ESF Project „*Establishment of interdisciplinary scientist group and modelling system for groundwater research*”

Evolution of groundwater composition in the depression cone of the Riga region

Baiba Raga, Andis Kalvāns, Aija Dēliņa, Eleonora Pērkone, Inga Retiķe

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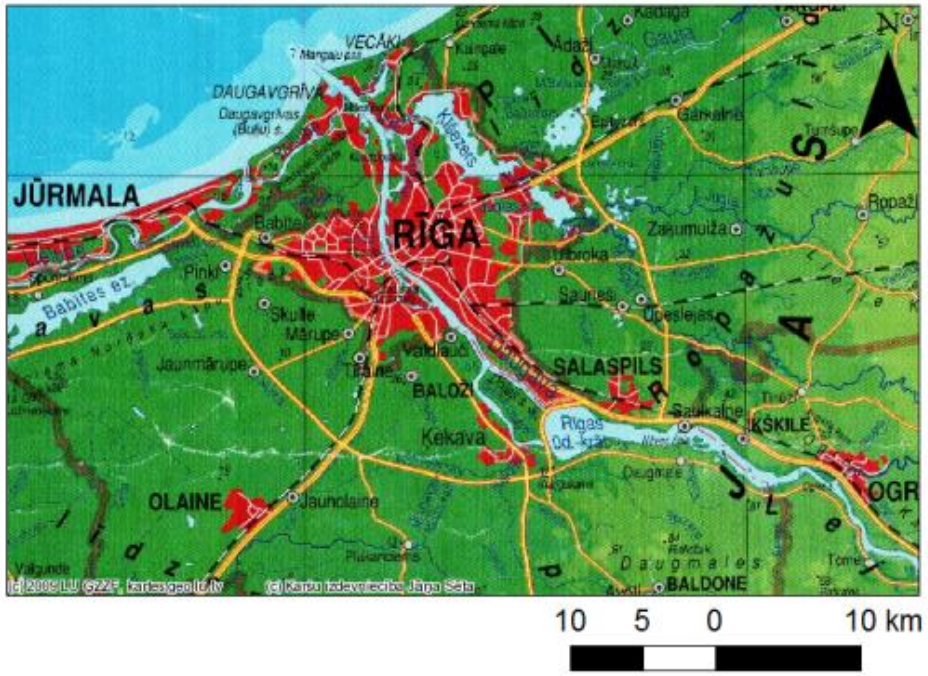
Project Nr. 2009/0212/1DP/1.1.1.2.0/09/APIA/VIAA/060

Background information

Region of Riga

- In Riga lives around 0.7millions inhabitants
- There are centralised and decentralised water supply
- At 60's groundwater resources ensured 1/3 part of all water supply needs, nowadays it is only 11% (*Aņikejeva R u.c. 1997)*
- Earlier studies indicated the groundwater composition chnges in some areas in cone of depression
- The maximal decline of groundwater level in Gauja aquifer in 1972 was observed , when it was around 16 m lower than the average.



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The aim of this study is track groundwater chemical changes in Arukila-Amata multi-aquifer.

This investigation is based mainly on the groundwater long – term monitoring data from «Latvian Environment, Geology and Meteorology Centre» database, collected during end of 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.

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Materials and methods

- **Statistical method to exclude «outlier» values**
- **Piper diagramm**

  Show water composition change in well, during observation period

  Define water type

- **Piezometric surface map of Gauja aquifer**

  Based on these maps and earlier studies territory is dived in 3 zones: central, middle and periphery:

- **Numerical modeling**

  To analyse groundwater flow and hydraulic connection of aquifer in 3 periods; 1950., 1980. and 2000. year.

- **Calcute amount of water that pumped out of Gauja aquifer**

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Study area

- Riga is situated in the central part of Baltic Sedimetnary basin.
- The study area is around 7200 km2, that include all cone of depression and the surrounding territory.
- The prevailing sediments of Arukilas- Amatas multi aquifer system is sandstone, siltstone.
- Above this system is lying Plavinu-Amulas multi-aquifer system, where Salaspils formation consists of marl and gypsum, but Plavinas formation of dolomite.

