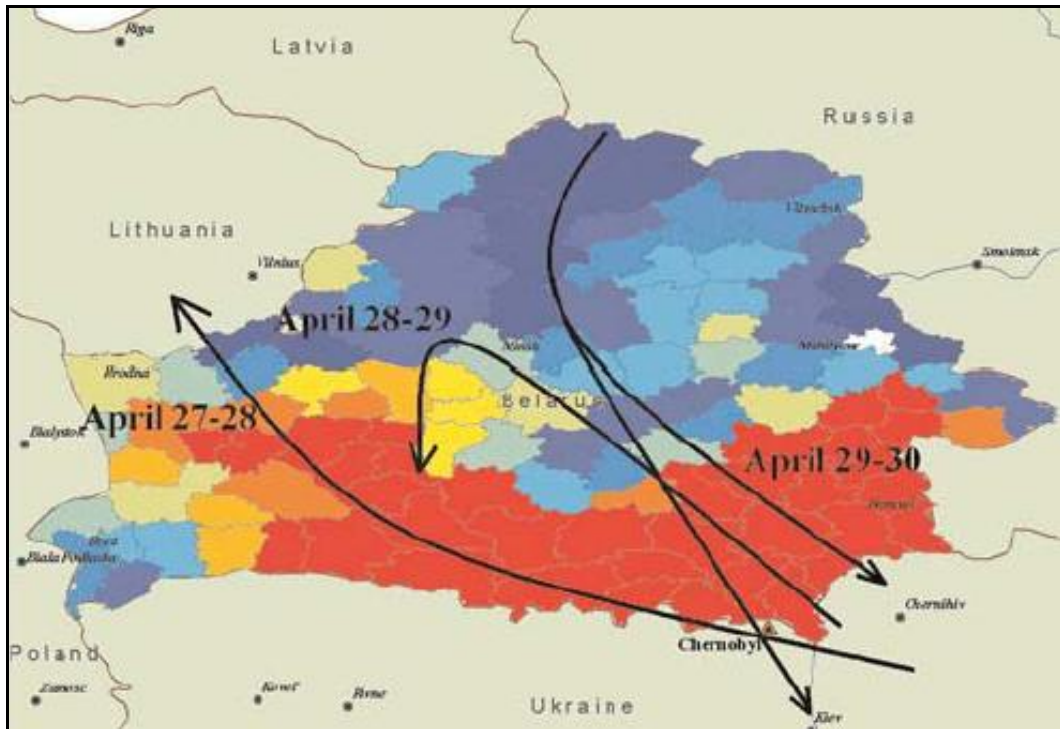
3.21 1960

- [23].

ERDAS IMAGINE.

ERDAS IMAGINE

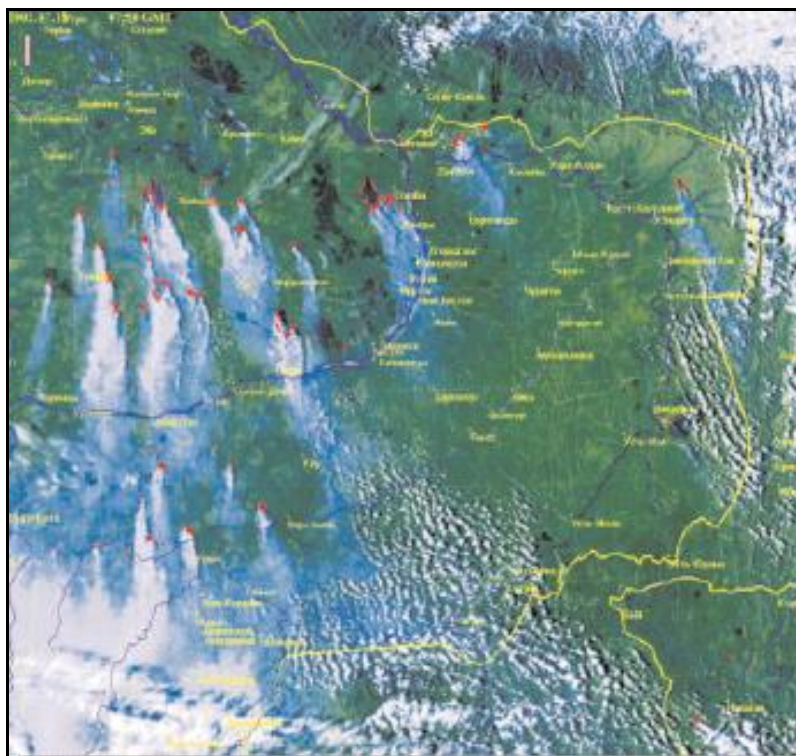
(. 3.22).



. 3.18.

27-30 1986

(ArcGIS GeoStatistical Analyst)



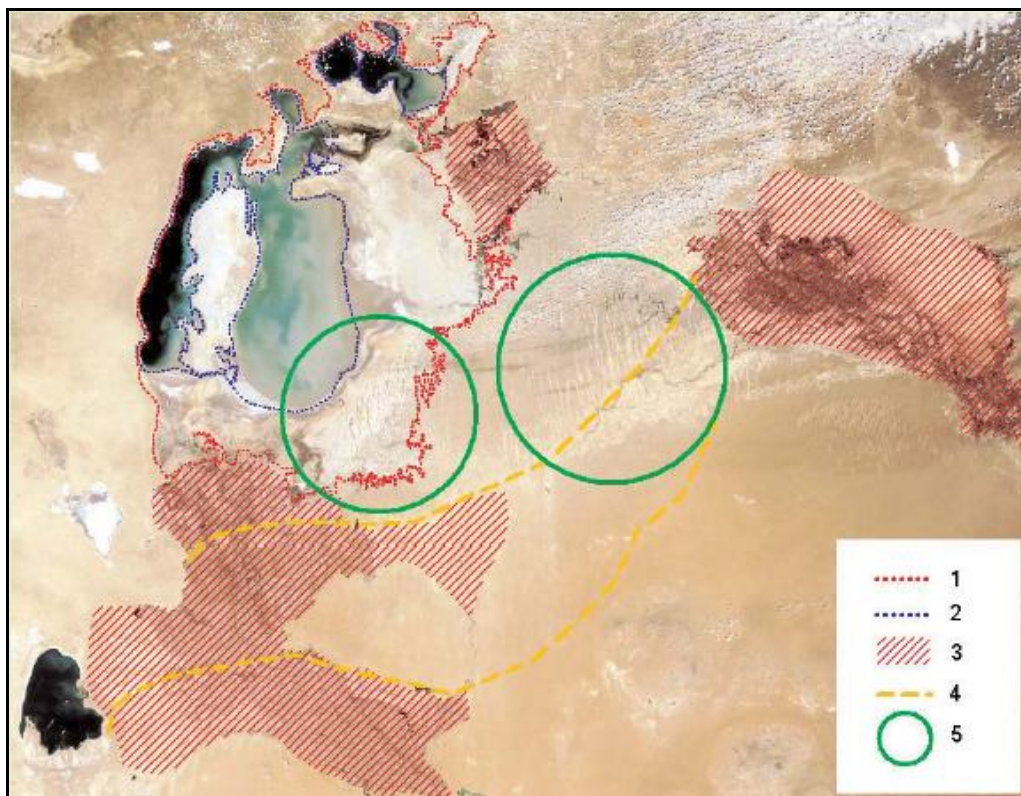
. 3.19.

(ArcView) [22]



. 3.20.

ASTER, 2001 [22]



. 3.21.

MODIS (12.06.2002 .): 1 – 1960 .;
 2 - 2000 .; 3 – . , . ; 4 –
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2004

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“ ”, : <http://www.quickbird.ru>).

5. ’ “ ”_

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(.3.24).

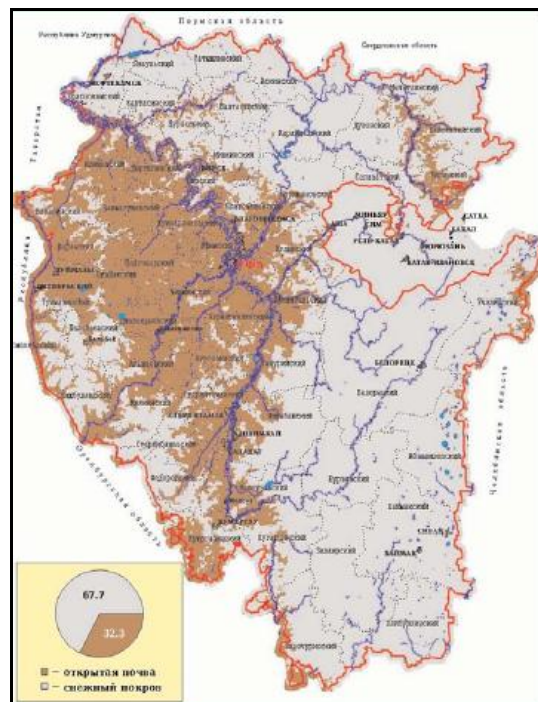
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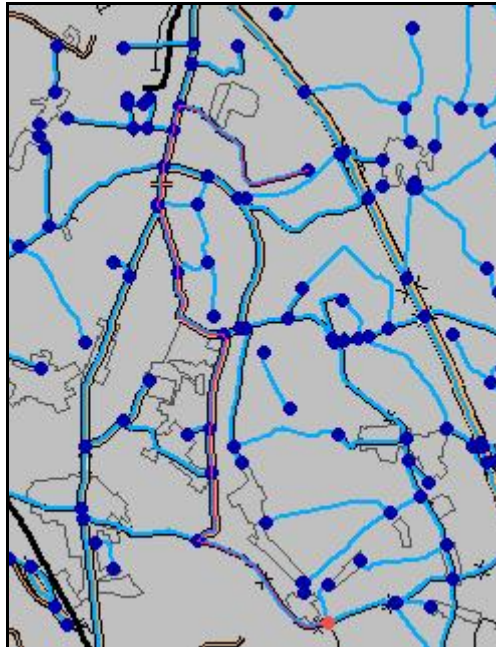


. 3.22.

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—) (ERDAS IMAGINE) [24]

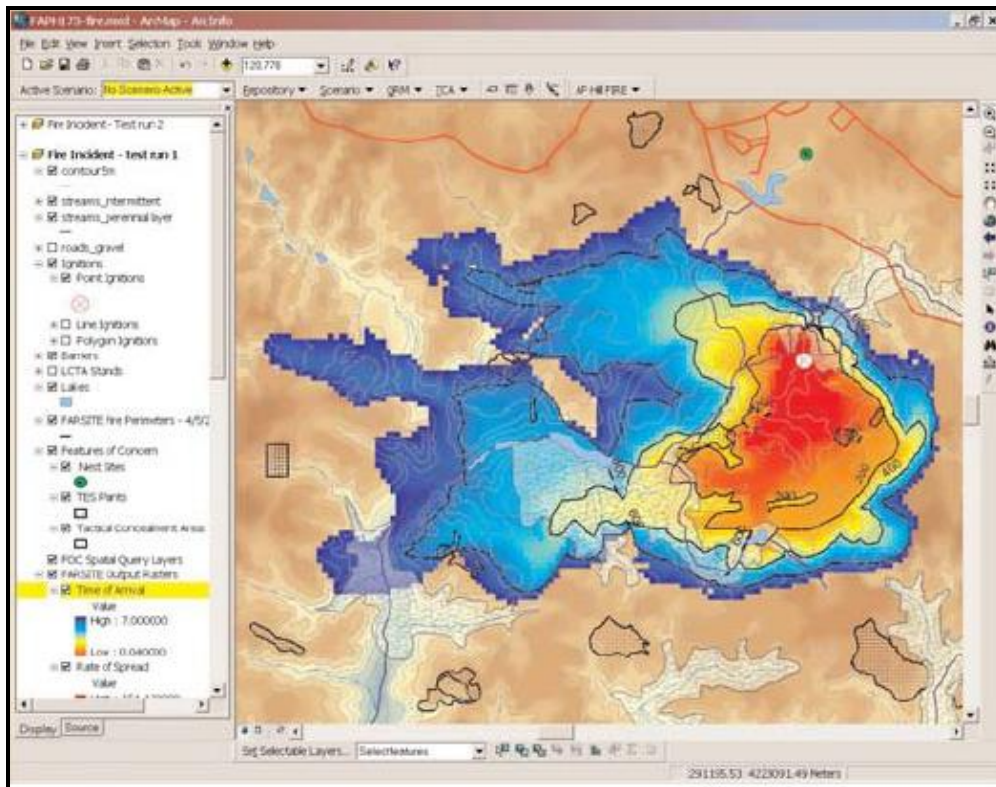


. 3.23. - (QuickBird;
" : <http://www.quickbird.ru/gallery/>)



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. 3.25.

ArcGIS

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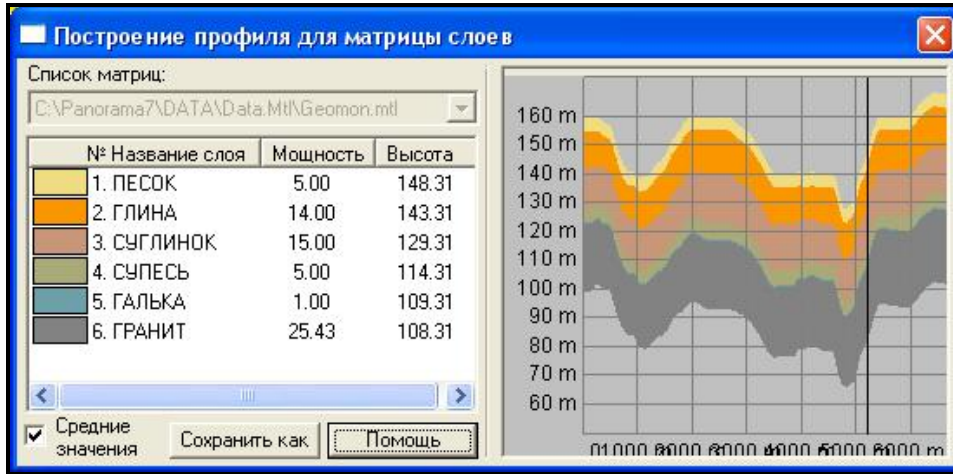
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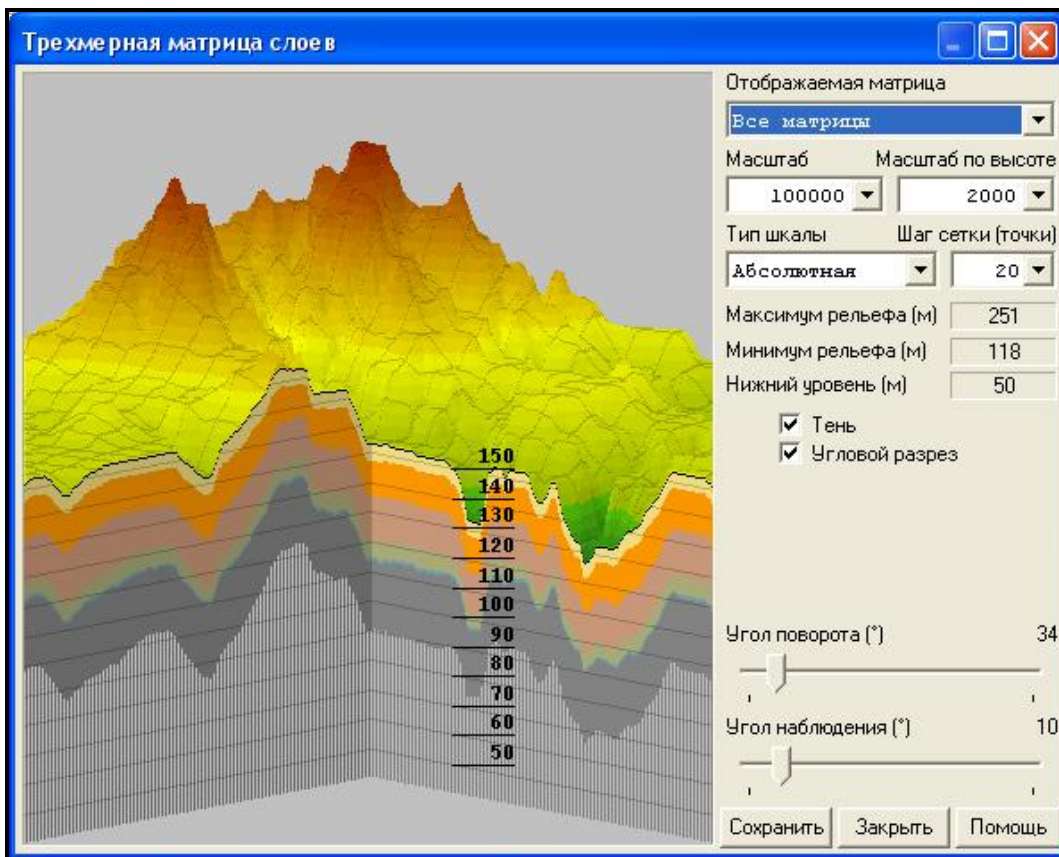
GPS-

