SPRAWL PREVENTION IN GERMANY: BUILDING LAND ANALYSIS WITH GIS

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Abstract
Urban sprawl causes problems of different kind. Besides of many environmental problems, there are also financial problems. The reason for the sprawl is the need for more living space. The tool of Building land analysis with GIS can be used to inventory all possible areas where new housing areas can be planned. Through the display to the public, planning decisions by local politicians get more transparent and more sustainable. The article shows at the example of Germany the problems of urban sprawl and demonstrates the building land analysis at the example of Grafenberg in a very detailed way. The tool can be easily transferred to other regions and countries. In the case, that there are no comparable local regulations, the ones of the example could be of use.

Keywords: Urban Sprawl, Planning Decisions, GIS, Local Regulations

PREVENCIÓN DE LA EXPANSIÓN EN ALEMANIA: CONSTRUCCIÓN DE UN ANÁLISIS DEL SUELO CON SISTEMAS DE INFORMACIÓN GEOGRÁFICO (SIG)

Resumen
La expansión urbana causa problemas de diferentes clases. Además de algunos problemas ambientales, hay también problemas financieros. La razón de la expansión es la necesidad de más espacios para vivir. Las herramientas de construcción para el análisis del suelo con SIG, puede ser usado para hacer un inventario de todas las áreas posibles, en donde se puedan planificar nuevas casas. Por medio de la visualización para el público, las decisiones de planificación de las políticas locales obtienen más transparencia y más sustentabilidad. El artículo muestra en el ejemplo de Alemania, los problemas de la expansión urbana y demuestra la construcción del análisis del suelo en Grafenberg con un ejemplo muy detallado. Las herramientas pueden ser fácilmente transferidas a otras regiones y países. En éste caso, que no hay regulaciones comparables, se pudiera usar uno de los ejemplos.

Palabras Claves: Expansión Urbana, Decisiones de Planificación, SIG, Regulaciones Locales

1. Urban sprawl and the actual Situation in Germany

Urban Sprawl is one of the biggest problems in environmental planning. The land use for housing, industrial and traffic areas increased enormously in Germany since World War Two. Today, 12,8% of the total area of Germany are no longer in a natural condition, which is an area of more than 45.762 km• about the size of the Venezuelan State Anzoátegui.

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The peak was reached during the period from 1997 to 2000, where settlement and traffic areas increased by 129 ha per day. Results from the newest data collection from 2001 to 2005, urban sprawl did slow down by a total of 1,682 km• which are 115 ha per day (FEDERAL STATISTICAL OFFICE: 2005A). Even of all programs to reduce urban sprawl, the reduce is seen as a result of the weak economic situation in Germany. According to the Federal Environmental Agency (2004:2) around 80 % of the new developed area is used by settlement and recreation. Additional 10 % are roads for new housing areas.

Through the high population density in Germany, the loss of natural areas carries a high ecological weigh. Also it is proofed by the AUSTRIAN CONFERENCE ON REGIONAL PLANNING (1992, 1999 and 2001) that the development of new housing areas produces additional cost for the communities, street management, public care and other topics. It is also of great interest that, according to the coordinated population projection of the Federal Statistical Office, the population in Germany will decline from currently 82 Million people to 75 Million in the year 2050. Through the "deficit of births" half of the population will be aged over 48 and one third is 60 or older in 2050 (FEDERAL STATISTICAL OFFICE: 2003). Besides, the number of inhabitants in Germany will decline in the long term despite the assumed rates of immigration from abroad. It is obviously that many projects, like schools or kindergarten won't have any use in 2050. Therefore there is a broad discussion in public about urban sprawl. For a sustainable development, the Federal Government has set the goal to reduce daily land use of by 30 ha/day by 2020 (GERMAN COUNCIL FOR SUSTAINABLE DEVELOPMENT: 2002).

Figure 1: E-Card for public discussion: "Less and less people in Germany need more and more area … 93 ha ... every day." (http://www.flaechenverbrauch.de/)

Differently to other countries, where additional land use traces back to population growth and urbanization, the cause for urban sprawl in Germany is mainly seen in the decoupling

between population and land use. The example of the State of Baden-Wuerttemberg shows the situation from 1950 to 2000, where the growing gap between population growth (bright) and the total area for housing, industrial and traffic (dark) since the sixties is good to define.