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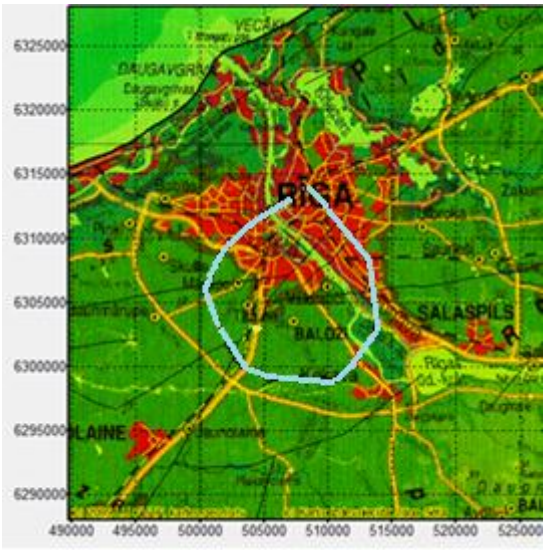
First results of calculating of volume of extracted water from Gauja aquifer

The total amount of water in this defined area in Gauja aquifer is around 3000 million m^3

Based on water supply data, , around 26 % of total amount of Gauja aquifer in period from 1960.-1995. year was pumped out.



Poligon of territory, where volume of water in Gauja auifer was calculated

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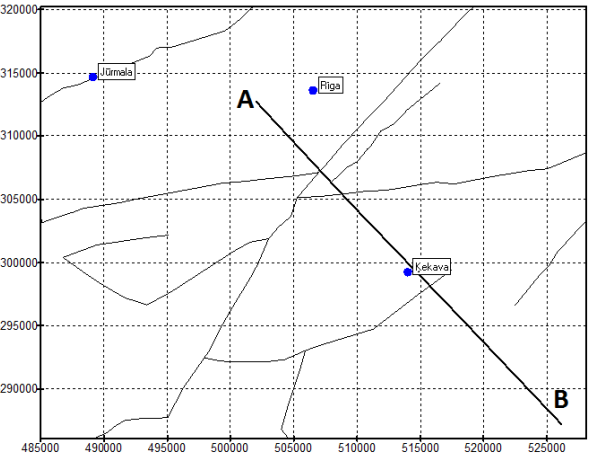
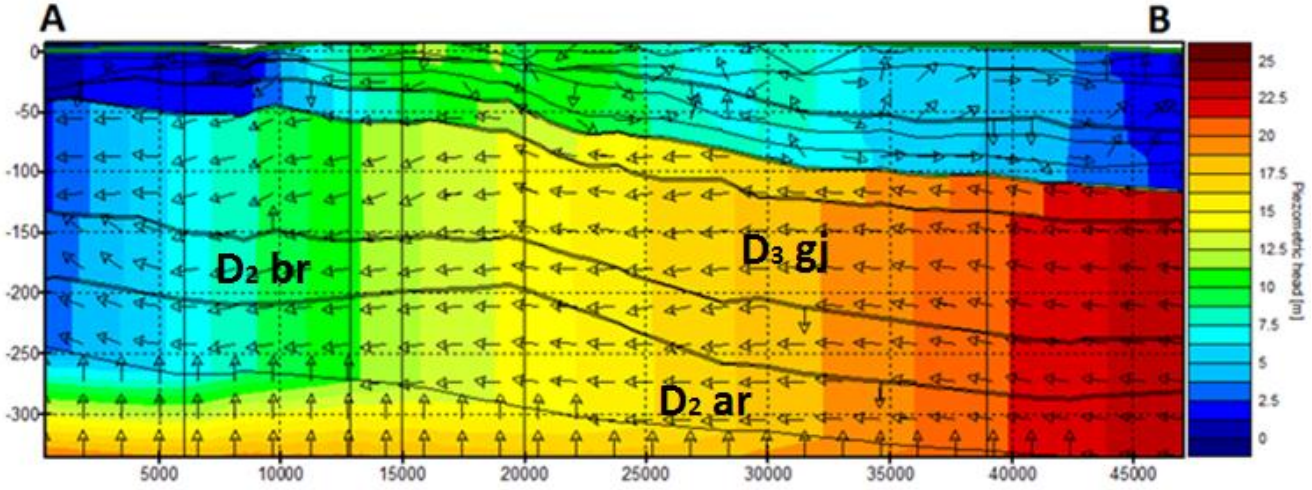
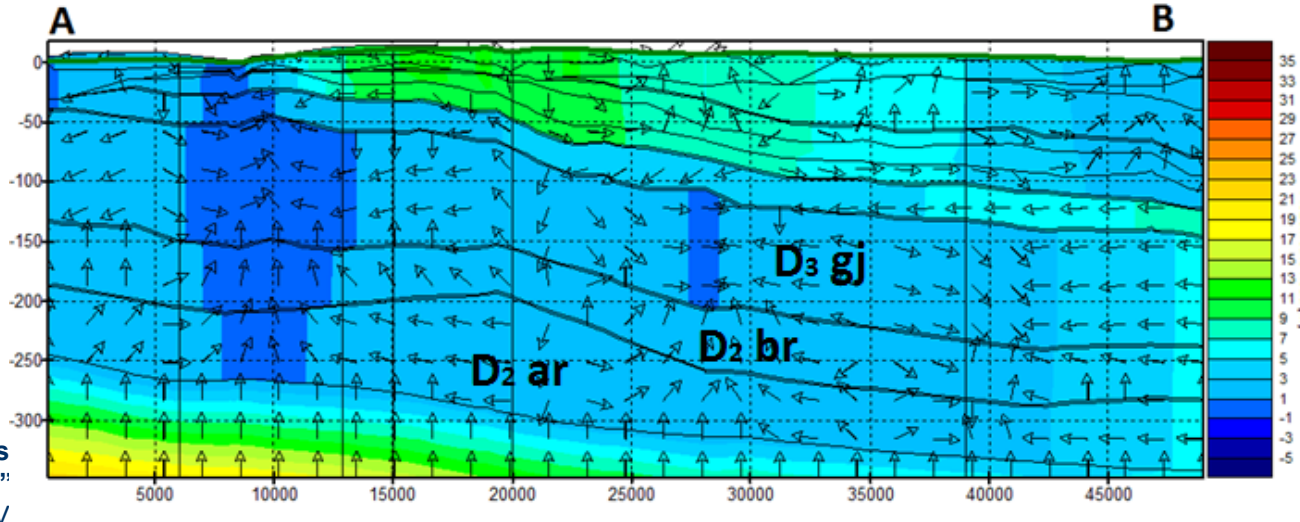
Groundwater flow in active water exchange zone