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(cartographic data base, cartographic

database) –

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GPS. GPS (Global Position System) –

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RIP- ArcPress,

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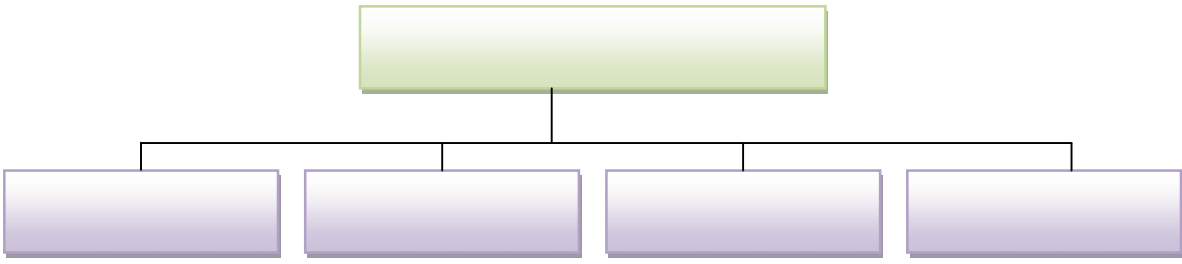
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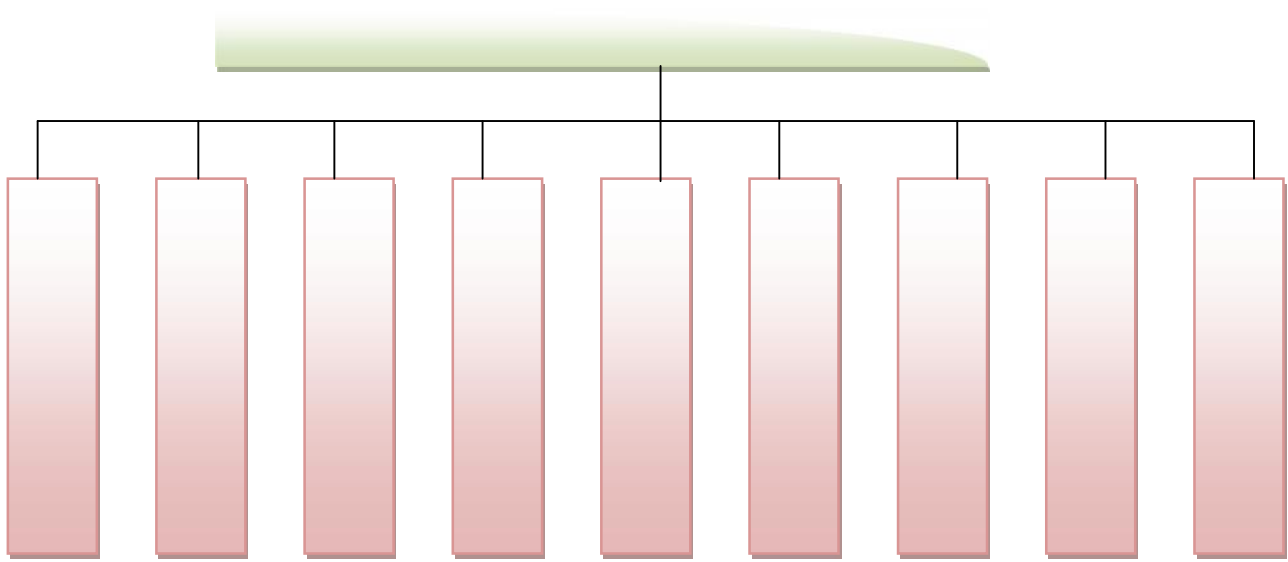


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4.1.1

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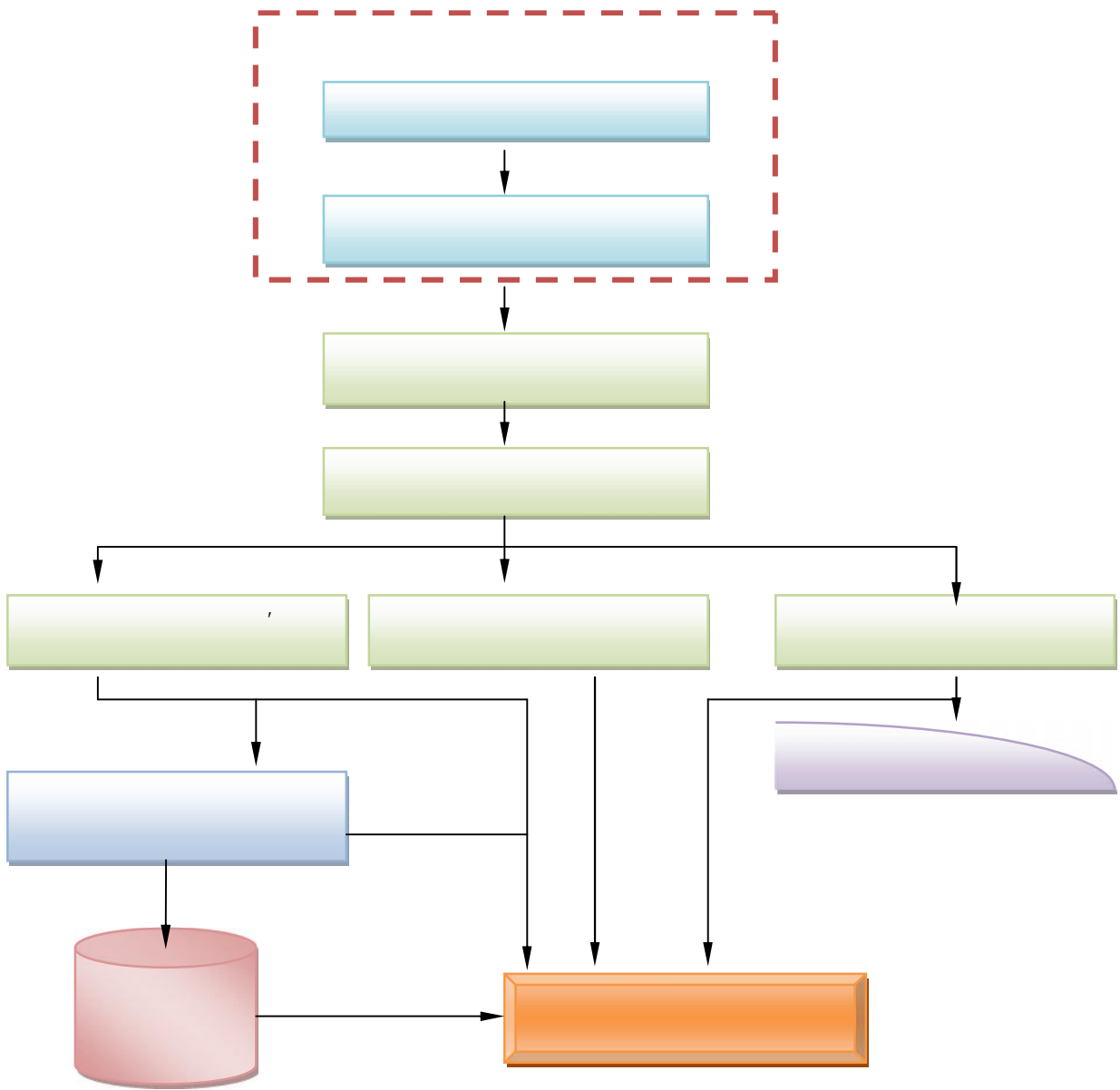
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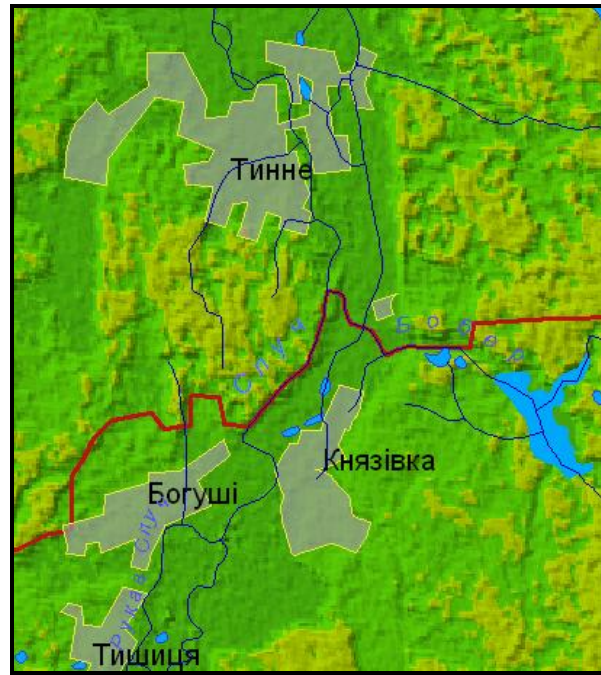


.4.3.

[26].

4.2

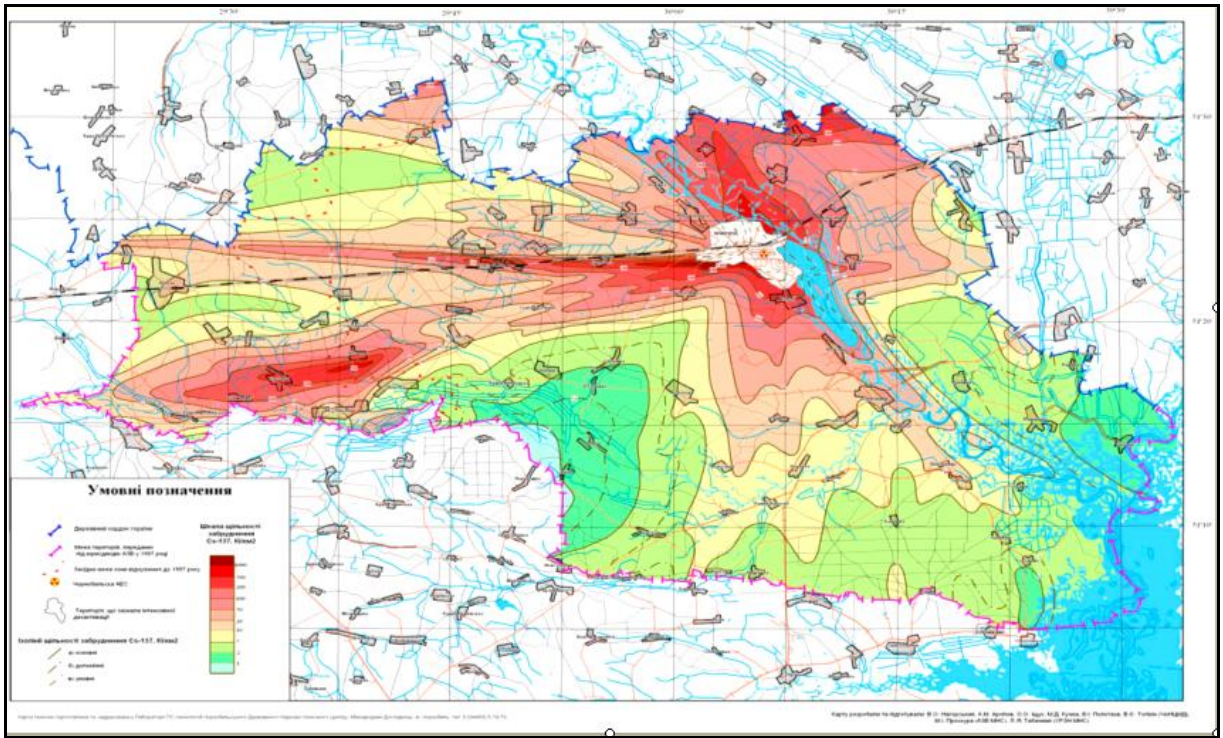
(. 4.4).



. 4.4.

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(. 4.5) [26].



.4.5.

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 (. grid -).

4.2.1

- (-
 - Digital Elevation Model, DEM, - Digital Terrain Model, DTM)

(grid DEM)

(TIN DEM).

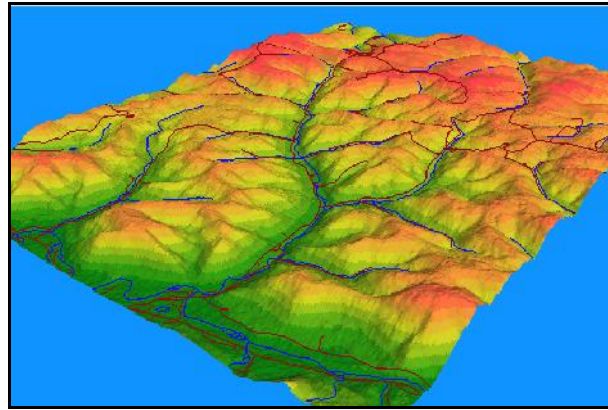
[6, 26].

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TIN),

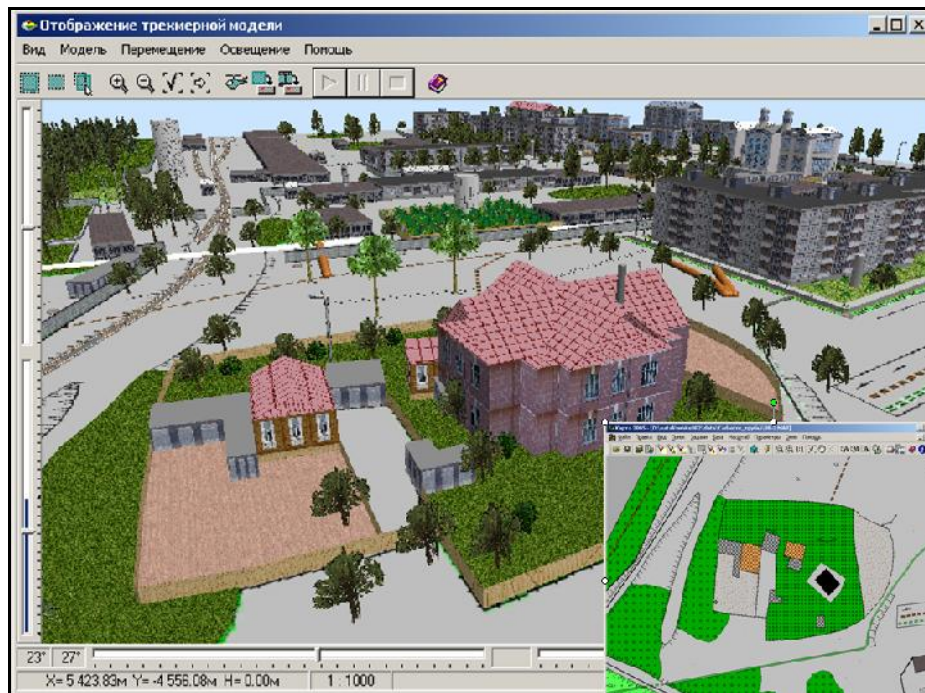
(grid



. 4.6.

