Geographic-epidemiological analysis of gastrointestinal infectious diseases with respect to water-supply structures in Rhein-Berg (Germany)

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table 1 : Reported waterborne disease outbreaks associated with drinking water and bodies of water used for recreational purposes in 19 European countries*, 1986-1996 (Lack 1999)

Country	total no. of outbreaks
Albania	14
Croatia	29
Czech Republic	18
England and Wales	20
Estonia	12
Germany	0
Greece	2
Hungary	27
Island	1
Latvia	1
Lithuania	0
Malta	162
Norway	0
Romania	57
Slovak Republic	61
Slovenia	45
Spain	208
Sweden	53
Yugoslavia (Federal Rep.)	68

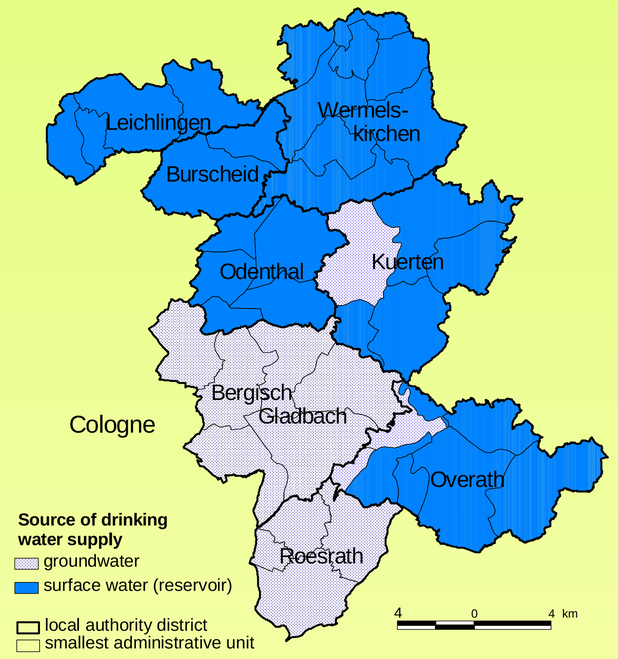
N = 779

* For the 19 countries listed, information was availble for a cumulative total of 198 surveillance years

Introduction

Recent reports on waterborne outbreaks have renewed the discussion about preventive strategies in drinking water-supply. In contrast to many other countries in Europe, in Germany there is hardly any information available concerning waterborne outbreaks (table 1). Two aspects may explain this situation: drinking water is indeed of very high quality and waterborne outbreaks do not occur. But it is also possible, that cases of waterborne infections were not reported due to an insufficient national surveillance-system for infectious diseases.
We present preliminary results of a retrospective study about gastrointestinal infections in a region with different drinking water resources (groundwater, surface water). One of the main objectives is to examine the hypothesis, that spatial variations of diarrhoeal diseases may be linked with the different structures of water-supply.

fig. 1: Study area Rhein-Berg District and its resources of water supply



Methods

The concept of “hazard analysis critical control point“ (HACCP), which was developed to ensure food production safety and introduced to drinking water production by Havelaar (1994), was applied to ascertain the water supply structure in Rhein-Berg. To assess the drinking water safety, data about resources of drinking water supply, water treatment and distribution in the study area have been collected.
Gastrointestinal infections are used as a non-specific indicator disease for the epidemiological data set (Payment et al 1997). Diarrhoea is caused by various types of pathogens (bacteria, virus, parasites) and their occurrence is notifiable in Germany (§ 3 BSeuchG). Additionally, health insurance data were available.
A wide range of data sets has been collected concerning water supply, population and epidemiological data sets. All data are stored and analysed in a Geographic Information System (GIS). The concept of data flow in the GIS is illustrated in fig. 2.

fig. 2: Concept of GIS-processing concerning epidemiological surveillance of waterborne infectious diseases