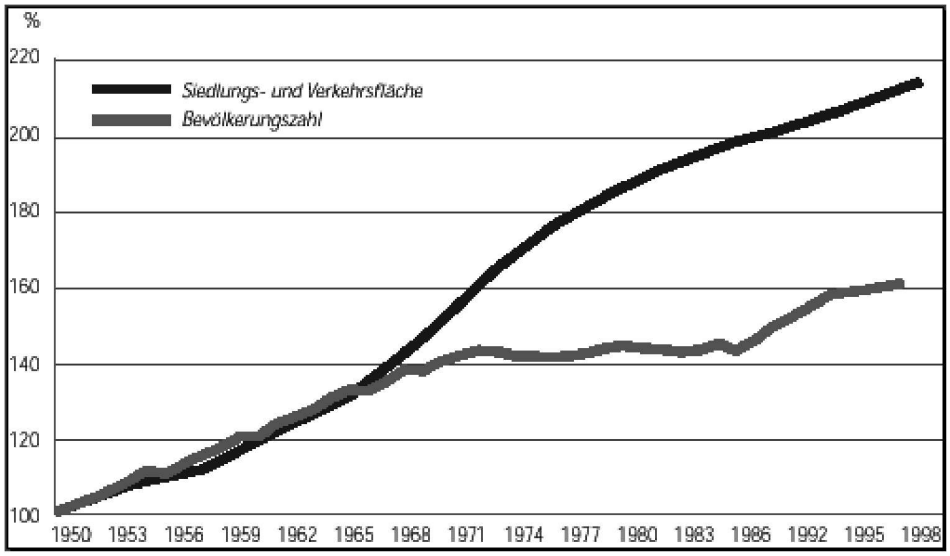

Figure 2: population growth (bright) and area for housing, industrial and traffic (dark). (UVM BW 2000:1.4.1)

One the one side the reason for the higher demand for area is seen in the economic boom and the increasing salaries. Both conduct to an additional increase of the size of households. For example the statistical size of living space per inhabitant grew from 19 m•in 1960 to 41,6 m•in 2002 (APEL ET AL.:1993:16; FEDERAL STATISTICAL OFFICE: 2005). Furthermore the number of persons in households declined from 3 in 1970 to 2,2 in 2002. The positive trend to single-households through modern life is strengthened by the increasing number of elderly people, who live alone in their houses, after their partner died.

On the other side, there are many effects that prevent the public from reducing sprawl. On federal level, there are governmental programs, like commuter tax reductions or Home Owner Benefit, who support the creation of new housing areas. Through the great coalition on federal level, both programs are will be reduced or stopped in 2006 mainly due to financial reasons. Another point of interest is that local land use planning in Germany is primarily done by local politicians. The procedure to calculate the necessary new housing areas is performed in the most cases without any methodical background. According to Boom (2002:219) the two basic motives for politicians are self-interest in the results or ideological ideas. Since behavior of politicians is linked to their motives, it is not the political intension to reduce urban sprawl, because it means to tell the people they should renounce on more living space, there is no demand for saving. And since there is no methodical background to identify and calculate potential building areas, there is no possibility for transparency in their decision. Or as it is seen by Yandle (2001:220), “the politician is at

best seen as the mouthpiece of the winning interest group."

2. Building land analysis for new areas

One tool which can show an overview of all possible new available areas outside the existing settlement is the building land analysis. According to Jacoby (1994:383), it is a tool to provide information about environmental issues and acceptability for land use. It does also make decision transparent and optimize the planning decisions. Building land decisions are subdivided several steps as shown in Figure 3.

Step one performs a restriction analysis, which defines the investigation area for the following steps. Step two proofs the investigation area on land use conflicts which have a restrictive effect on the choice. The results are potential areas which will be assessed in step 3 by land use conflicts and in step 4 by urban aptitude test. In step 5 both ratings (points of land use conflicts and negative urban aptitude) will be aggregated in a matrix. The end results shows a rating, which can be assessed again.

The tool is an easily transferred to other regions and countries. The following example demonstrates the building land analysis in a very detailed way. In the case, that there are no comparable local regulations, the ones of the example could be of use.