3D

, (.4.7)



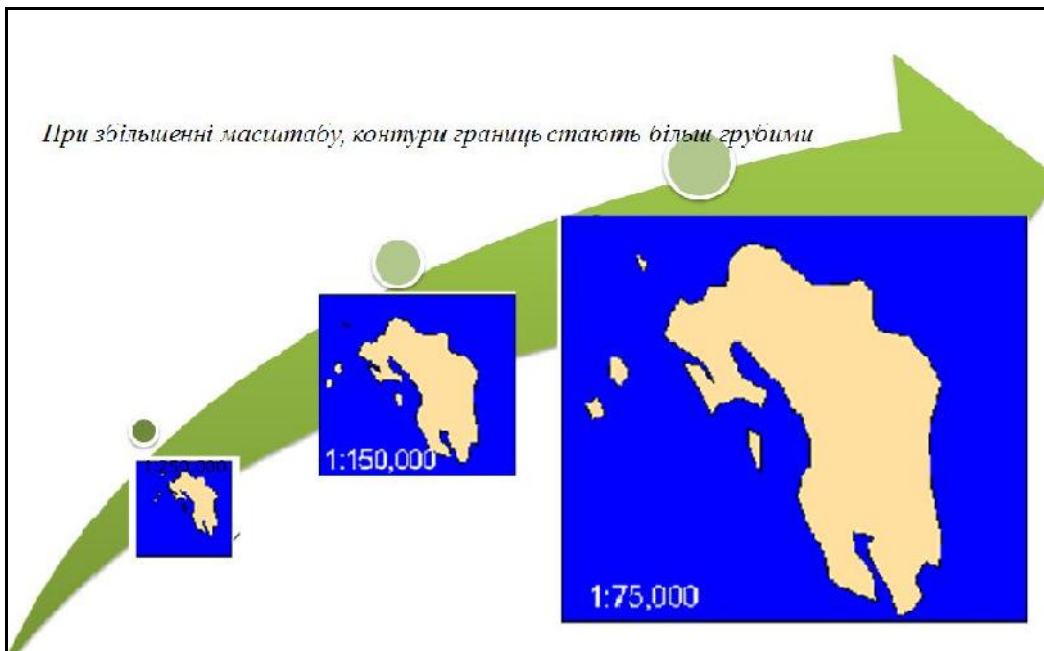
. 4.7.

3D

4.2.2.

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, grid DEM). -
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4.2.3.

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[26].

4.2.4.

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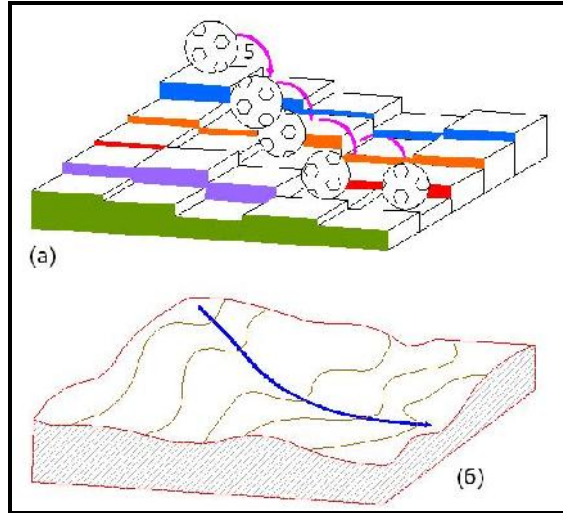
TIN

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[26].

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(.4.9).

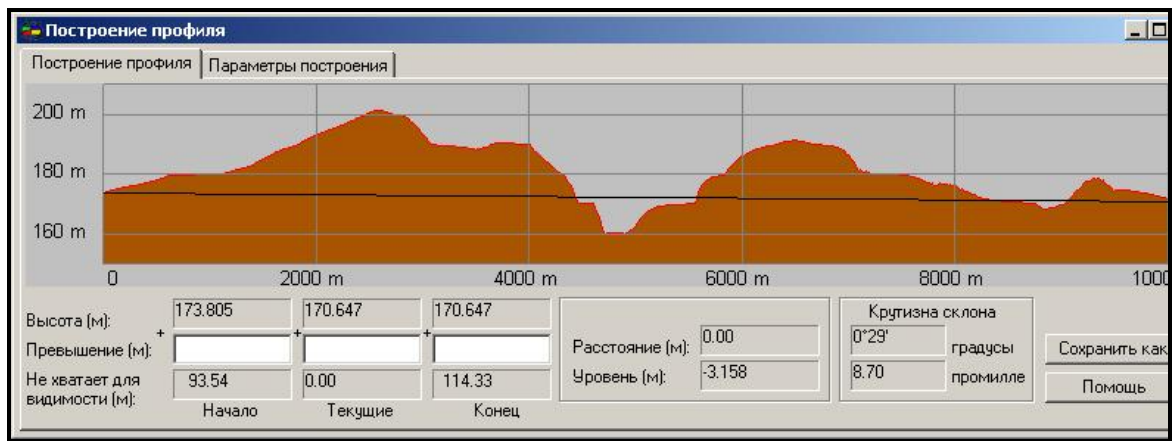


.4.9.

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[26].

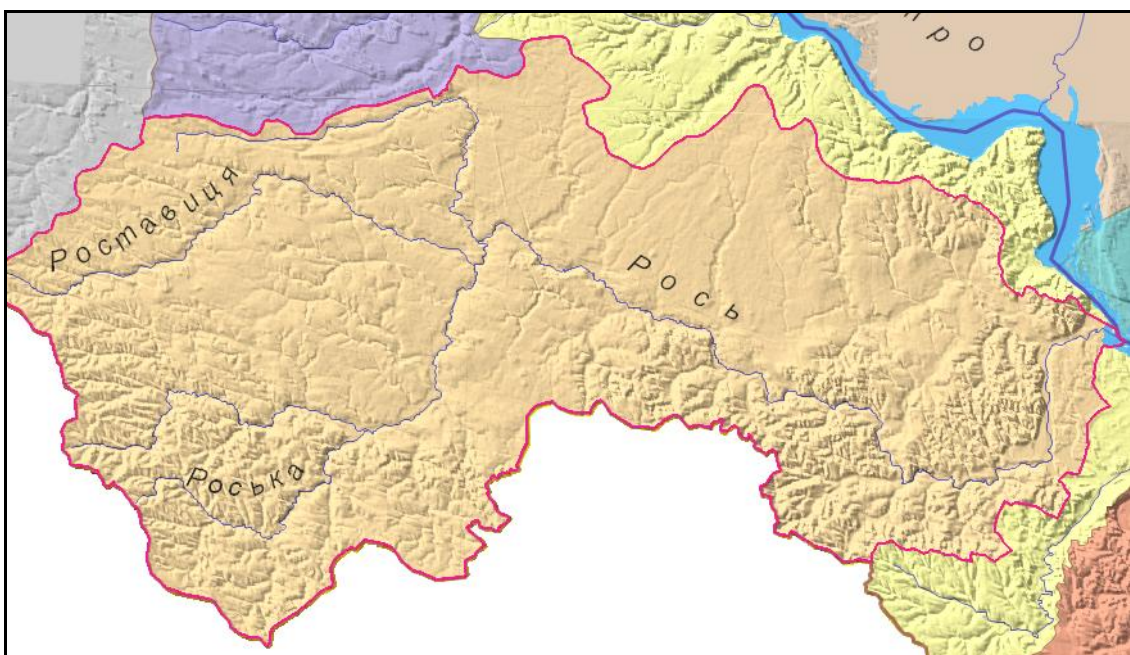
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 (cross-sectional profil).
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 TIN,
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 [26].



. 4.10.

(watershed)

(. 4.11).

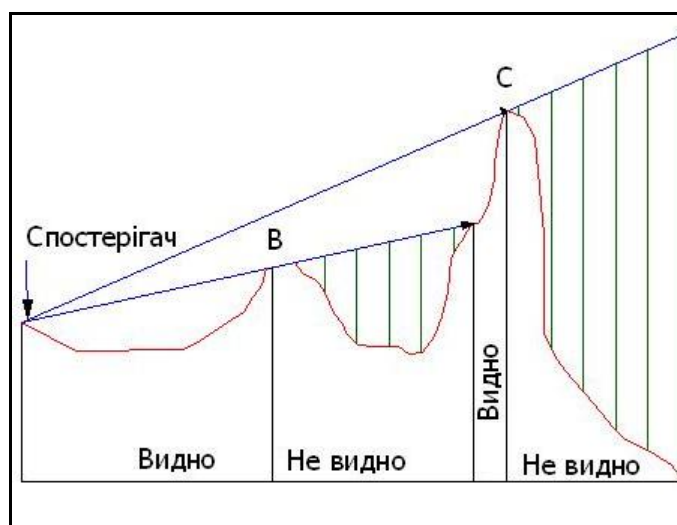


.4.11.

(viewshed)

[26].

(.4.12).



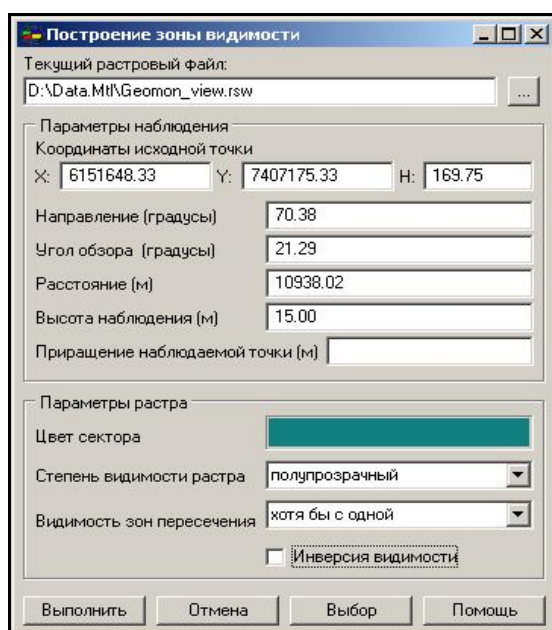
. 4.12.

TIN.

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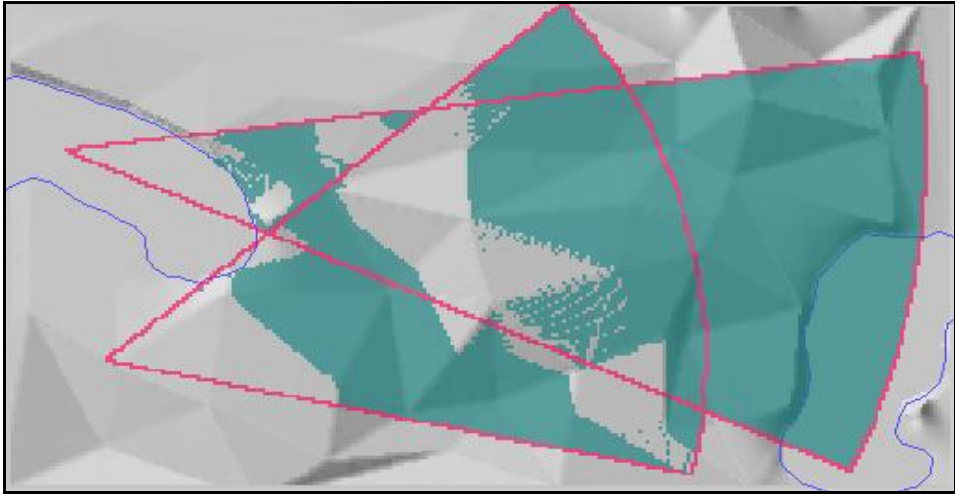
(. 4.13 – 4.14);

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. 4.13.

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. 4.14.

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[27].

4.3.

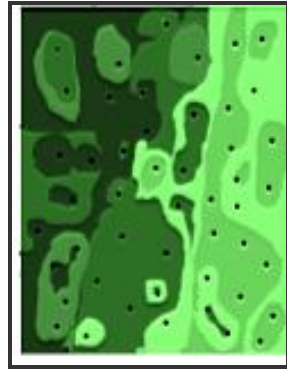
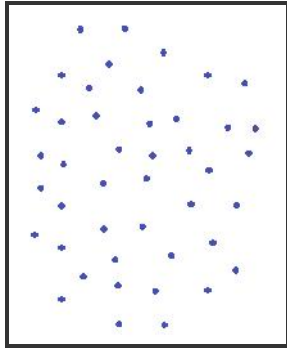
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4.3.1

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 x_k, y_k, z_k —
 („ ”). —
 , z_k . —
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 , h_x, h_y, h_z —
 (—
), $: f(x_k, y_k, z_k) = c_k = const$ [26]/ —
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. 4.15.

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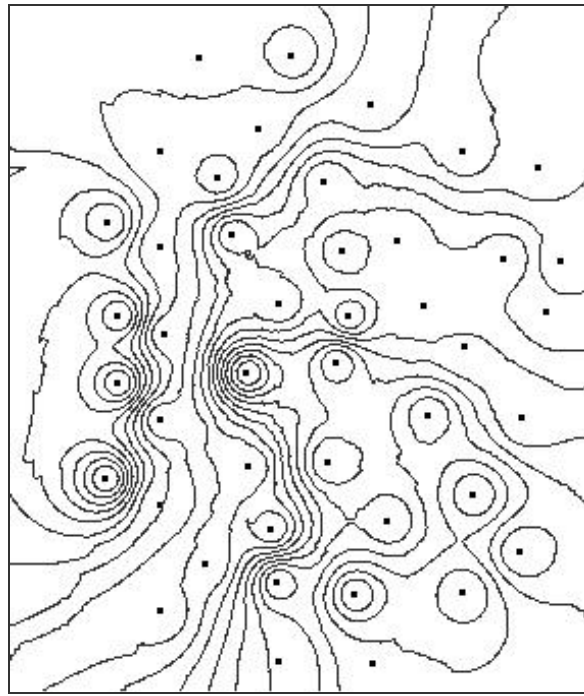
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. 4.16.

[26–29]:

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{40, 60}

{80, 100} 50 (40 + 10) 90 (80+10). , ,

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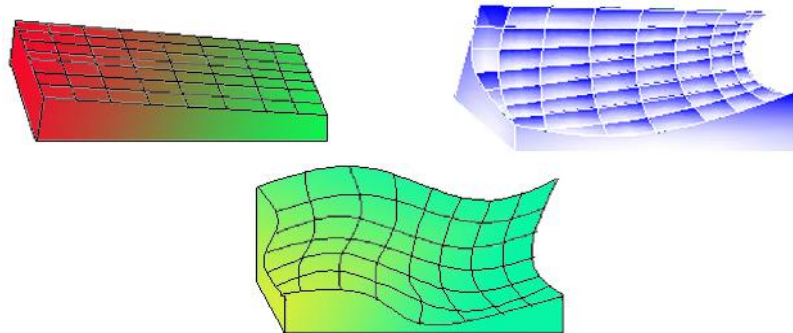
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110, 120, 130 140 .
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100, 110, 120, 130, 140 150 ,
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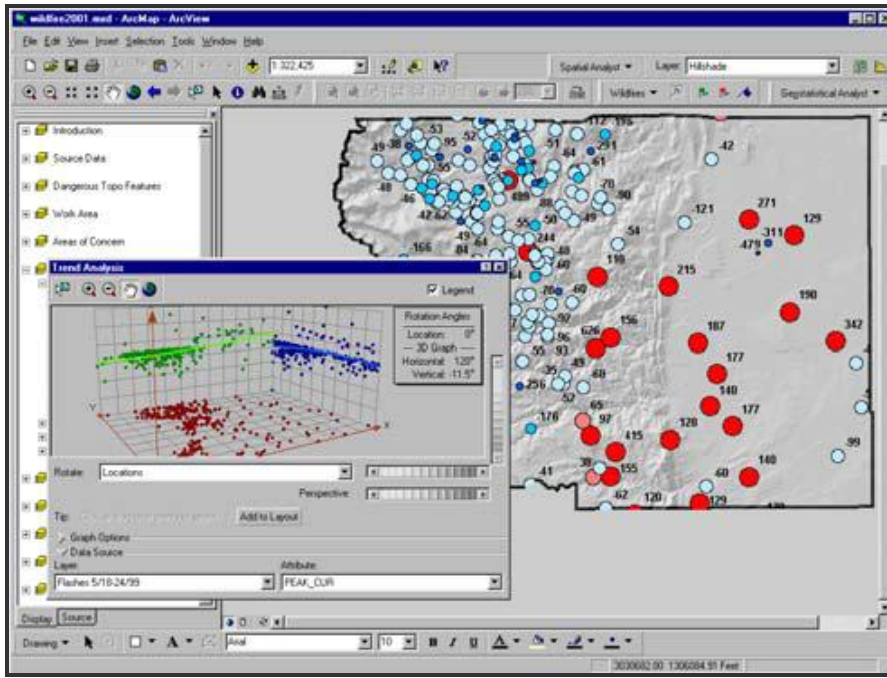


.4.17.

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(.4.18).