1950. year



2000.year



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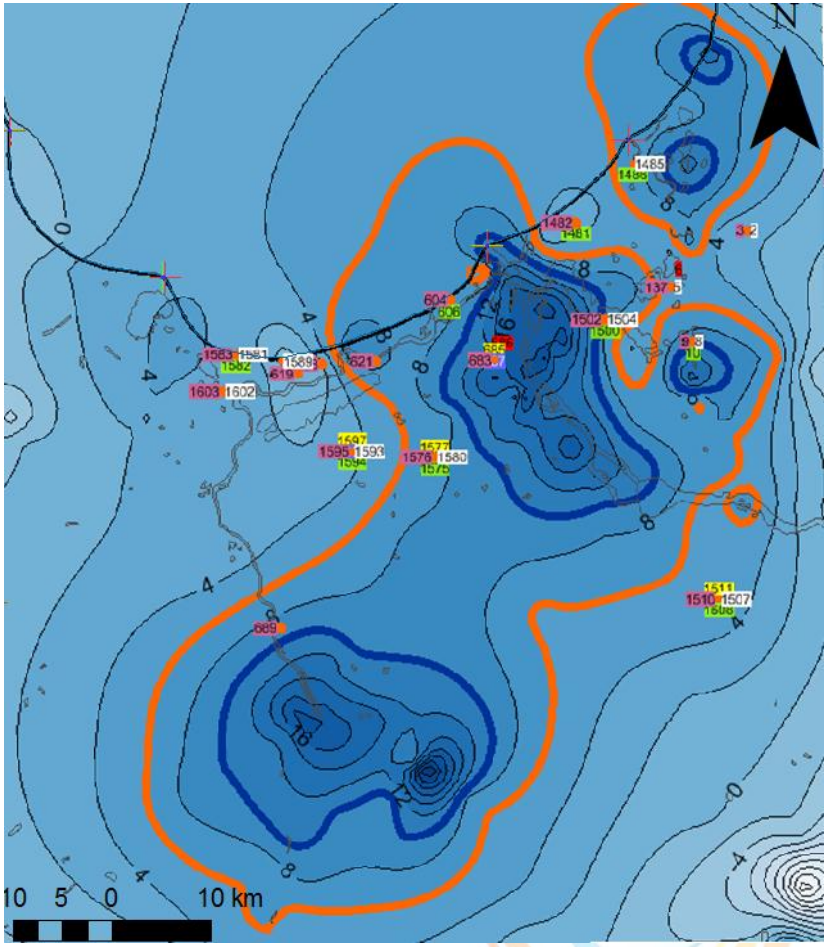
Division of the territory

- Map with monitoring wells and division into zones:
  - central
  - middle
  - periphery.