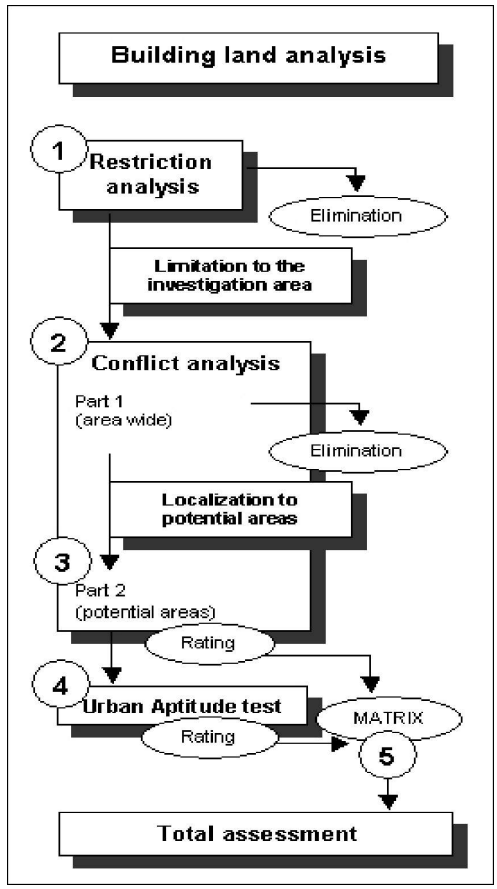

Figure 3: Building land analysis.

3. The Example of a building land analysis for Grafenberg, German

The following example shows the GIS building land analysis for the community of Grafenberg, Baden-Wuerttemberg, Germany. It is located in the suburban area southeast of Stuttgart. The small municipality has less than 3.000 inhabitants. Since the sixties, the population of Grafenberg as also the number of houses has doubled. For the future development a building land analysis was developed for the municipal council, as a background for future decisions concerning the providing of new housing areas. The analysis was calculated with ArcView GIS 3.2a in addition with XTools.

a. Restriction Analysis

The restriction analysis performs an area wide analysis with elimination due to the following restrictions (provided by legal reasons):

- Already developed area (housing areas, industrial areas, …)
- Water areas
- Protected Areas: e.g. National Parks, Conservation areas, Landscape areas, Natural monuments, Special protected Biotopes, Special protected Woodlands Natura 2000 (Flora-Fauna-Habitates, Bird Protection Areas)
- Regional planning restrictions: Core areas for green corridors according to the actual regional scheme

Land use conflict Analysis

The Land use conflict analysis is dived in two parts. In part 1, a research for conflicts with a restrictive character is performed, which eliminates again restrictive areas. Figure 4 shows the example of Grafenberg after the elimination process.

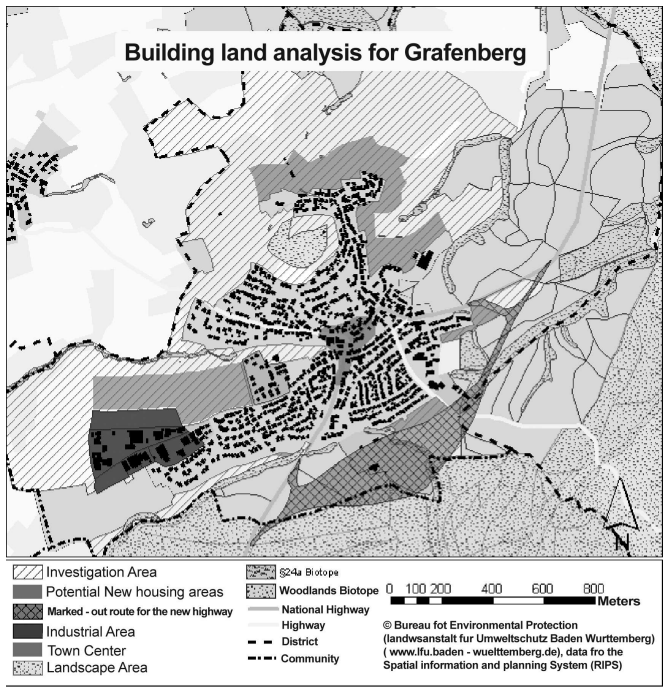

Figure 4: Building land analysis for GrafenbergIn part 2 the conflicts have no

restrictive character. Possible negative points will be added and ranked. For the ranking, an ordinal scale is used with the three steps:

No conflict = 0 negative points

Possible conflict = 1 negative point

Definite conflict = 2 negative points

The difference between the restriction and conflict analysis are the seriousness of the restrictive character. In the restriction analysis mainly hard facts like protected areas by laws have been used. In the conflict analysis, buffer around protected areas and self-defined goals like scenic protection could be used in the process.