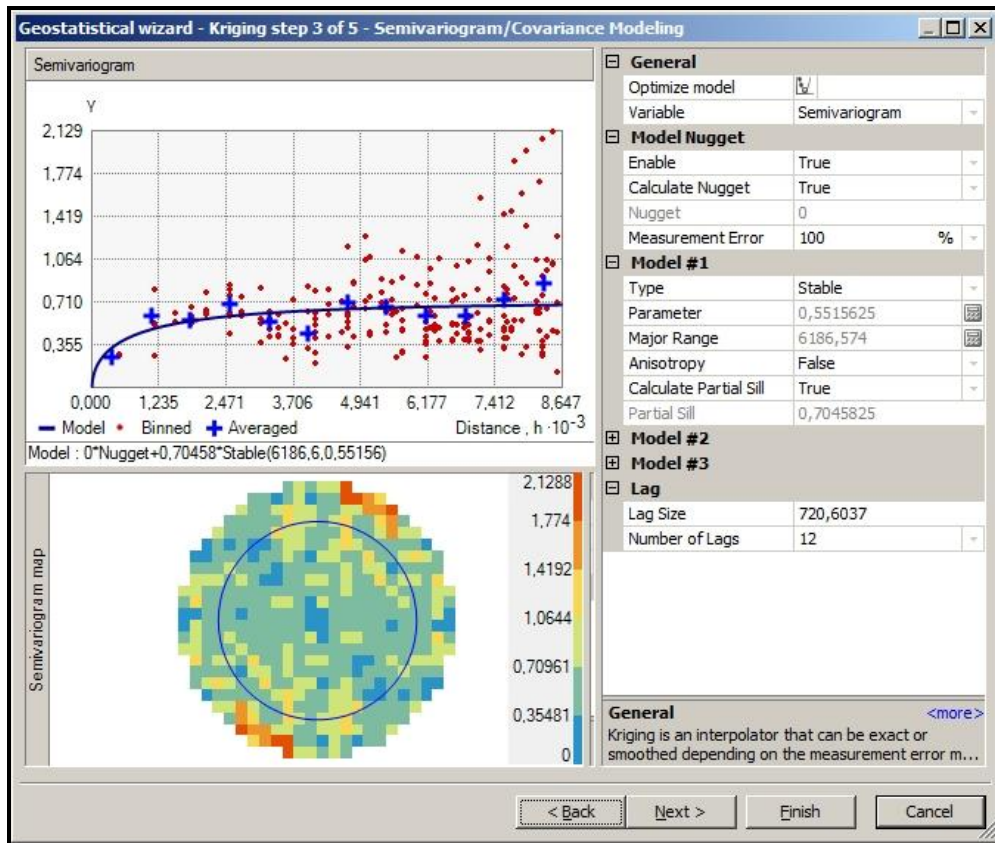


. 4.18.

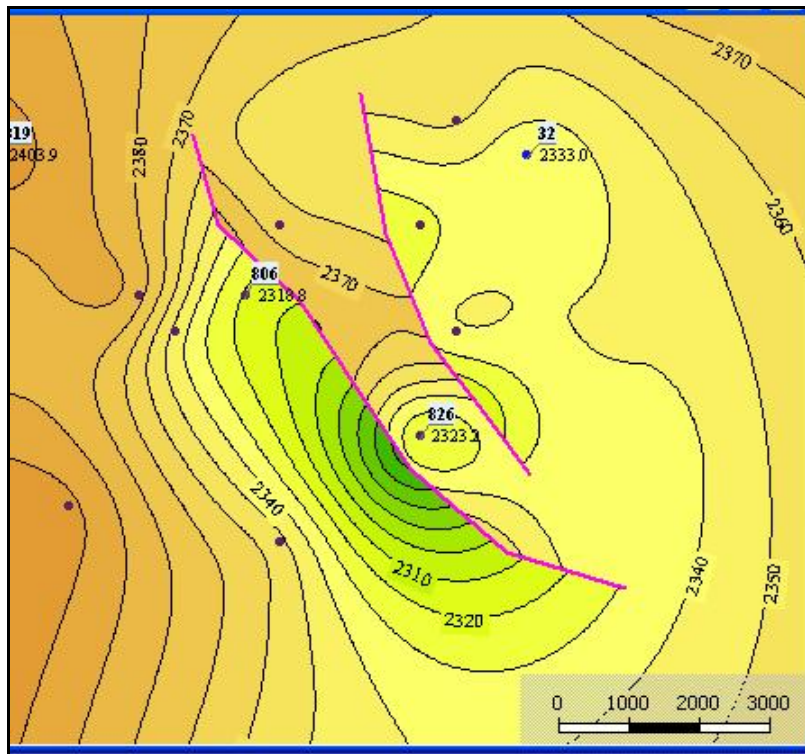
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(. 4.19).

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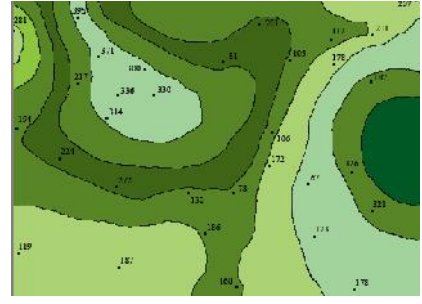
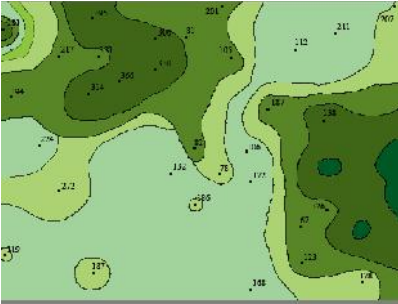
. 4.20. Geostatistical Analyst (ArcGIS)



. 4.21.

(. 4.22).

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. 4.22.

;) ;)

$z(x,y)$

()

(triangulated irregular network -

TIN),

XY

GRID-

TIN-

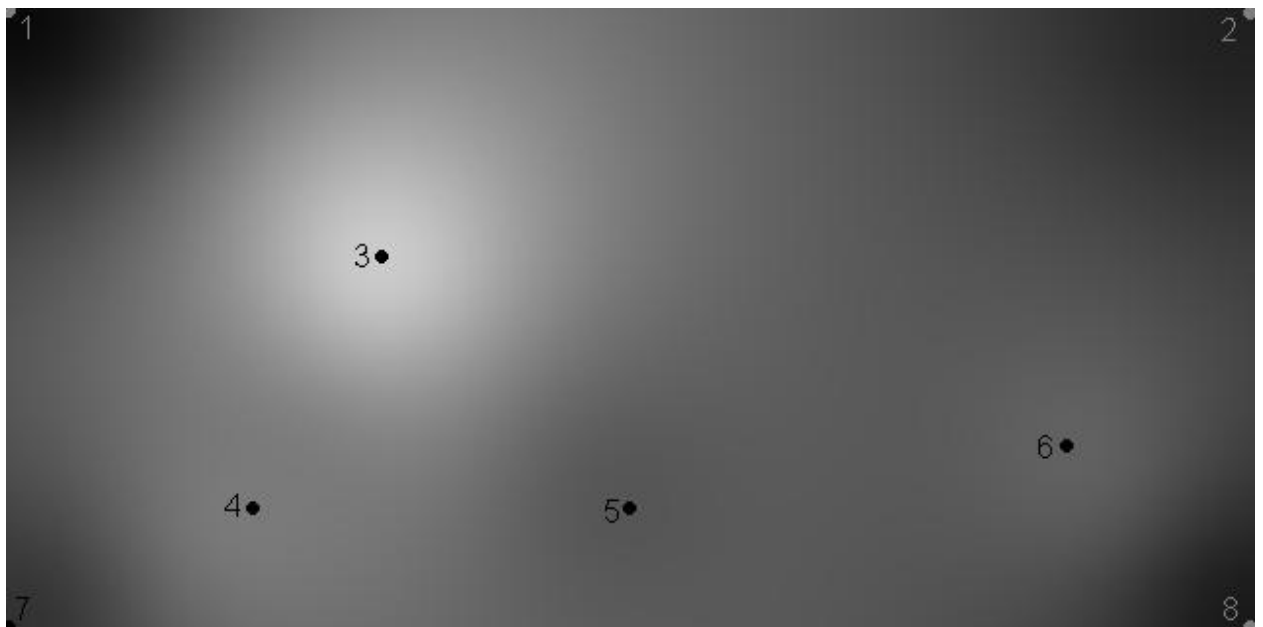
GRID- (. 4.23).

$$pMatrix_{x,y} = \frac{\sum_{i=1}^{size} pZ_i \cdot \frac{1}{((x - pX_i)^2 + (y - pY_i)^2)}}{\sum_{i=1}^{size} \frac{1}{((x - pX_i)^2 + (y - pY_i)^2)}} \quad (4.1)$$

(4.1).

4.1 –

	1	2	3	4	5	6	7	8
X	0	2	0,6	0,4	1	1,7	0	2
Y	0	0	0,4	0,8	0,8	0,7	1	1
Z	10	32	204	123	86	98	50	25



. 4.23. GRID-

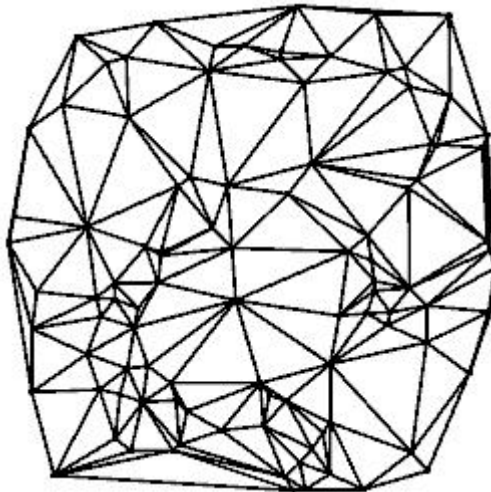
. 4.1

TIN-

TIN-

TIN,

(.4.24).

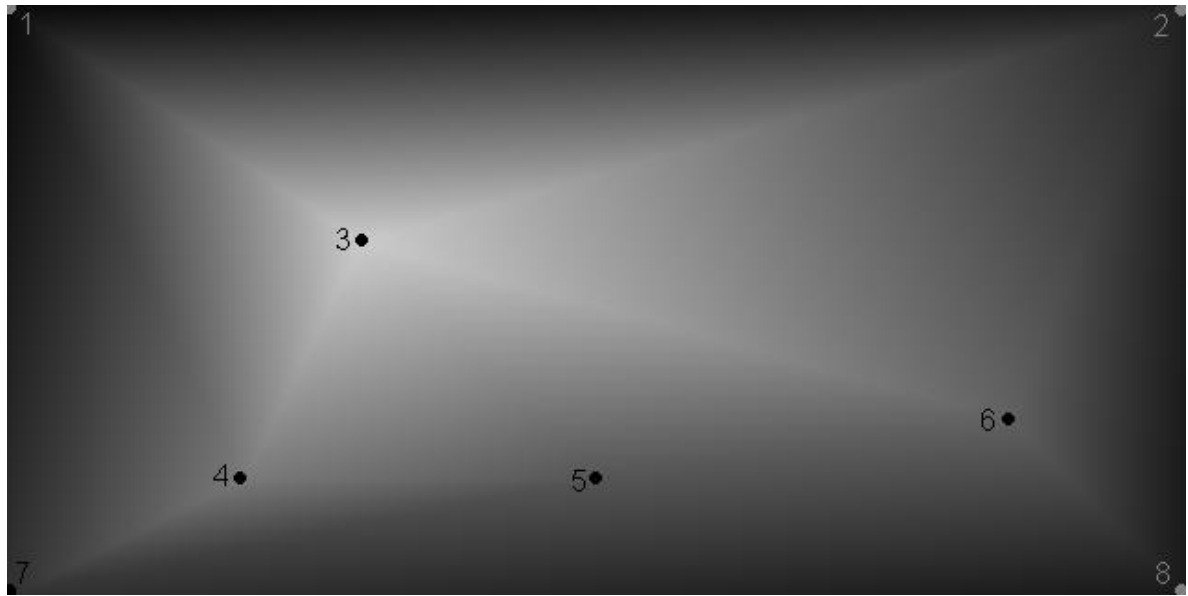


.4.24.

Z.

$$\begin{vmatrix} x-x_1 & y-y_1 & z-z_1 \\ x_2-x_1 & y_2-y_1 & z_2-z_1 \\ x_3-x_1 & y_3-y_1 & z_3-z_1 \end{vmatrix} = 0. \quad (4.2)$$

$Z,$
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 $- \text{TIN}-$
 $(. 4.25)$
 $(. (4.1)),$



. 4.25. TIN-

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4.4.

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4.4.1

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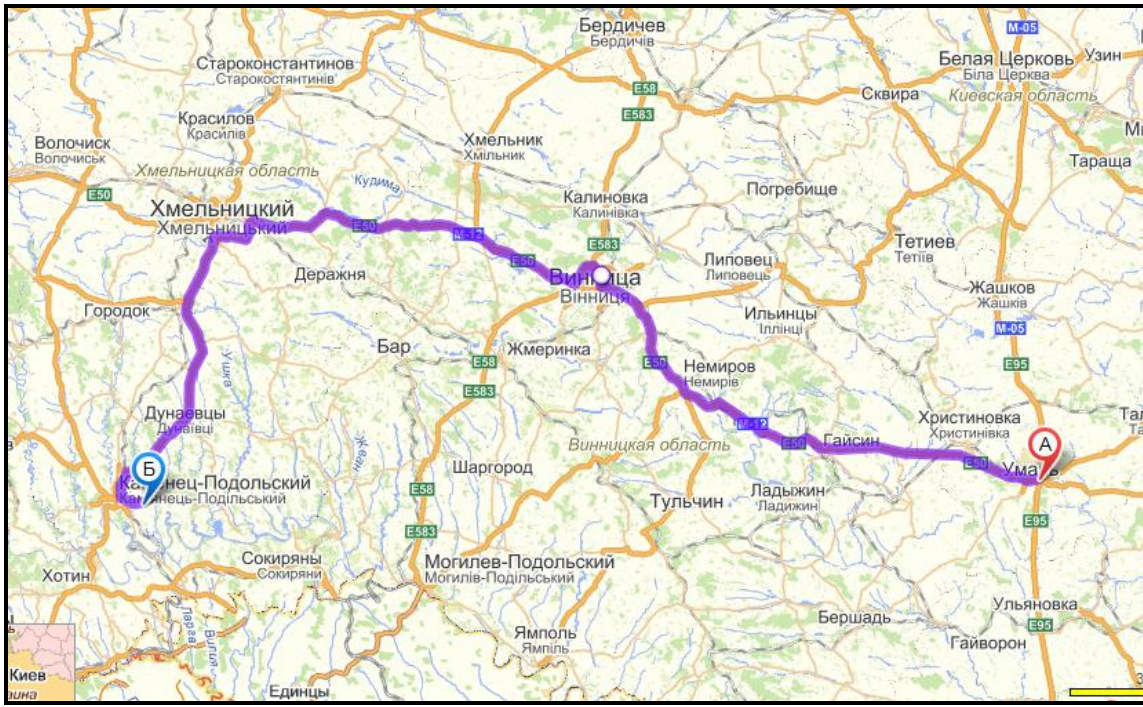
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. 4.27.

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Network Analyst ArcGIS,

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ArcGIS ArcGIS Schematics,

ArcGIS Desktop (ArcView, ArcEditor ArcInfo).

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ArcGIS Schematics ArcGIS

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ArcGIS Schematics

. ArcGIS Schematics

ArcGIS Schematics

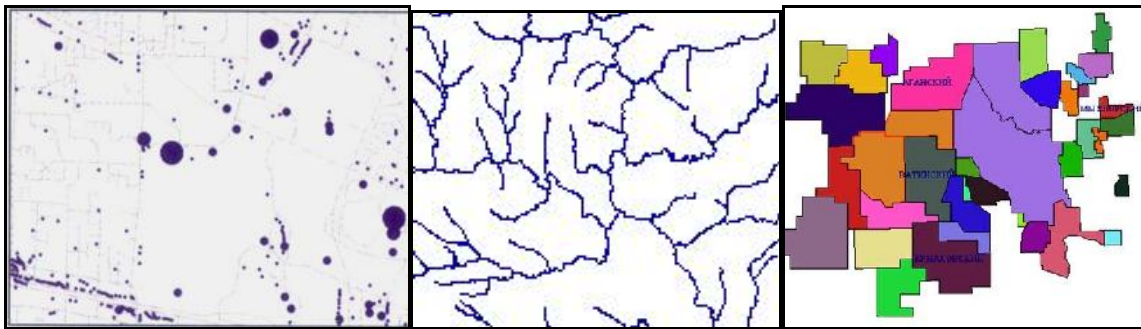
.). ArcGIS Schematics

4.5

4.5.1

4.5.2

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(. 4.28) [26].