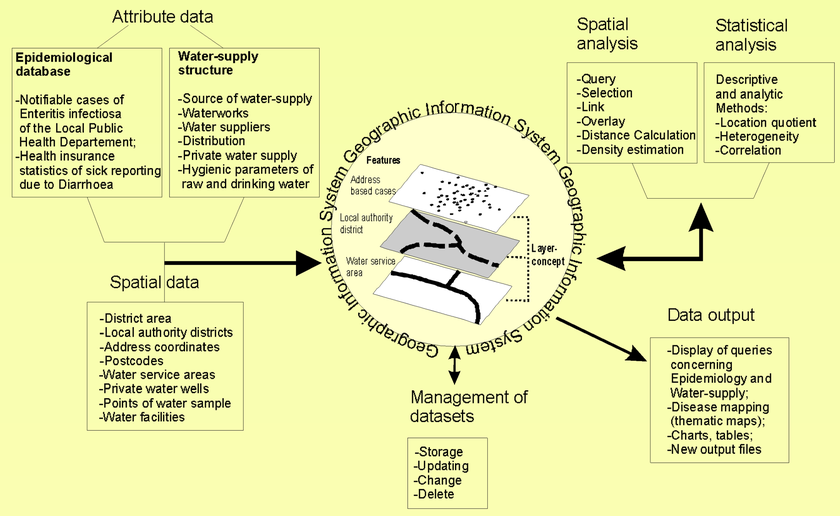
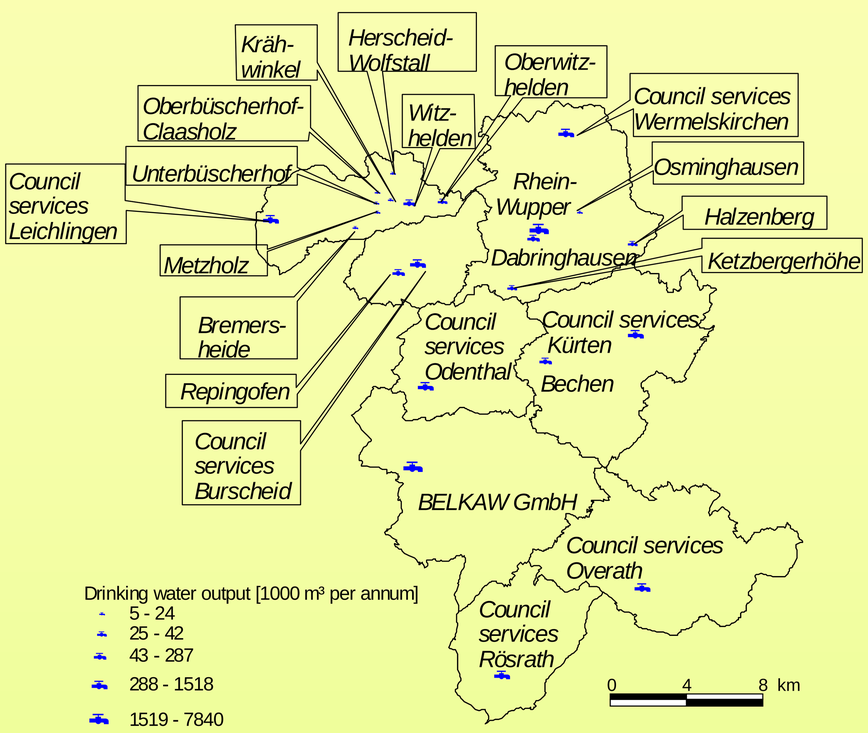


fig. 3: Water-supply companies in the Rhein-Berg District
(Source: Local Public Health Department)