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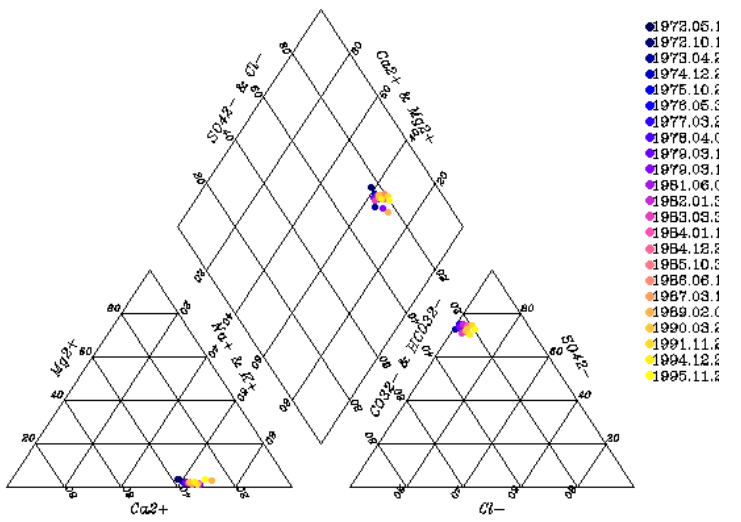
Results

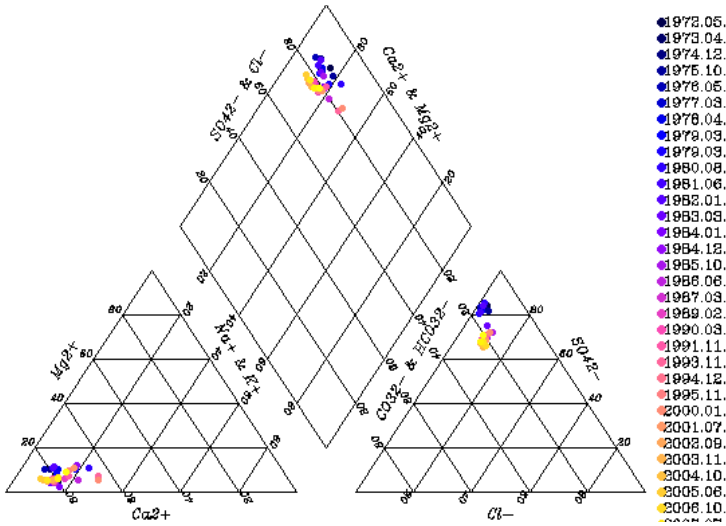
Central part: groundwater level decline from 10-20 m

Monitoring station «Imanta»

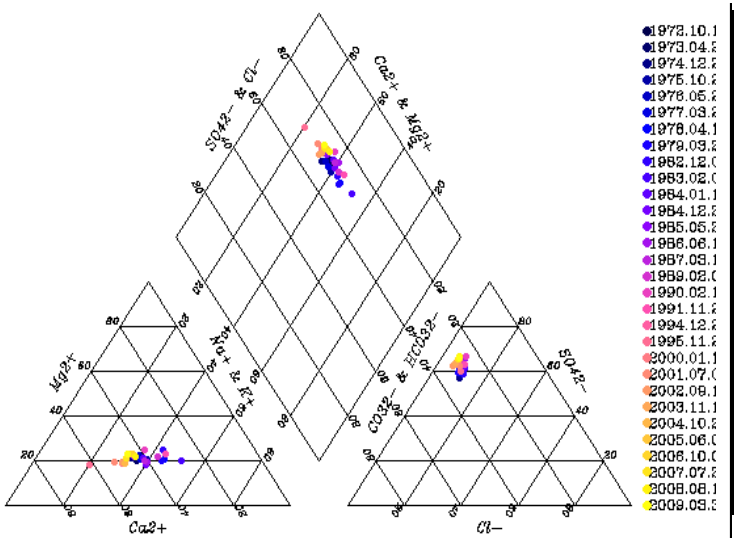
687 (D_3 *slp*)



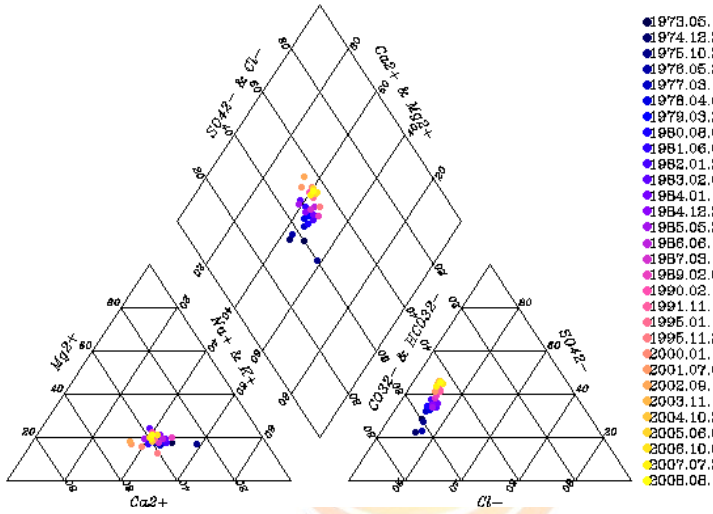
686 (D_3*pl*)