. 4.28.

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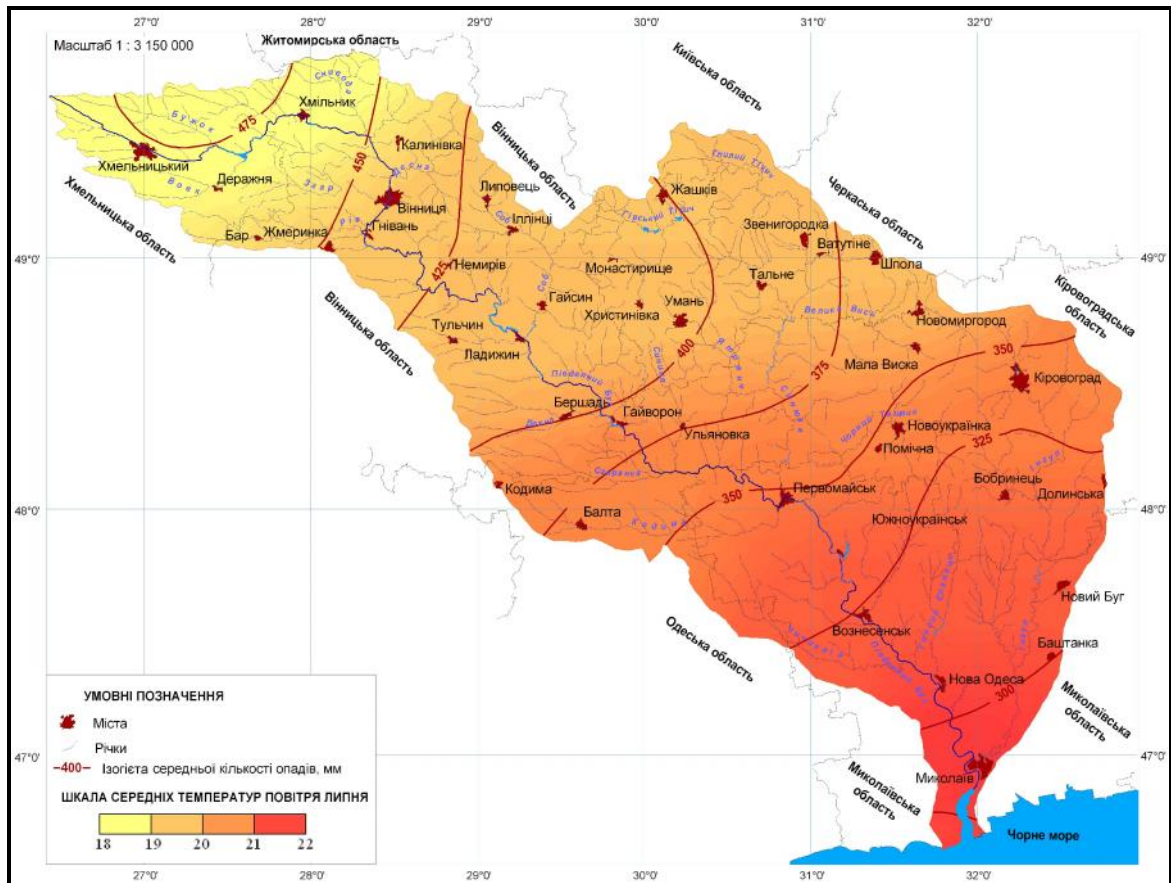
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[26].

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4.5.3

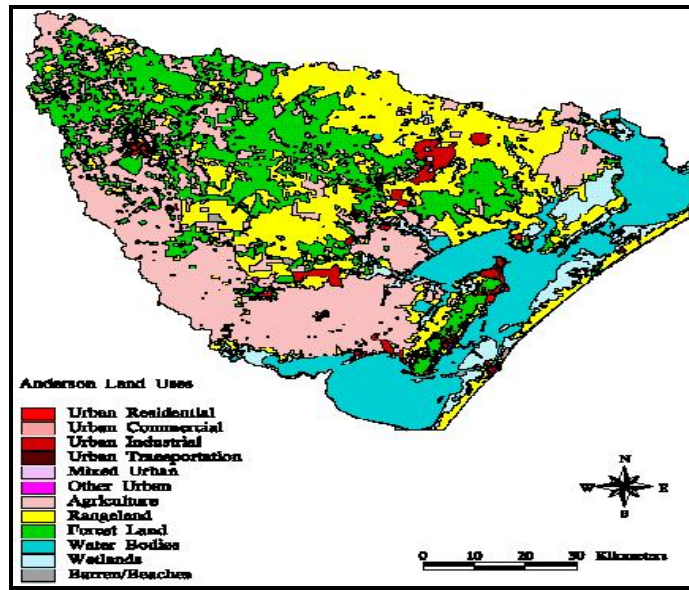
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 ,) (.4.29).



. 4.29.

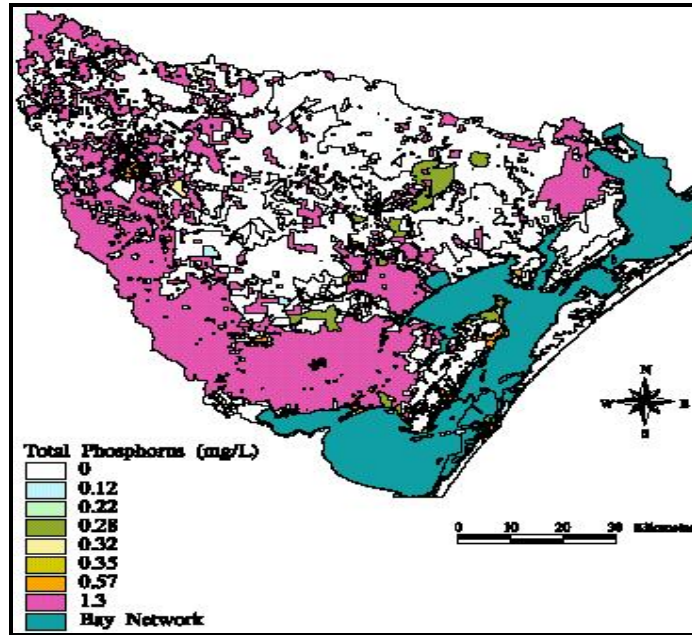
.) (. 4.31).

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. 4.31.

[26].



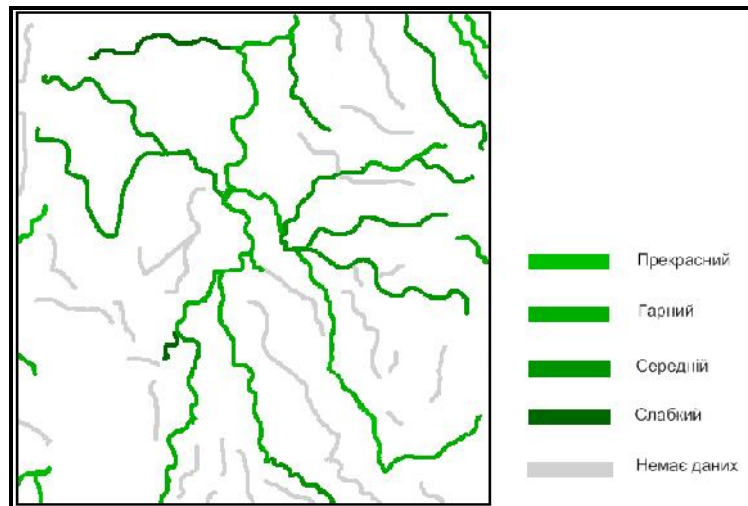
. 4.32.

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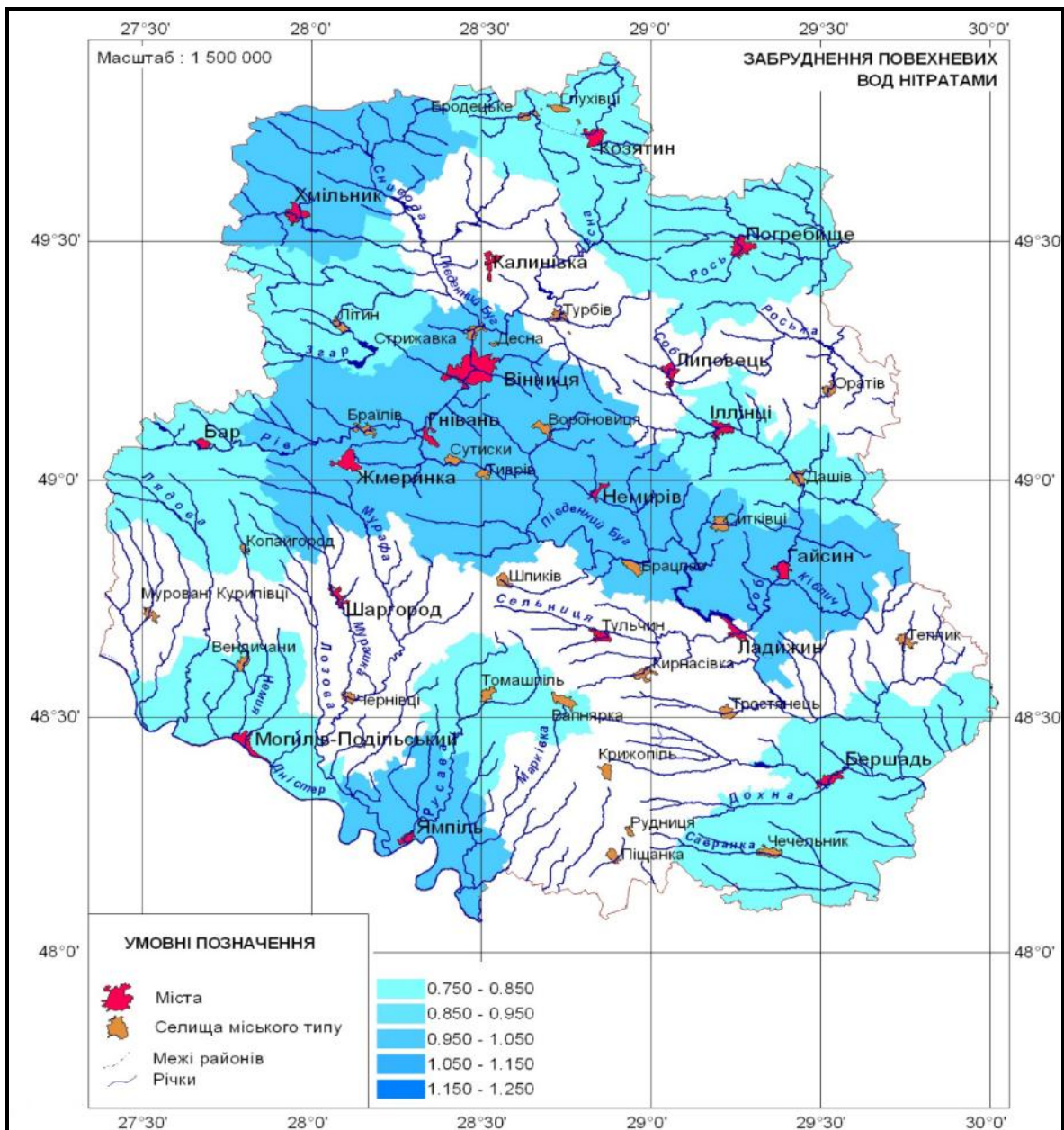
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[26–32].



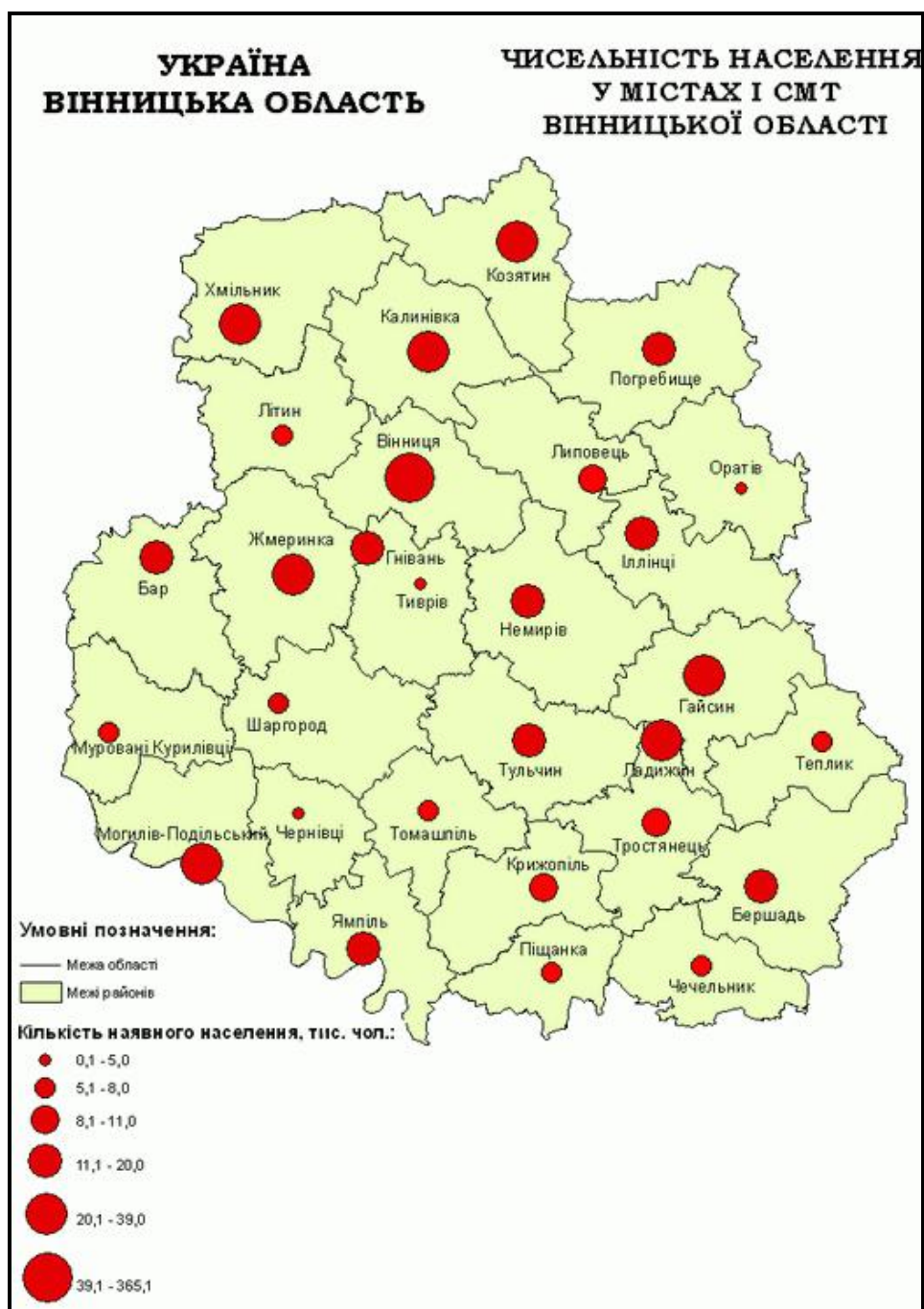
. 4.34.

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 (. 4.35) [26–32].
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.4.35.

(. 4.36).



. 4.36.

