Groundwater chemistry changes in Gauja aquifer in depression cone in Riga region, Latvia

Baiba Raga [1], Andis Kalvans [1], Aija Delina [1], Inga Retiķe[1] and Eleonora Pērkone[1]
[1]University of Latvia, Faculty of Geography and Earth Sciences, Alberta Street 10, Latvia, e-mail: baiba.raga@lu.lv

Introduction

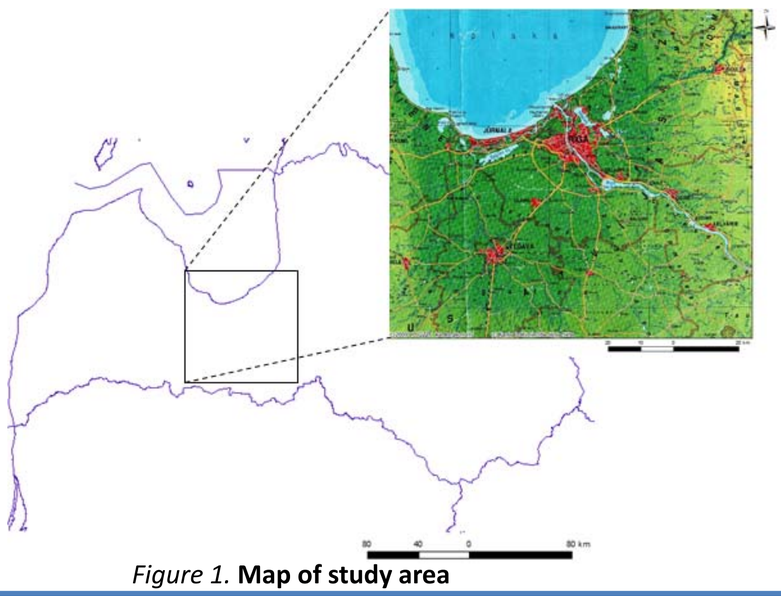

Figure 1. **Map of study area**

Riga is the capital of Latvia with around 0.9 million inhabitants.There the main water supply is centralised and decentralised, mostly from groundwater sources, that is from the the ***Arukilas – Amatas multi-aquifer system*** (fig.1.).

Gauja aquifer is one of the main drinking water resource for water supply in Latvia. This aquifer belongs to upper Devonian and has good properties for groundwater extraction: it has high permeability and is widely spread

The excessive water extraction in Riga causes sharp and significant lowering of the piezometric surface. The maximum decline of groundwater level of Gauja aquifer was observed in 1972, when it was 17 m lower than the average. Beginning with the end of 80's, decreased the volume of water usage and the regeneration of water table started.
In figure 2 is showed study are and its zone distribution.

THE AIM: Defined changes of Gauja aquifer composition, in period of cone of depression evolution

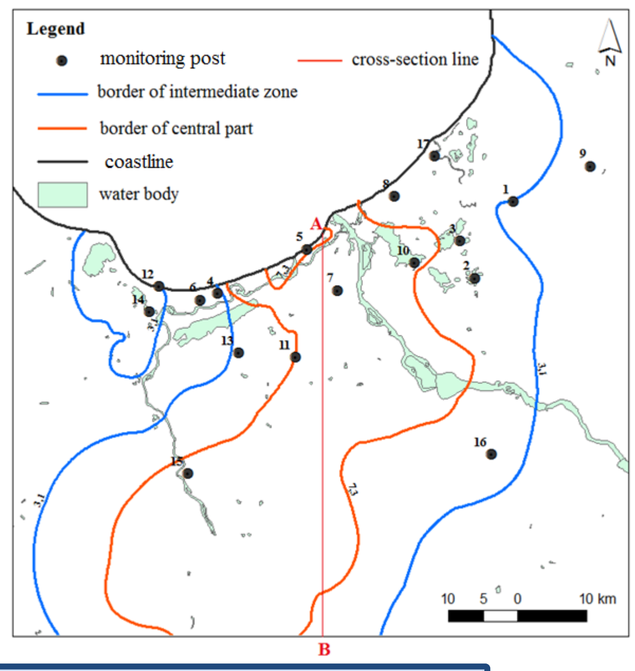

Figure 2. **Territory of study**

Monitoring posts:
1 – Piukas, 2 – Upesciems, 3 – Baltezers, 4 – Jaundubulti, 5 – Buļļupe, 6 – Asari, 7 – Imanta, 8 – Kalngale, 9 – Inčukalns, 10 – Jugla, 11 – Mārupe, 12 – Kauguri, 13 – Tīreļi, 14 – Sloka, 15 – Lielupe, 16 – Baldone, 17 – Carnikava

Methods and input data

In this research work long – term monitoring data is used. These data comes from **«Latvian Environment, Geology and Meteorology Centre»** database, collected during end of 20th century 50's until 2010.

Data include information about major ions (Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}, SO_4^{2-}, HCO_3^{-}, Cl) and piezometric surface from 45 monitoring wells.