685 (D_3 *am*)



683 (D_3 *gj*)



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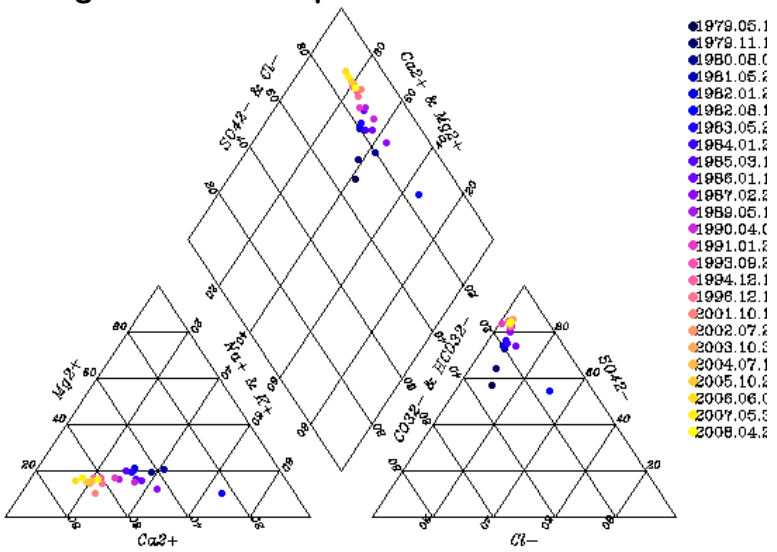
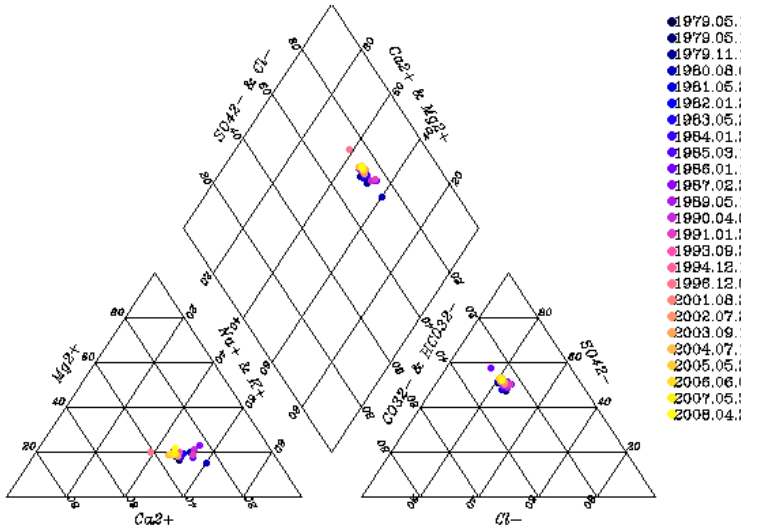
Middle part: groundwater level decline from 5-10m

Monitoring station «Mārupe»

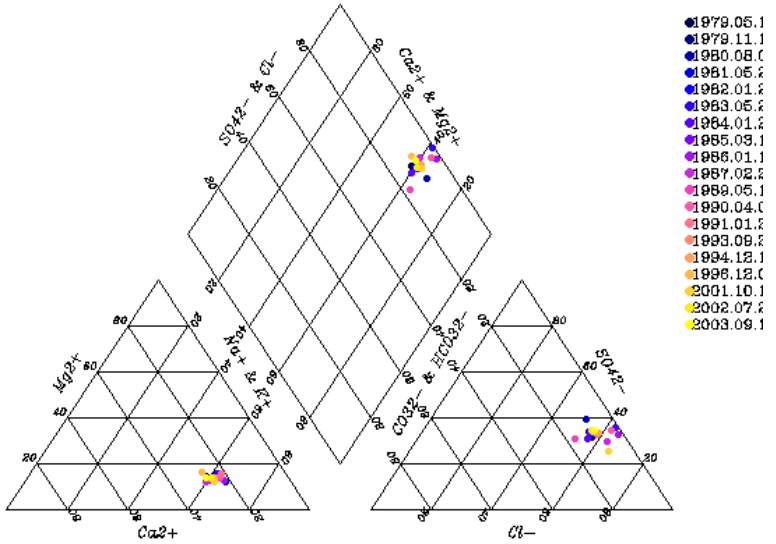
1577 (D_3am)