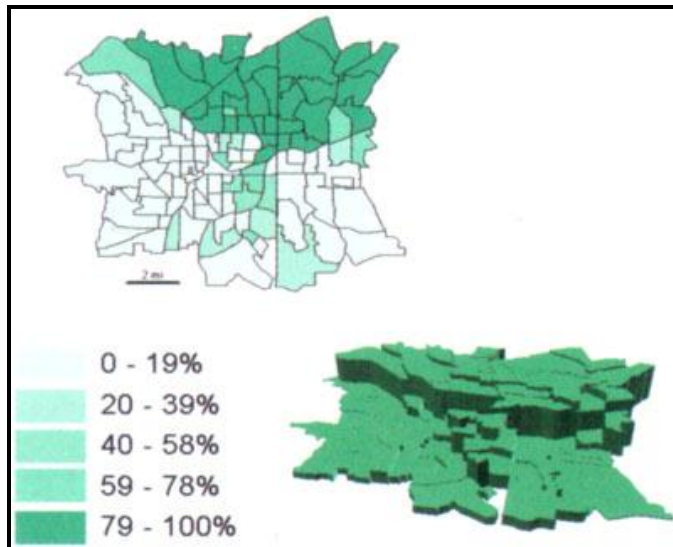
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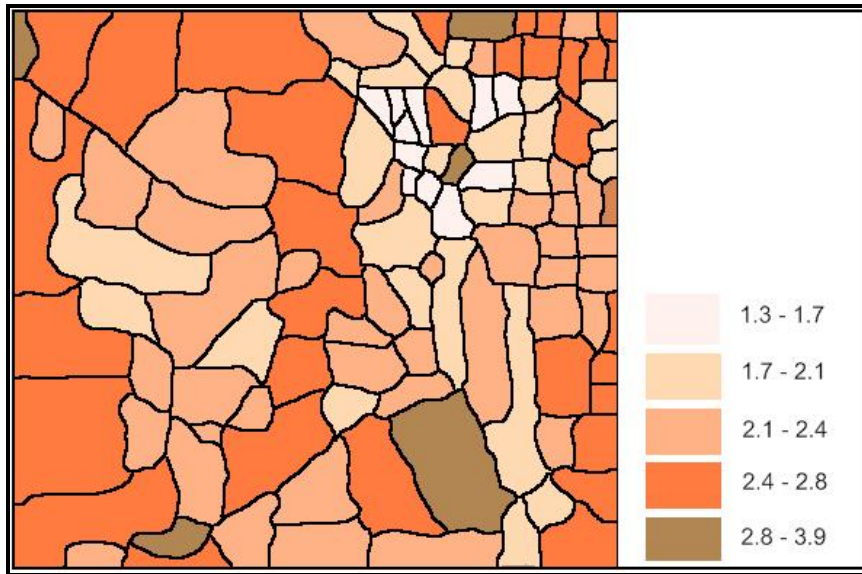
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(.4.37).



.4.37.

(.4.38).



.4.38.

4.6

4.6.1

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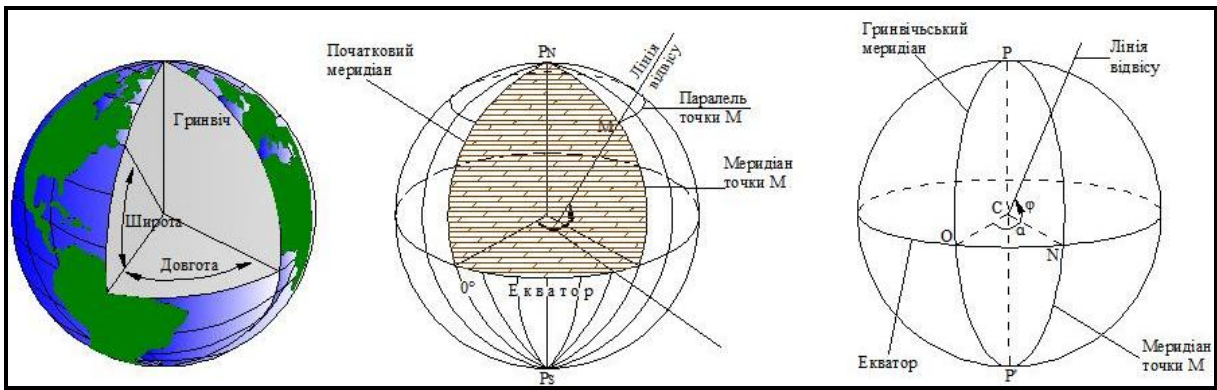
, $X Y$, -

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() -

$x y$

x (), xy -
 y ().
 (x, y, z) .
 $($).
 $xy-$ x y , z .
 $($. 4.39)
 $[25]$.



. 4.39.

2.

$x \quad y \quad -$

$, \quad -$

$x \quad y \quad , \quad -$

$z \quad .$

$, \quad -$

$, \quad -$

$. \quad -$

$. \quad -$

$- \quad , \quad , \quad -$

$. \quad , \quad .$

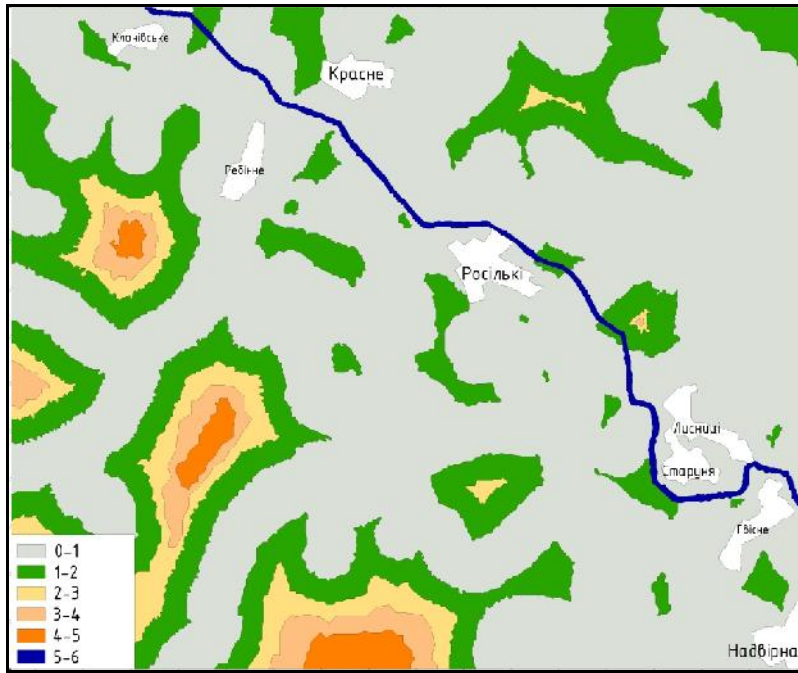
$X \quad Y,$

$(\quad) \quad . \quad -$

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4.6.2

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 . 4.40 , Spatial
 Analyst - CostPath (), -
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. 4.40.

Cost path (Spatial Analyst)

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„Distance”

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4.6.3

(„Object Length”, „Perimeter”),

[26–32].

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$$15 \cdot 50 = 750$$

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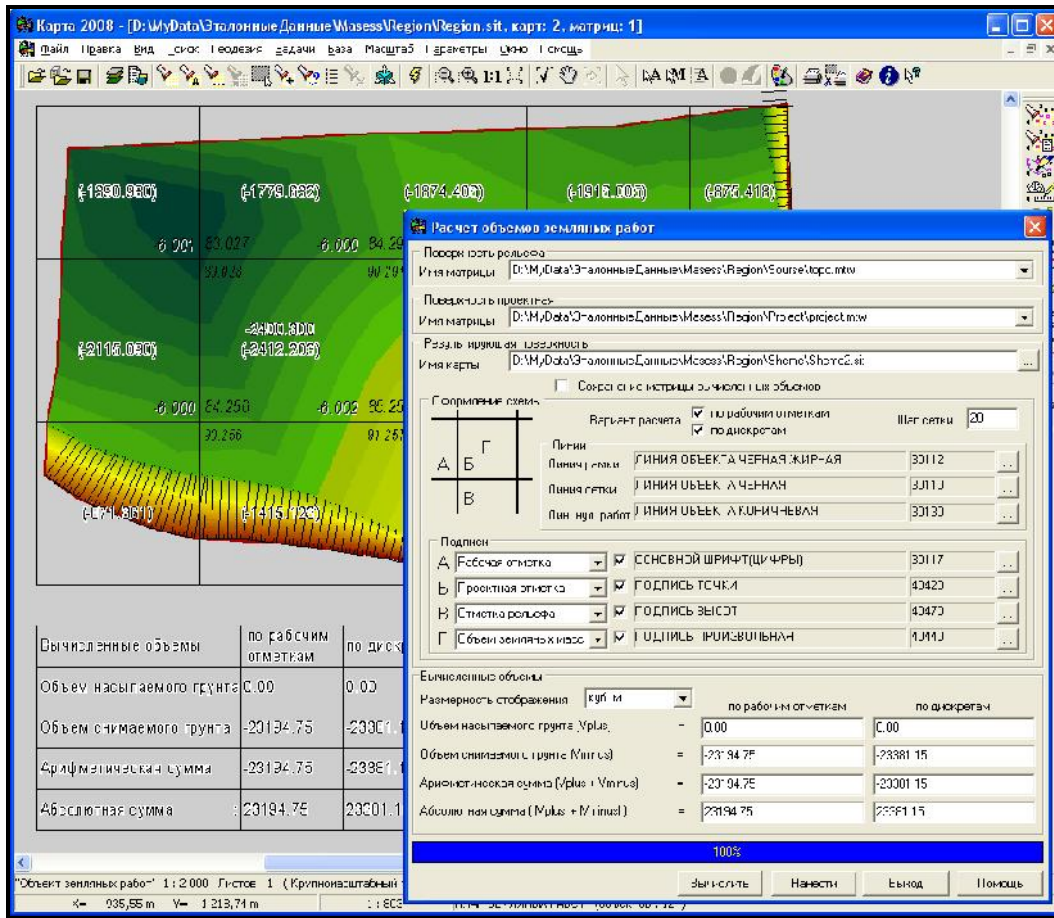
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[26].

(GRID, TIN-).

4.41



4.41.

« » [5]

4.6.4.

(query)

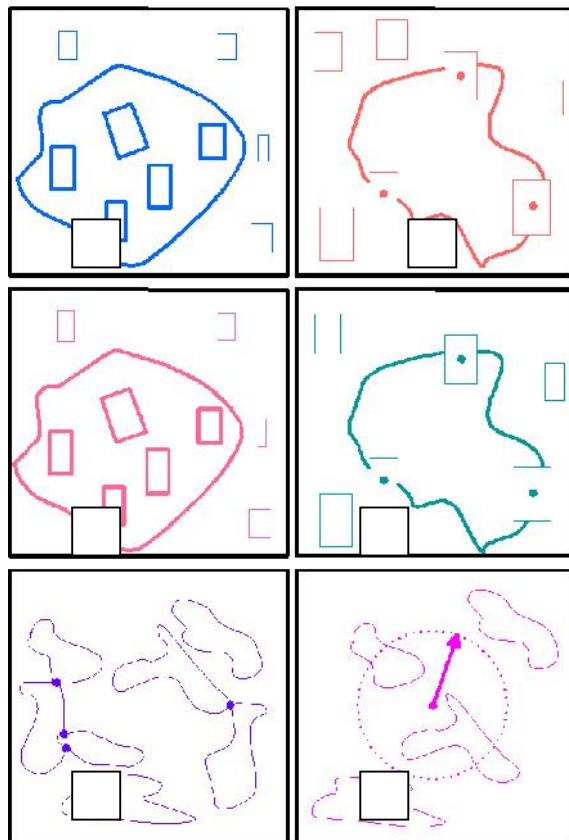
[26].

[26–32]:

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(. 4.42) [26–32]:

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 - (,) ,
 ())
 (4.42).

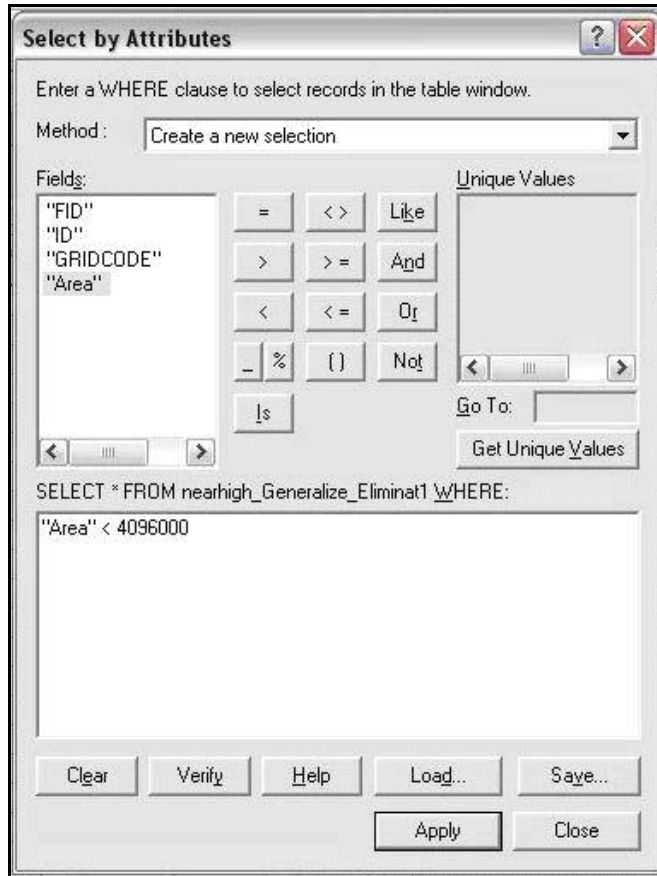


. 4.42.

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 - (SQL, -
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 , [26–32].
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 [26]:
 - (, , , , -
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 - (, , , , -
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 - (, , -
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 („ ” (and) - , ’ -
 ; „ ” (or) - , ’
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4.43

ArcGIS



. 4.43.

ArcGIS

[26]:

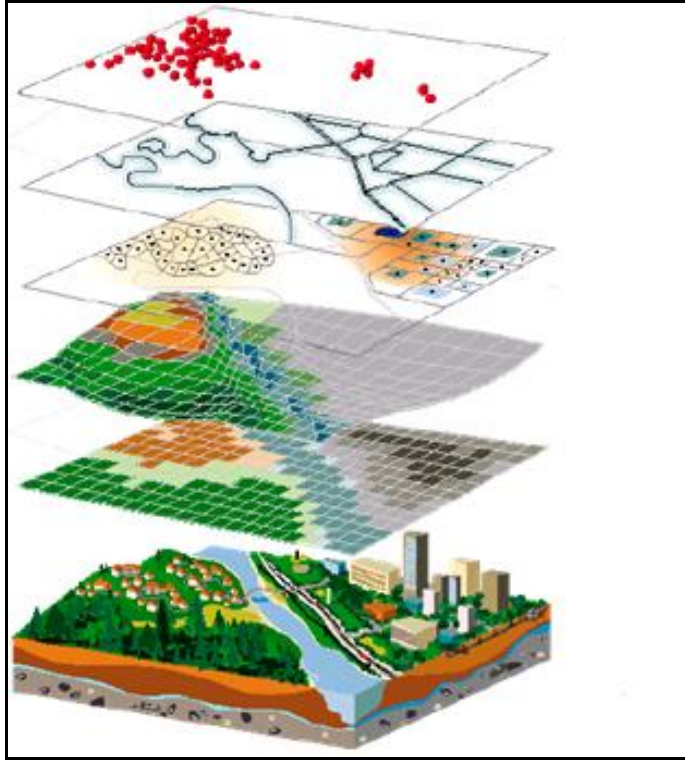
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 SQL
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 - [1, 26].

4.7.

4.7.1

(overlay) –
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 [26].
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(.4.44).



.4.44.

4.7.2

[26]:

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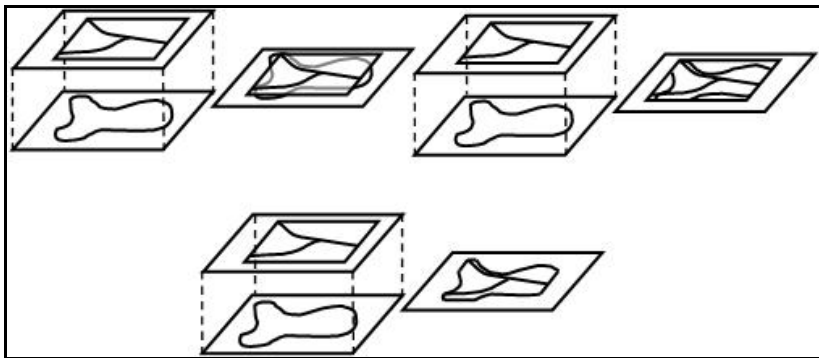
[26]:

(union) (. 4.45.) -

(intersect) (. 4.45.) -

(. 4.45.) -

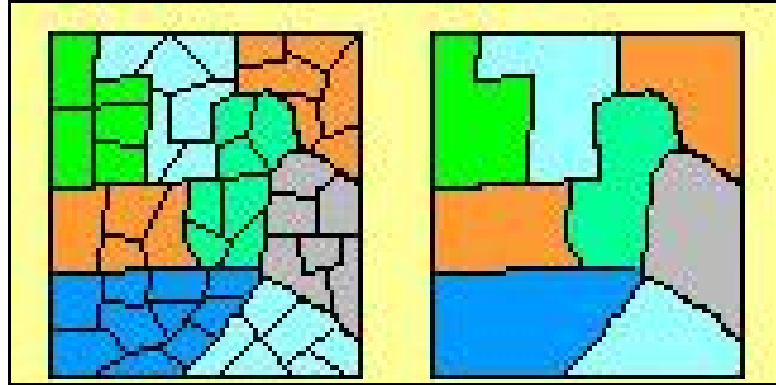
() -



)))

.5.45.