Areas with a restrictive character, which will be eliminated:

- Marked-out route for the new highway
- Planned Conservation areas, Landscape areas, …
- Protection of scenic areas
- Connection to an already existing housing area (No split up)

The remained areas are the potential areas for housing. In the second part of the land use conflict analysis, the areas will be defined, numbered and assessed by the following points:

Table I: Assessment of Land use conflicts

Category:	Indicator:	No conflict	Possible conflict	Definite conflict
Regional Planning	Regional Green corridors according to regional scheme (Kistenmacher et al. 1988:35)	Location outside	Located partly within	Definite located within
	Areas in need of protection by regional planning and significant regional recreation areas (Kistenmacher et al. 1988:39ff)	Areas are not affected	Areas are in immediate vicinity to potential housing areas	Areas are overplayed by potential housing areas
Landscape and nature protection	Location to Water areas and protected water protection areas type III	no or a small overlay of the potential areas with the protected area	Large Overlay of the potential areas with the 100 m buffer around a water area or a water protection area type III	Potential areas cut water areas or watercourse OR Location total or Partly inside of a water protection area type III
	Location to existing protected areas (Conservation areas, Landscape areas, …)	Not in a distance	Potential Area in buffer of 300 m around a protected area OR Small Overlay of the potential areas with the 100 m buffer around a protected area	Potential Area is in immediate vicinity of a protected area OR Large Overlay of the potential areas with the 100 m buffer around a protected area
	Impairment of the characteristic landscape	Potential Area shows not the characteristic landscape	Potential Area shows the characteristic landscape but can not be overlooked	Potential Area shows the characteristic landscape and can be overlooked

4. Urban aptitude test

In the next step, the urban aptitude test, the potential areas will be assessed by the following points. Possible negative points will be added and ranked. For the ranking, an ordinal scale is used with the three steps:

Suited = 0 negative points

Partly Suited = 1 negative point

Unsuited = 2 negative points

Table II: Assessment of Urban aptitude

Category	Indicator	No conflict	Possible conflict	Definite conflict
Protection against the effects of air pollution, noise, noxious substances, radiation, etc. …	… by existing industrial areas[vii]	Distance over 300 m. (Distance category V)	Distance between 100 m and 300 m (Distance category VI and VII)	Less than a distance of 100 m
	… by traffic	Distance over 450 m	Distance between 100 m and 450 m	Less than a distance of 100 m
Urban architecture	Walk able Distance to the town center[viii]	Less than 500 m	500 – 800 m	More than 800 m
	Rounding off the developed area[ix] (vgl. Kistenmacher et al. 1983:73)	Positive effect on the rounding off	No effect on the rounding off	Negative effect on the rounding off or split up in several communities
Structural condition	Geology	Good conditions	Moderate Conditions	Bad conditions
	Slope angle & slope aspect (According to Figure 4: slope classification by Kistenmacher et al. (1988:68))	Good conditions	Moderate Conditions	Bad conditions