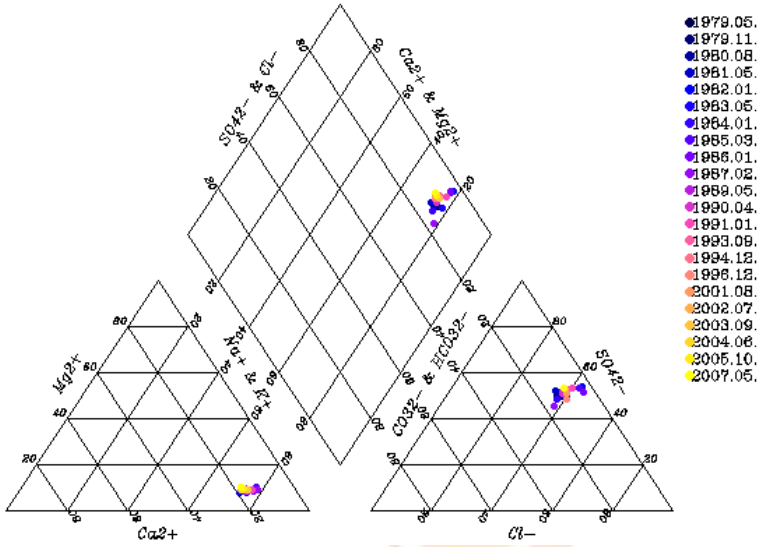
1576(D_3 gj)



1575 (D_2 br)



1580 (D_2 ar)



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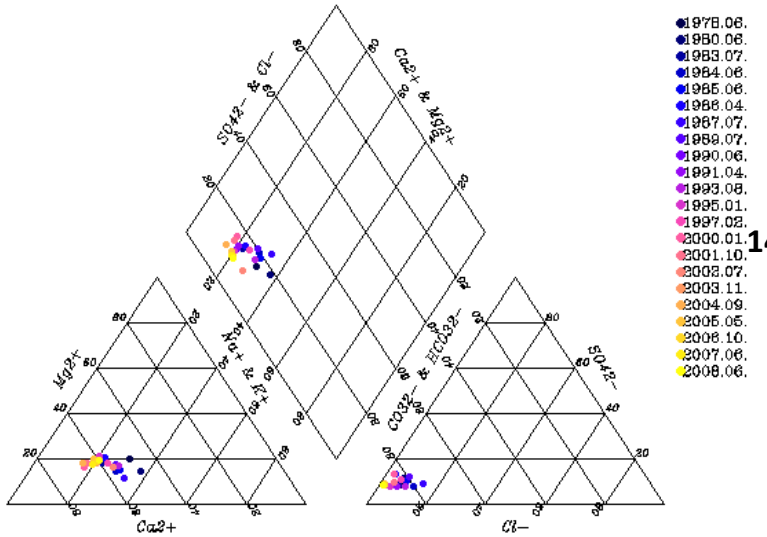
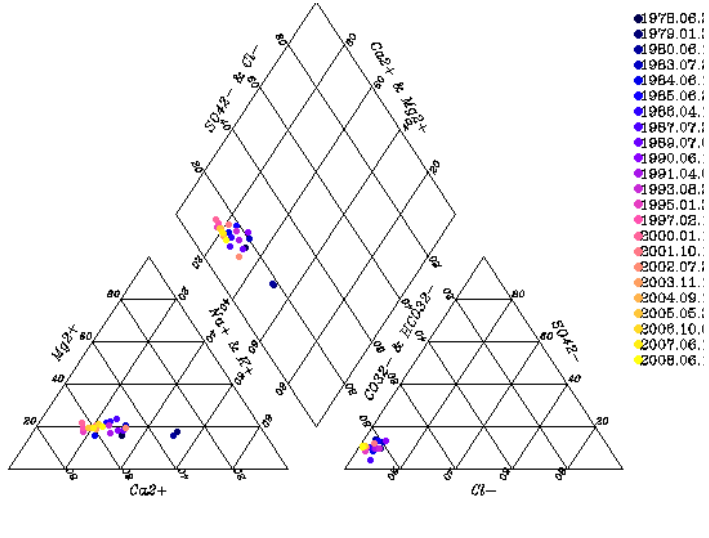
Middle part: groundwater level decline from < 5 m
Monitoring station «Inčukalns»