(.4.46).



. 4.46.

4.7.3

GRID Spatial Analyst,

ArcInfo Workstation ArcGIS

AND, N T

[27].

« 11» « »(. 4.47),
 « »

[5]:

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. 4.47. « » « 11»

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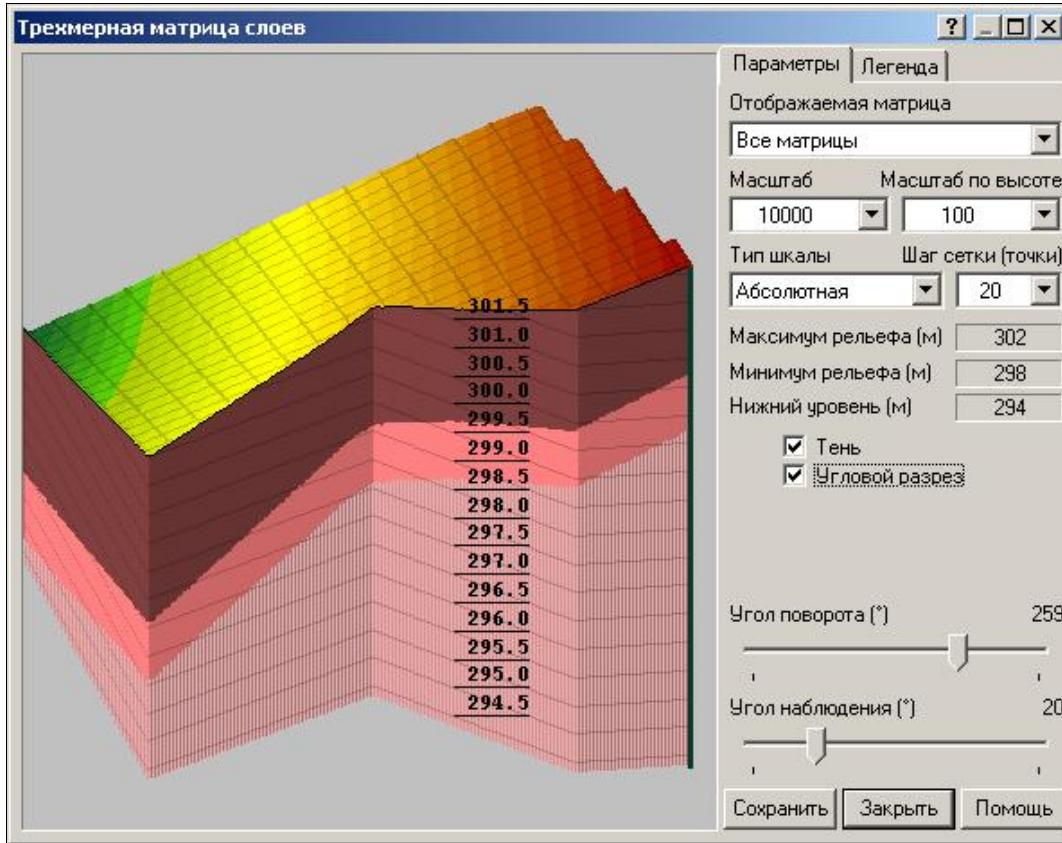


. 4.48. « » « 11»

4.8.

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GPS

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ArcGIS (ESRI) Finder (Schlumberger);

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[10, 11].

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 $B_0(\lambda)$,
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 [10, 11].
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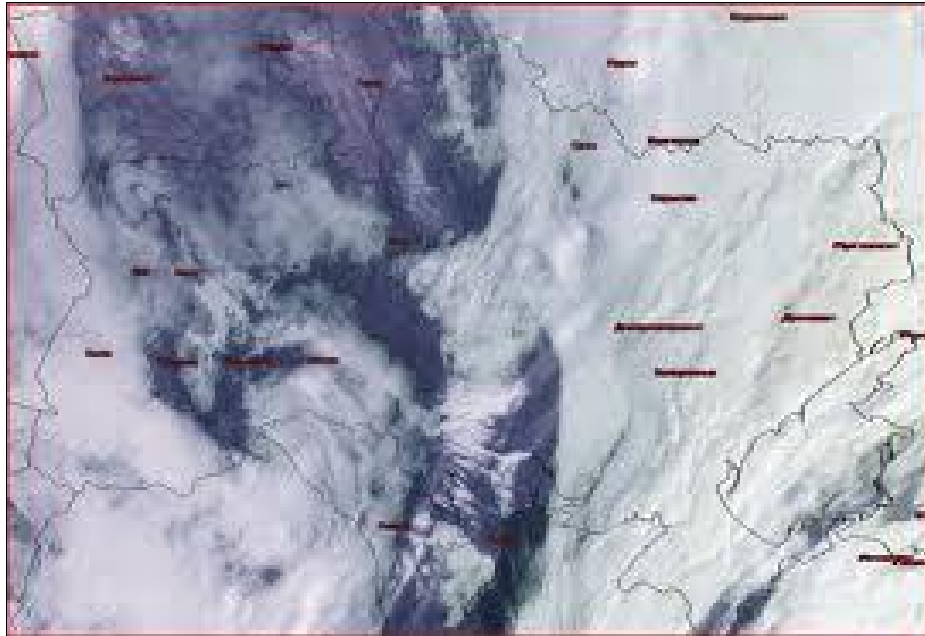
80%.

10...15 / 3.

[33].



[10].



.5.2.

[10].

5.2

GPS

(GPS Global Positioning System) 24

[33].

1977 .

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15

GLONASS

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GPS.

GPS

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GPS [33].

GPS

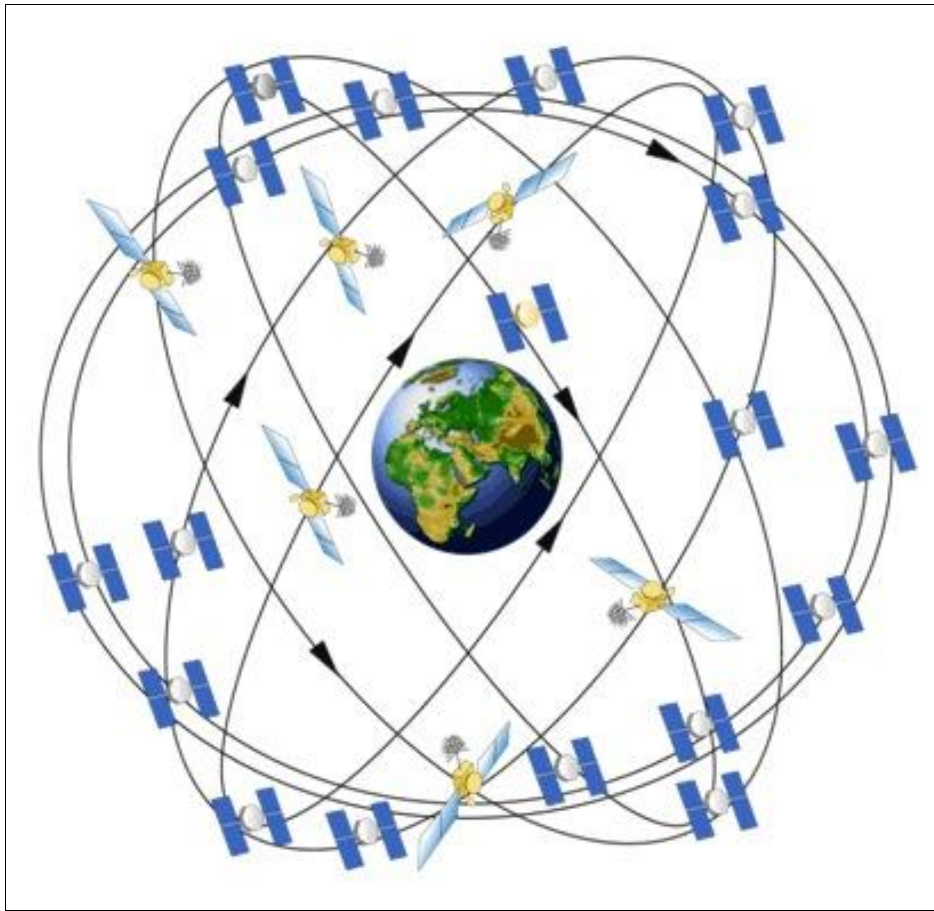
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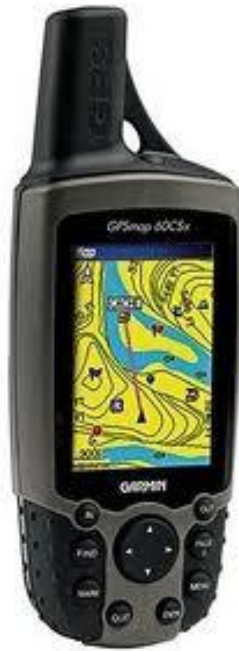
GPS

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. 5.3.

12- . , 12- GPS- GARMIN
 GPS ,
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 . GPS- GARMIN
 15 (. 5.4).



. 5.4.

GPS-

GARMIN

GPS-

GPS

WAAS,

EGNOS

MSAS.

GPS-

1-3

GPS

GPS

-42

-63,

GPS-

WGS-84.

[11].

GPS

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GPS (

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GPS (. .),

10-50

GPS

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GPS

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GPS

GPS-

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GPS,

[33]:

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(ArcGIS, Mapinfo, .)

GPS,

5.3

ERDAS Imagine , ER Mapper , ENVI , IDRISI .

ERDAS Imagine. ERDAS Imagine (. 5.5),

ERDAS,

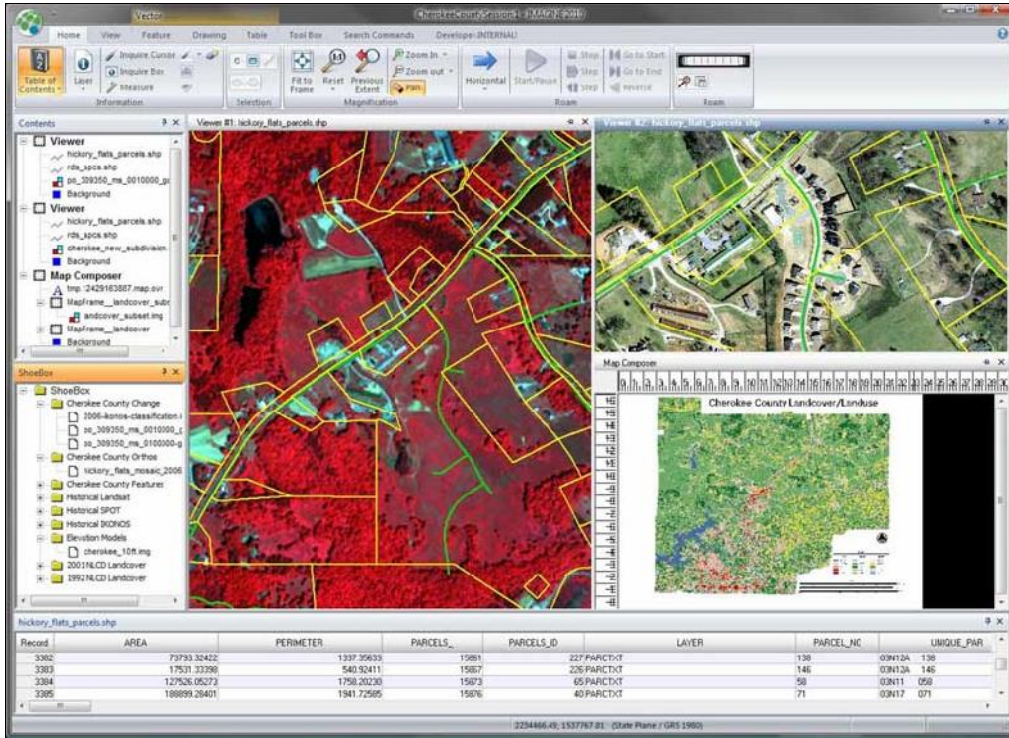
- ,
- . ,
- - -
- ,
- ERDAS Imagine

[34].

() ERDAS Imagine

: Imagine Essentials, Imagine Advantage

Imagine Professional.



. 5.5. ERDAS Imagine

ERDAS

Imagine VirtualGIS, Imagine OrthoBASE, Imagine Subpixel Classifier, Imagine Radar Mapping Suite, Imagine Developers Toolkit, Stereo Analyst ..

Imagine VirtualGIS

Imagine OrthoBASE –

ERDAS.

Stereo Analyst

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Imagine Subpixel Classifier

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Imagine Radar Mapping Suite

Imagine Developers Toolkit

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ERDAS Imagine

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ERDAS Imagine

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ERDAS Imagine

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Model Maker,

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Map Composer.

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Vector ERDAS Imagine

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ArcInfo,

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[34].

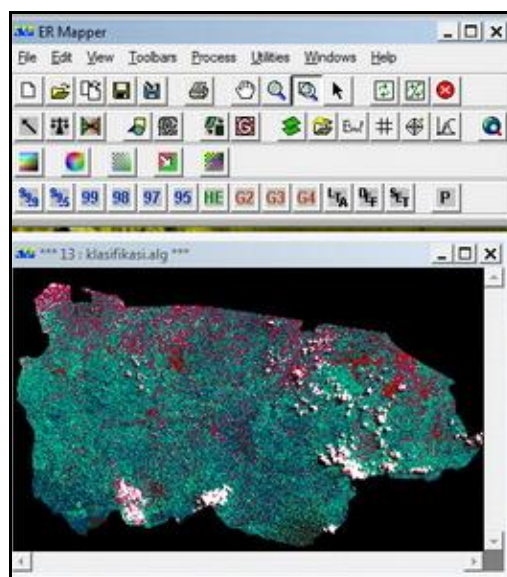
IMG

. ERDAS Imagine

ERDAS ER Mapper.

ERDAS ER Mapper (. 5.6),

ER Mapper,



. 5.6. ERDAS ER Mapper

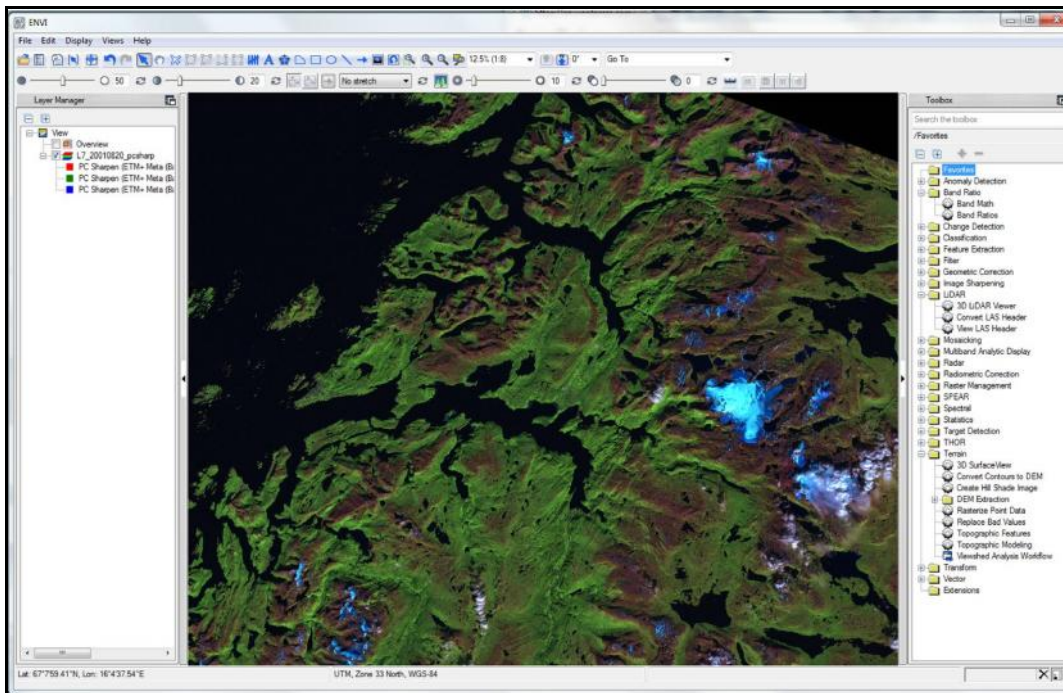
, -
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 . ER Mapper -
 « » ,
 .
 ER Mapper
 ,
 (Landsat, Spot, NOAA . . .), -
 (ArcInfo , MapInfo . . .). -
 130 [34-39].
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 ER Mapper ,

ER Mapper

ENVI (5.7) (Environment for Visualizing Images –)
ITT Visual Information Solutions

. ENVI

QuickBird, Ikonos, Orbview, Cartosat-1, Formosat-2, Resourcesat-1, SPOT, IRS, Landsat .



