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, 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 noticeable in Germany (§ 3 BSchG). Additionally, health insurance data were available. A wide range of data sets has been collected concerning water supply, population and geographical 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.

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 (Künten) 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 address-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. By 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 infections 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 increase disease incidence and the amount of groundwater (table 2). In contrast, districts with treated surface-water-supply show less disease rates.

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 consumption, 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.

References