Application of GIS technology to groundwater vulnerability assessment in the context of sustainable development. Study case Iasi city, Romania

Introduction and background

Territorial expansion of urban area involve qualitative and quantitative pressure on natural resources available to sustain urban growth. Groundwater represent an important resource in urban environment sustainable development, being used as drinking water or in different activities (agriculture, industry, household), affected by numerous pollution sources: point, non-point and potential sources.

The purpose of the paper is determining the groundwater vulnerable zones in Iasi city build-up area, one of the largest cities of Romania, using GIS techniques. DRASTIC model was chosen being an international method for groundwater vulnerability assessment establishing correlation with nitrate content, the methodology was implemented by Aller et al, 1987. Model was applied for different region of the world, including urban areas, excepting Iasi city.

Materials and methodology

DRASTIC classic methodology based on seven thematic layers (D - the depth to water table, R - recharge, A - aquifer media, S - soil media, T - topography, I - impact of vadose zone, C - hydraulic conductivity) was used to map groundwater vulnerability. Each layer received a standardized rank and final score was computed applying formula below:

DRASTIC equation = $D_rD_w + R_rR_w + A_rA_w + S_rS_w + T_rT_w + I_rI_w + C_rC_w$

Where:

r = rating

*w = weight (*Depth to watertable – 4, Net recharge – 2, Aquifer media – 5, Soil media – 2, Topography – 1, Impact of Vadose Zone media – 5, Hydraulic conductivity of aquifer Not used).

For obtain data input as thematic layers (table 1) were used various materials as maps (digitized for geology, soil, topography, land-use) and data tables:

Table 1: Thematic layers input data

	Data type	**Source**	**Format**	**Scale of map**	**Date**	**Output layer**
1	*Water table level*	*Own measurements*	*Table*	*1:5000*	*2011*	*Depth to water*
2	*Average annual rainfall*	*Moldova Meteorological center*	*Table*	*1:5000*	*1961 – 2011*	*Recharge*
3	*Geology Map*	*Romania Geological Map*	*Map*	*1:200000*	*1966*	*Aquifer*
4	*Soil Map*	*Romania Soil Map*	*Map*	*1:500000*	*1971*	*Soil*
5	*Topographical sheets*	*National agency for Cadastre and Land Registration*	*Map sheet*	*1:5000*	*1964*	*Topography*
6	*Geological profile*	*Geological study of Liteanu EM., Macarovici N., Bandrabur T.*	*Table*	*1:5000*	*1963*	*Impact of Vadose Zone*
7	*Land use map*	*Satellite images (2005 edition)*	*Map*	*1:5000*	*2005*	
8	*Nitrates*	*Own measurements*	*Table*	*1:5000*	*2011*	

Nitrate level in groundwater was determined after collecting 22 water samples from wells of the city, analyzed using spectrophotometric method with sodium salicylate. This parameter was included in the study due to the relevance for

Results and discussions

DRASTIC vulnerability map, verified by nitrate level in groundwater data revealed similarities between land-use map and vulnerable areas, highlighting anthropogenic influence. The vulnerability varies between 82 – 178 (table 2), over 63% of the groundwater from Iasi city urban area is under very high vulnerability values and 21.9% under extremely high values (according to Ne'mat, 2006), while nitrates level varies between 7.13 - 292.68 mg/L.

Table 2: Area under vulnerability to groundwater pollution in Iasi city area

	DRASTIC Index	**Area (ha)**	**Area (% of total)**	**Vulnerability zones**
1	82 – 90	128	1.38	Medium
2	91 – 120	1237	13.35	High
3	121 – 150	5864	63.34	Very high
4	151 – 178	2029	21.91	Extremely high
	Total	*9258*	*100%*	

Vulnerable areas to groundwater pollution were assessed and analyzed using GIS techniques being the most efficient tool for this type of study that synthesize natural conditions (DRASTIC thematic layers) and anthropogenic influence (land – use map, nitrate level) on groundwater resources quality, obtaining a spatialization of vulnerable areas easily to use by local authorities for improve groundwater quality.

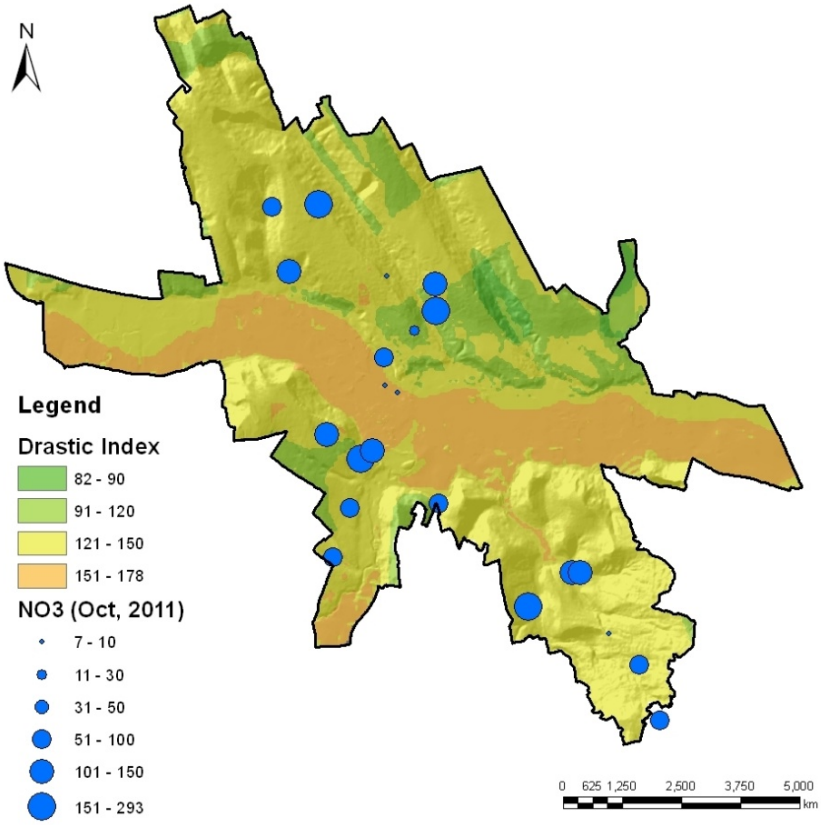

Figure 1: Spatial distribution of groundwater vulnerability score

Conclusions

Groundwater quality protection and conservation can be more efficient managed due to the conclusions of this study, that analyze and process spatial data, in addition of chemical analysis, delimiting different vulnerability zones with impact on sustainable development process.

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