. 5.7. ENVI

ENVI

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-ENVI

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- K-means, ISODATA;

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ENVI,

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ENVI

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[34-39].

ENVI IDL (

Interactive Data Language) ,

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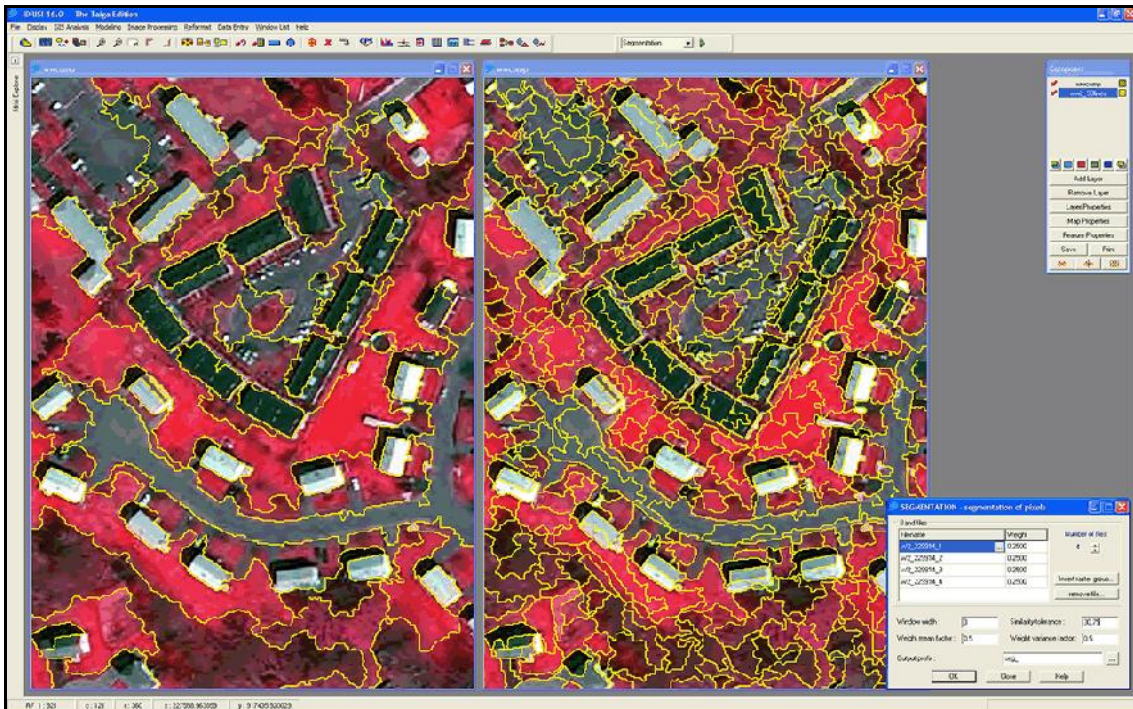
ENVI

IDRISI. IDRISI (. 5.8) (,)

80- DOS-

IDRISI Windows

DOS-



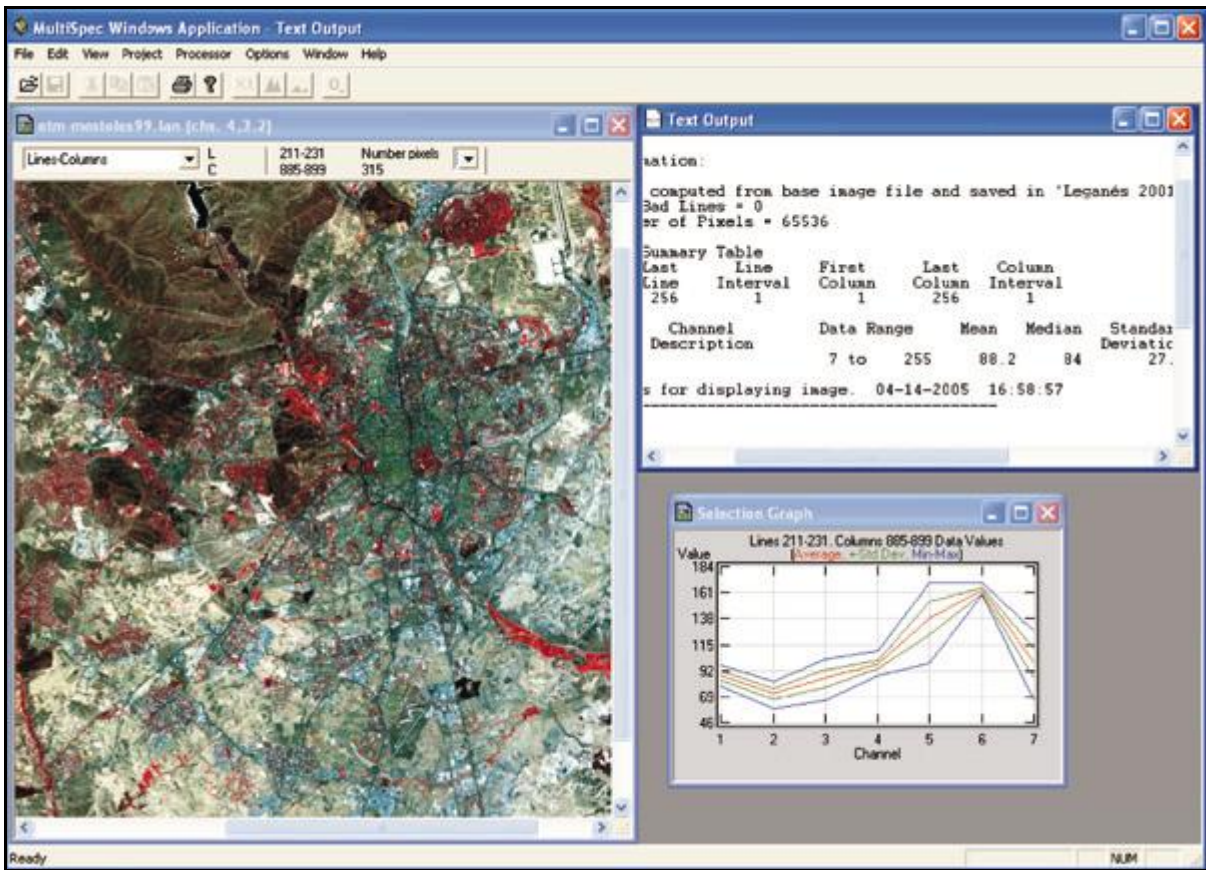
. 5.8. IDRISI

MultiSpec (. 5.9) ; MultiSpec

MultiSpec (. 5.9) ; MultiSpec

MultiSpec

MultiSpec



. 5.9. MultiSpec

Digitals (. 5.10).

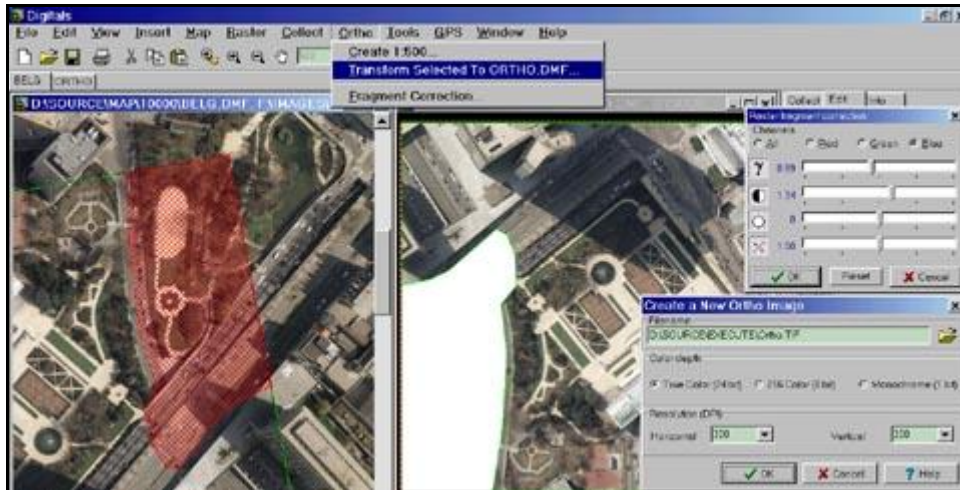
(Topotracer).

Digitals

TIFF BMP;

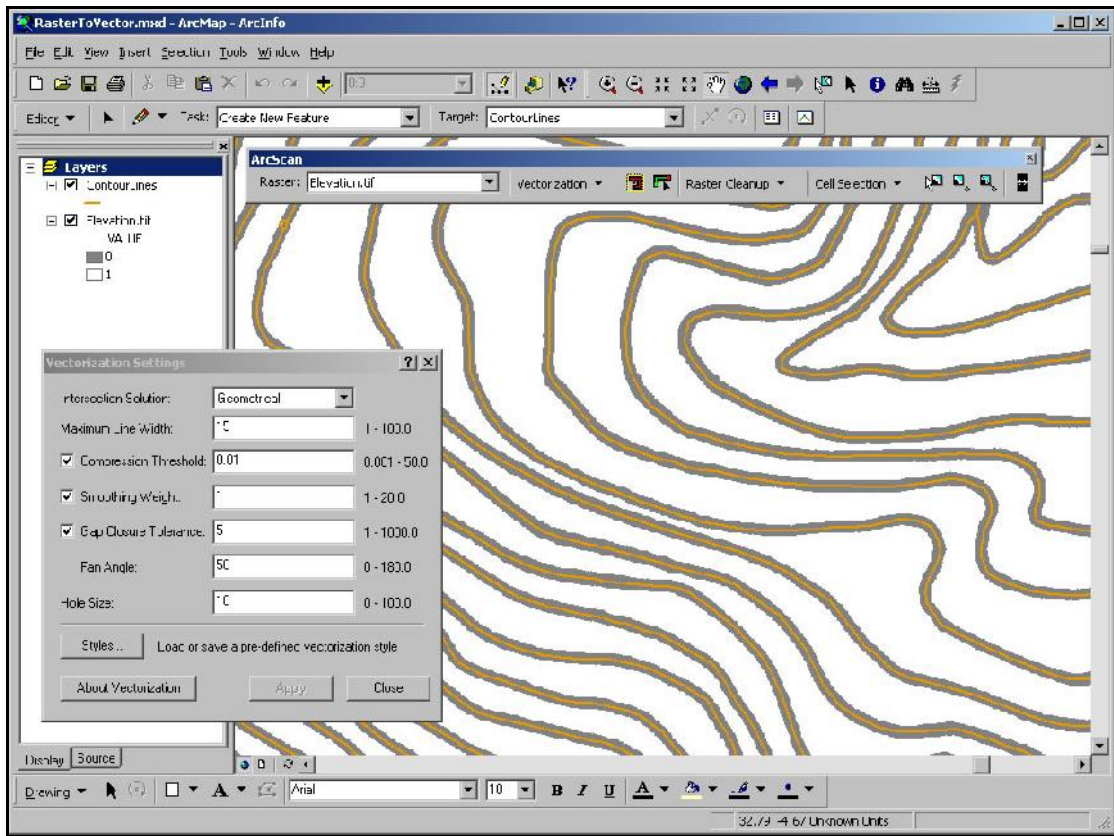
- ;
- MID/MIF, DGN, TXF, ASCII;

DWG, DXF+DBF, Shape,



. 5.10. Digitals

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- DXF- ;
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- AcrGIS ArcScan -
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. 5.11. ArcScan

ArcScan

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ArcScan

ArcMap

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GeoTIFF

RSW.

GeoTIFF

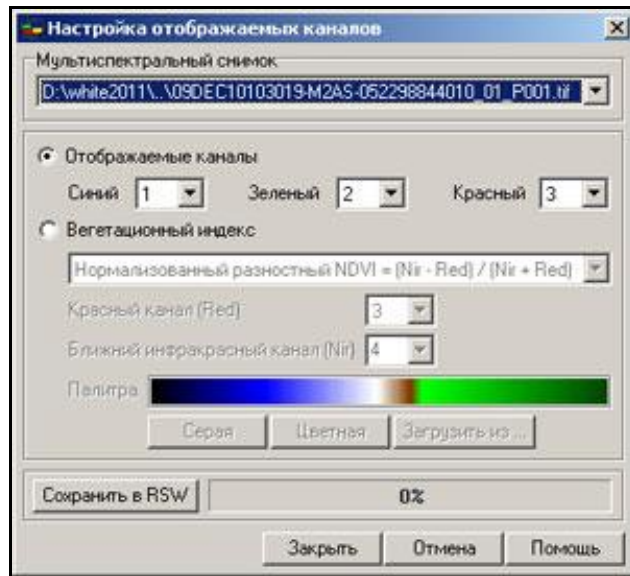
(EPSG)

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[39].

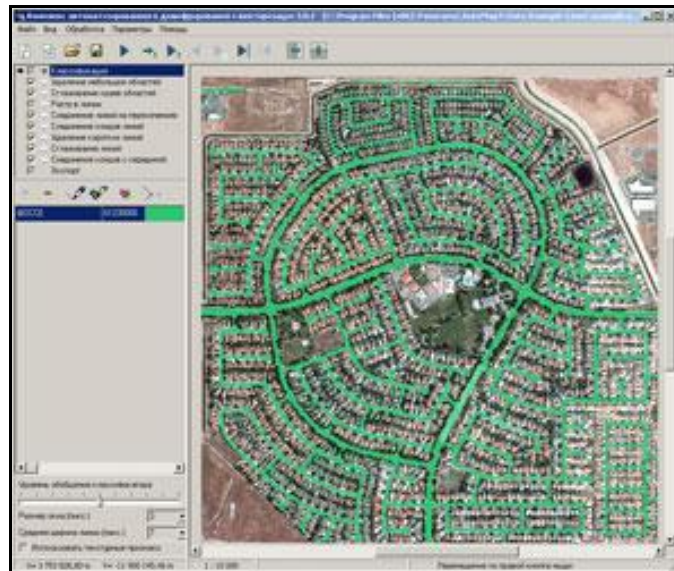
(. 5.12).



. 5.12.

(. 5.13)

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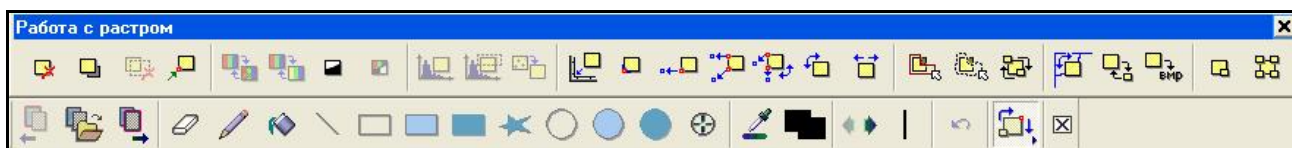
.5.13.

SIT , SXF , SHP

[39].

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(.5.14).



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GPS?
- 13) ,
ERDAS Imagine.
- 14) *ERDAS ER Mapper.*
- 15) - *AcrGIS* .
- 16) - *Digitals* .
- 17) - .

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- 13) <http://www.dataplus.ru> – .
- 14) <http://www.sitc.ru> – « ».
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