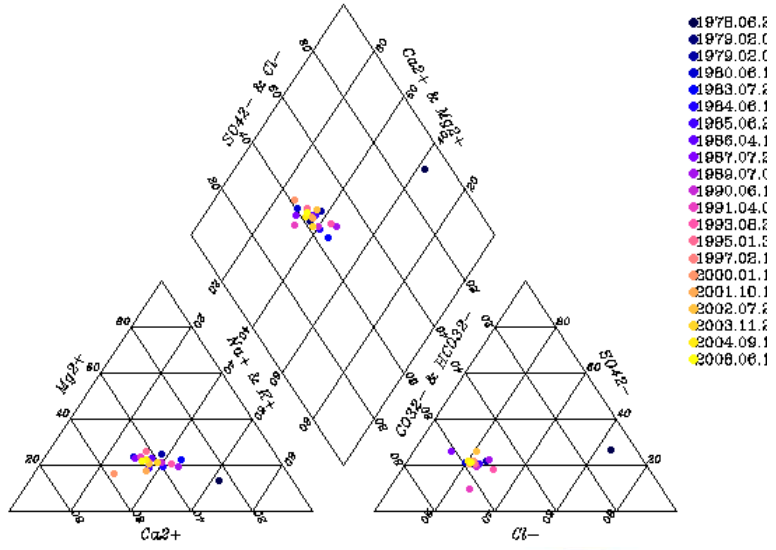
1493 (D3 gj)



1492 (D2 br)



1491 (D2 ar)



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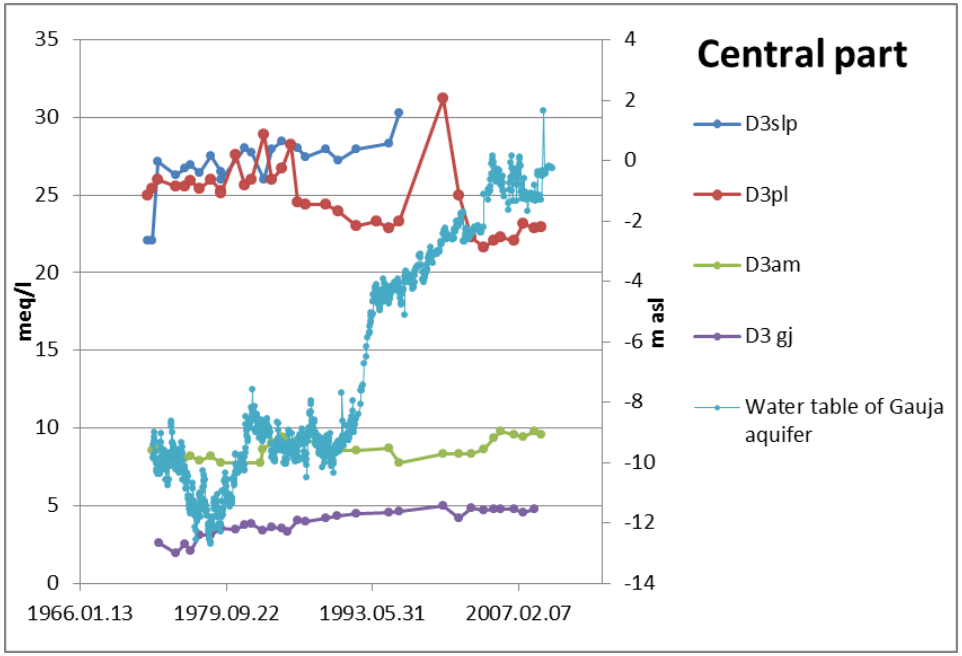
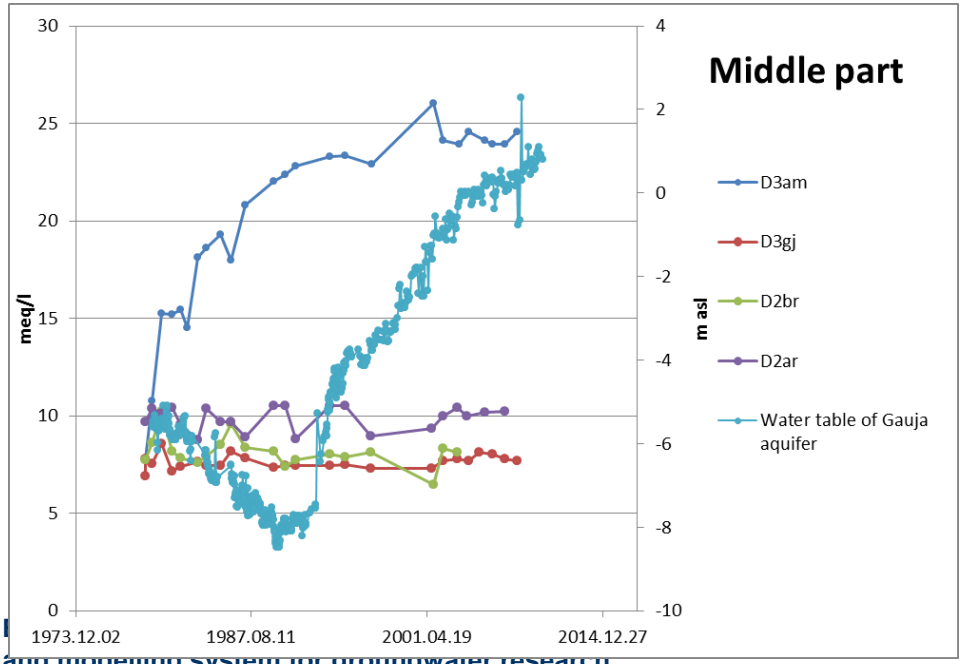
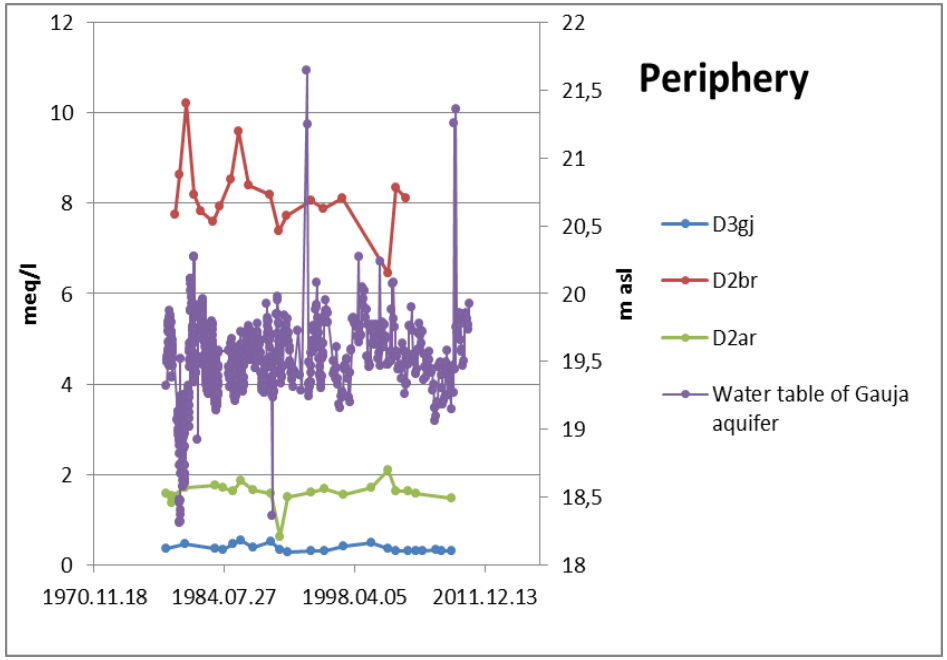
SO_4^{2-} ion change in territory of cone of depression