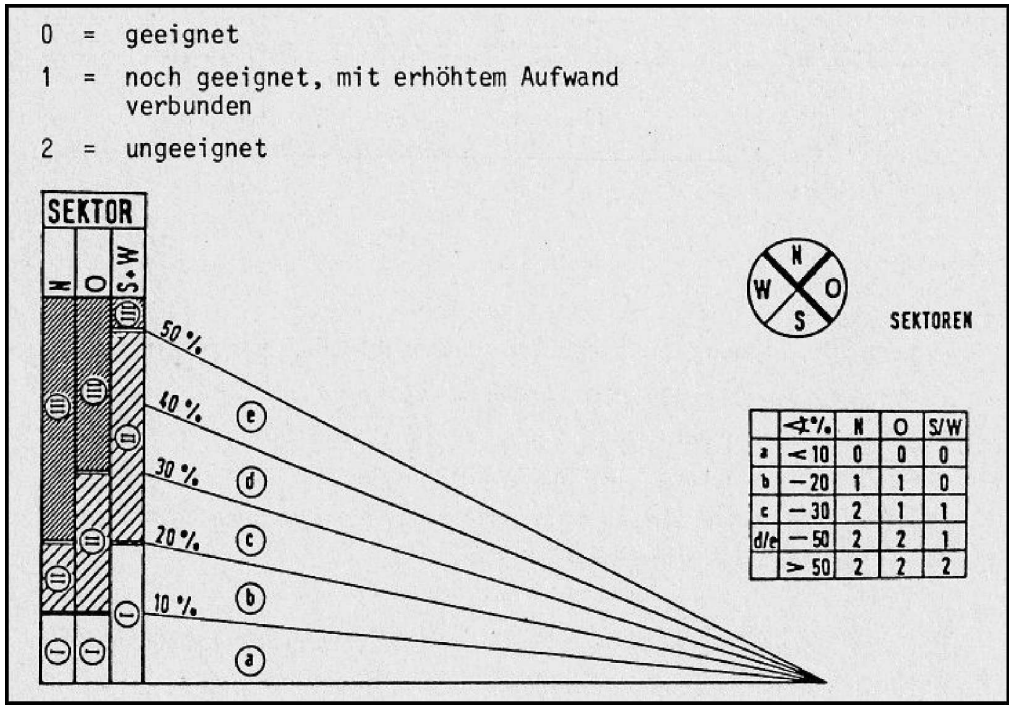

Figure 5: slope classification by Kistenmacher et al. (1988:68)

5. Aggregation and Assessment

In the last step, the negative points will be combined by the following matrix. The decision rule is defined as followed: the less points, the better recommended the potential area is.

Land use Conflict analyis	Urban aptitude analysis 1-2	3-4	5-6	7-9	10-12
1-2	1	2	2	3	3
3-4	2	2	3	3	4
5-6	2	3	3	4	4
7-8	3	3	4	4	5

Recommendable → Not recommendable

Class 1	Class 2	Class 3	Class 4	Class 5

Table III: Combination Matrix and Classes for Recommendation

Grafenberg has a total area of 351 ha. 88 ha are used for settlement and traffic. The restriction analysis eliminated approximately 233 ha. After the first step of the land use conflict additional 118 ha were eliminated. As potential areas could be identified an area of 24,71 ha, which is divided in 8 locations around Grafenberg. The results auf the assessment have been add up and are presented in Table 3. After the add up, the summary of the land use conflict points and the summary of the Urban Aptitude Test points will be combined according the matrix shown in Table III.

An overlaid orthophoto (Figure 6) was created to visualize the results for the public. With this tool the total available areas can be shown to the public. Therefore planning decisions of new housing areas will become more transparent. At the same time, politicians are forced to act in a sustainable way, especially in fast growing areas with a high population pressure.

Table IV: Results of the assessment of land use conflict analysis and urban aptitude test and ranking of the potential areas. Total aggregation to classes of recommendation according to the matrix in Figure 5.

		Land Use Conflict						Urban Aptitude Test							
Potential Area Number	Size in ha	Regionale Grünzüge	Erholungsbereiche	Gewässer	Schutzgebiete	Landscape scenery	Summary Negative Points	Protection by influence of industrial area	Protection by influence by traffic	Distance to town center	Rounding off	Geology	Slope	Summary Negative Points	**Class of Recommendation**
1	9,30	0	1	0	1	1	3	2	1	0	1	1	0	5	3
2	0,09	1	1	1	2	0	5	1	2	1	0	1	0	5	3
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	