- **Statistical methods to exclude «outlier» values**
- **Piper plots are made using software «*R*»**
- **Hydrogeolocial cross – sections are made using hydrogeological model of Baltic Artesian Basin and calculated scenarios of groundwater abstraction** (Seņņikovs 2011; Klints et.al. 2012).
- **Mixing curves of different water types**

Results

1. Groundwater flow in Gauja aquifer

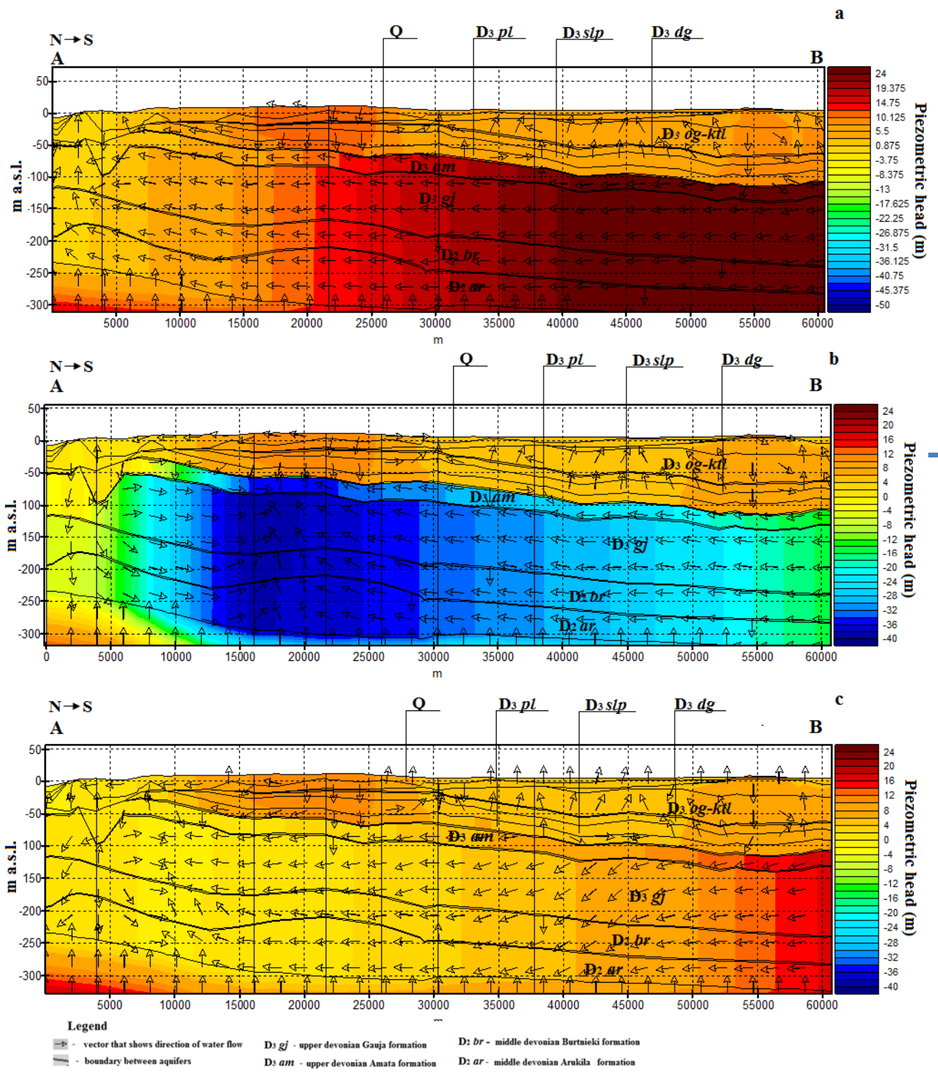

Figure 3. **Groundwater flow directions and distribution of piezometric head in the cross-section A-B a) in the year 1950; b) in the year 1980 ; c) in the year 2000**