Results

The drinking water-supply in Rhein-Berg District is dominated by public supply. 99,9 % of the population is connected to the public grid. Drinking water is pumped from four waterworks and is distributed by 27 water-supply companies. In the North, lots of small water providers display the persistence of former water-supply structures. In the South, the providing structures coincide with the local authority districts (fig. 3). All administrative districts show a very low amount of private wells, despite their numbers varying between the areas. The most rural region with the lowest population (Kürten) turned out to have the highest numbers of private wells.
Address-based epidemiological data of gastrointestinal infections were available from the local public health department for the period 1988 - 1998. GIS provides a linkage between adress-coordinates and cases. It is possible to display queries about the distribution of diarrhoeal diseases in the study area concerning date of infection, pathogen, suspicious source of infection etc. Aggregating the data on the smallest administrative unit results in choropleth maps of incidence (fig 4). Statistical test (chi²-test, spatial autocorrelation) and the location quotient (fig. 5) prove spatial variation of disease patterns in the study area. Health insurance data (1991-1998) show a high rate of sick reporting due to diarrhoea (1.130 cases/100.000 members/year) confirming, that the occurrence of Enteritis infectiosa is underrepresented (RKI 1998) by case reporting to the Public Health Department (48 cases/100.000 inhabitants/year).
Correlating the incidence rate with parameters of water-supply structures (amount of drinking water produced from surface or groundwater) revealed a medium positive linkage between the disease incidence and the amount of groundwater (table 2). In contrast, districts with treated surface water-supply show less disease rates.

fig. 4: Incidence of Enteritis infectiosa in Rhein-Berg 1988-1998
(Source: Local Public Health Departement)

fig. 5: Location quotient (1988-1998)
(Source: Local Public Health Department)

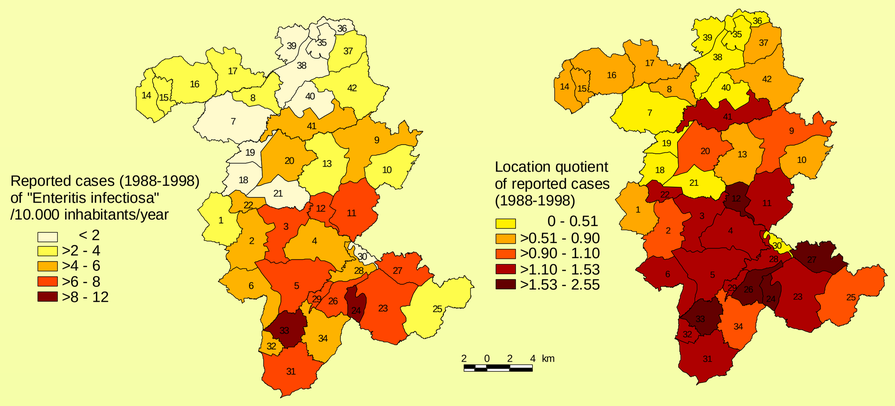


table 2: Results of the correlation analysis

local authority district	Enteritis Infectiosa Incidence / 100.000 /Year	delivery of surface water 1000 m³	delivery of groundwater 1000 m³	amout of public water-supply %	amount of surface water-supply %	amount of groundwater-supply %
Bergisch Gladbach	52.5	0	10456	99.8	0	100
Burscheid	21.4	1145	25.8	99.8	97.8	2.2
Kürten	62.3	883.3	326.7	99	73	27
Leichlingen	32.5	1553.3	0	99.8	99.7	0
Odenthal	40.1	712	88	99.9	89	11
Overath	74.2	1176.5	197	99.7	86	14.4
Rösrath	77.4	14.56	1441.44	99.9	1	99
Wermels-kirchen	24.7	2188	0	99.8	100	0
r		**-0.61**	**+0.17**	**-0.26**	**-0,60**	**+0,60**
$r^2xy=B$ in %		**0.37 36.7**	**0.03 3**	**0.07 6.9**	**0,36 36,0**	**0,36 36,0**

Discussion

The preliminary results reveal, that collected databases characterizing the water-supply structure and Enteritis-epidemiology in the study area are of sufficient quantity and quality for running a surveillance-system with GIS.
In fact, the epidemiological data show spatial heterogeneity. Simple correlation methods yield significant association between water-supply structure and the variation of diarrhoeal disease: incidence rates are below the average in districts with surface water-supply.
In future, additional data have to be evaluated with respect to population mobility, tap water consume, distribution network and integrated in multiple correlation models. More attention should be given to point-patterns analysis (density estimation, nearest neighbour) and probability maps, which could confirm our hypothesis of spatial variation due to different drinking water sources.

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