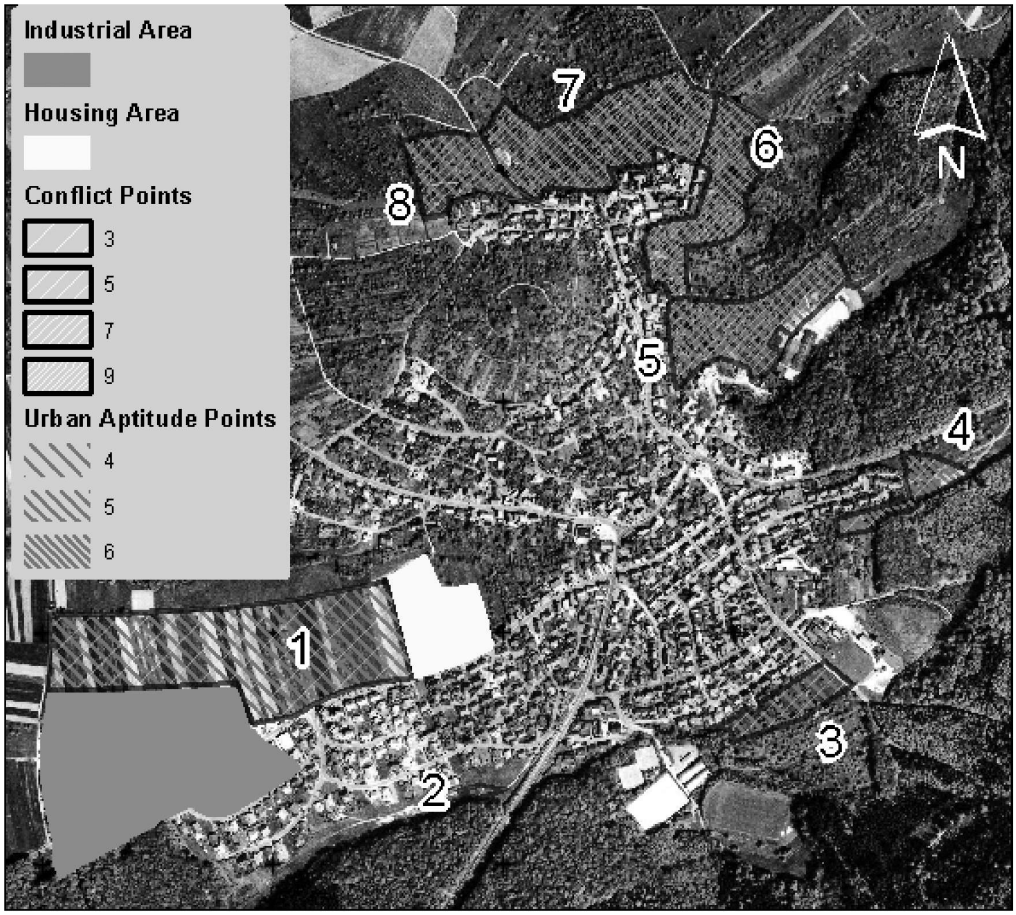

Figure 6: Building land analysis for Grafenberg. Orthophoto 7520.28 200/93 v. 29.4.1993 by the Landesvermessungsamt Baden-Württemberg

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NOTES:

[i]The average children per woman is 1.4.

[ii]ArcView GIS 3.2a (2002) von Environmental System Research Institute (ESRI), Redmond, CA, USA.

[iii]XTools, Version 6/1/2001 (2001), Oregon Dep. of Forestry, Salem OR, USA. (http://www.odf.state.or.us/DIVISIONS/management/state_forests/XTools.asp)

[iv]Richtlinie 92/43/EWG vom 21. Mai 1992 vom 21. Mai 1992 zur Erhaltung der natürlichen Lebensräume sowie der wildlebenden Tiere und Pflanzen (ABl. EG Nr. L 206/7 vom 22. 7. 92), geändert durch Richtlinie 97/62/EG des Rates vom 27. 10. 1997 (ABI. EG Nr. L 305/42)

[v]Richtlinie 79/409/EWG des Rates vom 2. April 1979 über die Erhaltung der wildlebenden Vogelarten (ABI. EG Nr. L 103 vom 25. 4. 1979 S. 1, zuletzt geändert durch Richtlinie 97/49/EG der Kommission vom 29. 7. 1997, ABI. EG Nr. L 223 vom 13. 8. 1997 S. 9)

[vi]According to the administrative instructions of the State of Nordrhein-Westfalen about the environmental compatibility of Flora-Fauna-Habitate Areas (FFH-VwV NRW 2000)

[vii]According to the Distance Enactment of the Ministry of Environment of the State of Nordrhein-Westfalen 1998.

[viii]The walking distance was calculated with ArcView Extension Network-Analyst 1.0b for ArcView 3.2 (1999), Environmental System Research Institute (ESRI), Redmond, CA, USA.

[ix]The rounding off could be described with „Landscape Shape Index“(LSI). The LSI describes the proportion between form and circumference, where LSI = 1 describes a circle (McGarigal et al. 1995 : 115). The LSI is calculated with ArcView Extension Fragstats 3.3 - Spatial Pattern Analysis Program for Categorical Maps (2002) von McGarigal, K., Cushman, S., Neel, M. & E. Ene, University of Massachusetts, Amherst, MA, USA. (www.umass.edu/landeco/research/fragstats/fragstats.html)