2. Water composition changes in Gauja aquifer

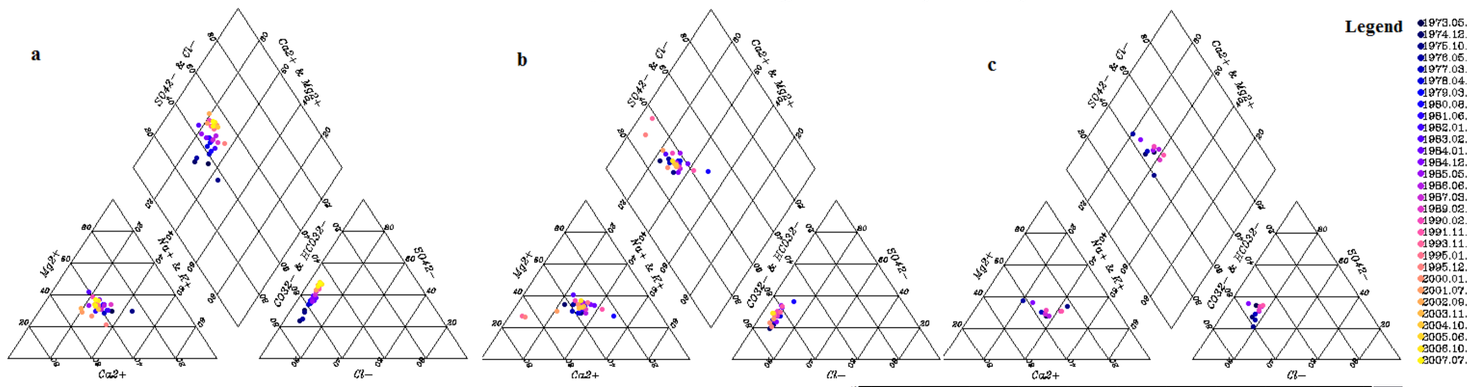

Figure 4. **Central part** Changes of groundwater chemical composition in monitoring post «Imanta». a) borhole nr.683; b) borhole nr. 682; c) borehole nr. 681

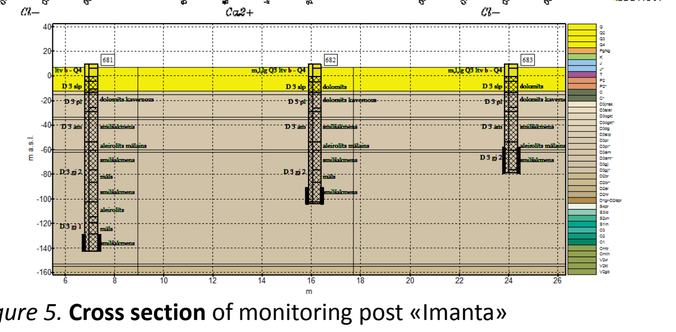

Figure 5. **Cross section** of monitoring post «Imanta»

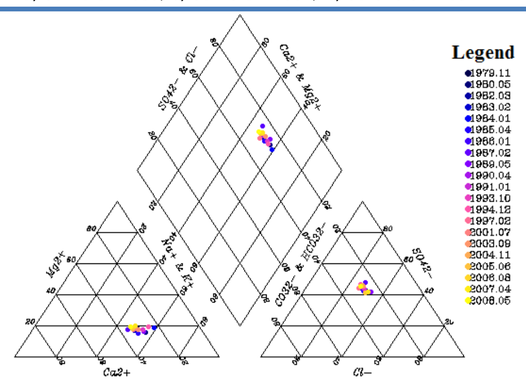

Figure 6. **Intermediate zone:** Changes of groundwater chemical composition in monitoring post «Tīreļi»

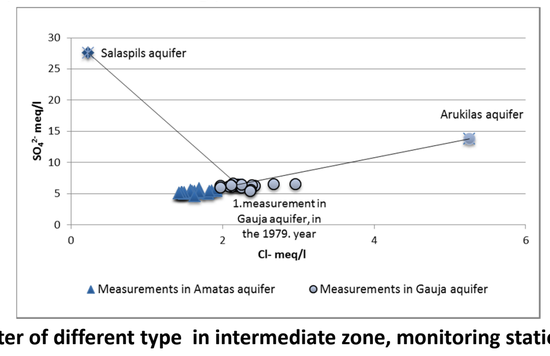

Figure 7. **Mixing of water of different type in intermediate zone, monitoring station «Tīreļi»**

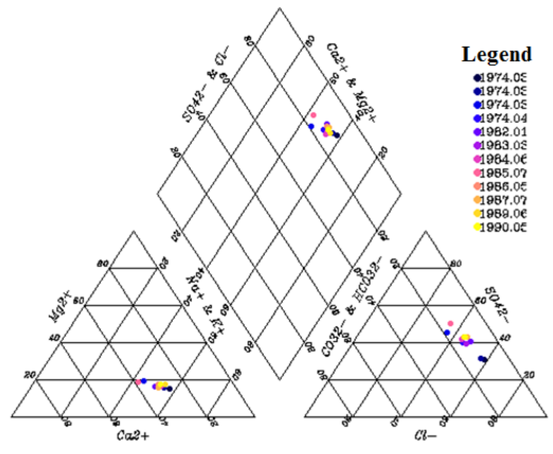

Figure 8. **Periphery:** Changes of groundwater chemical composition in monitoring post «Asari»

Conclusions

- ❑ **The groundwater resource in Gauja aquifer was supplemented by water from adjacent aquifers. The sea water intrusion is observed only in some areas, where intrusion occurs through the bed of river Daugava.**
- ❑ **Supplement of Gauja aquifer in central part mainly comes from covering aquifers, but in intermediate zone from deeper (Arukila and Burtnieki) aquifer.**
- ❑ **In areas where piezometric surface of Gauja aquifer was declined in right side of river Daugava, supplement of aquifer comes from covering aquifers.**
- ❑ **Canges of water supply without significant time delays affect the groundwater level decline and renew.**

References

- Klints I., Virbulis J., Dēliņa A. 2012. Influence of water abstraction on groundwater flow in the BAB. Groundwater in Sedimentary Basins Abstract book. Riga. 48 p.

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