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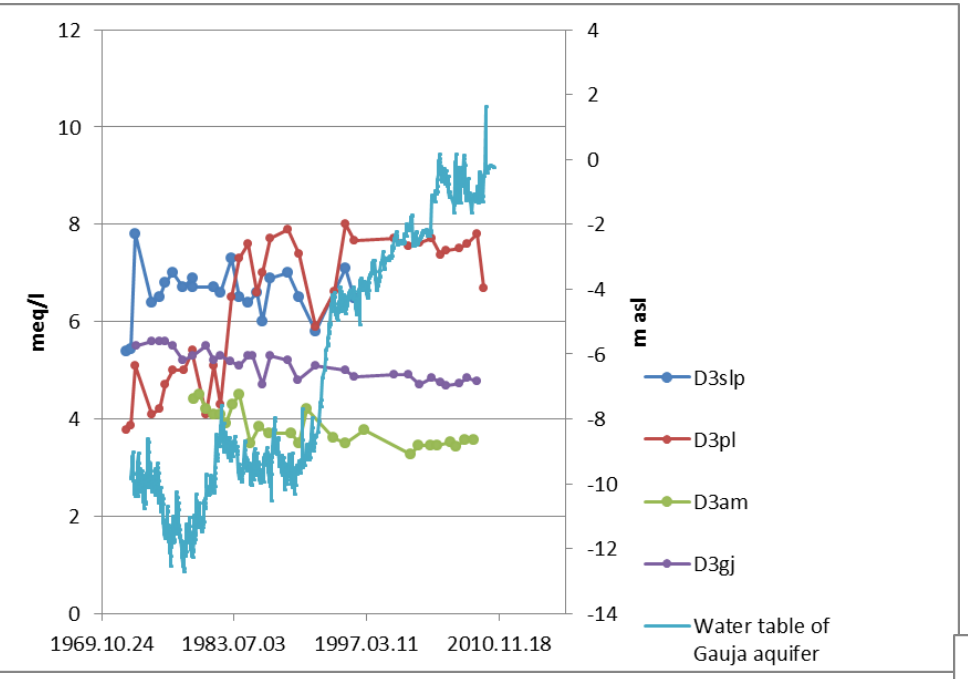
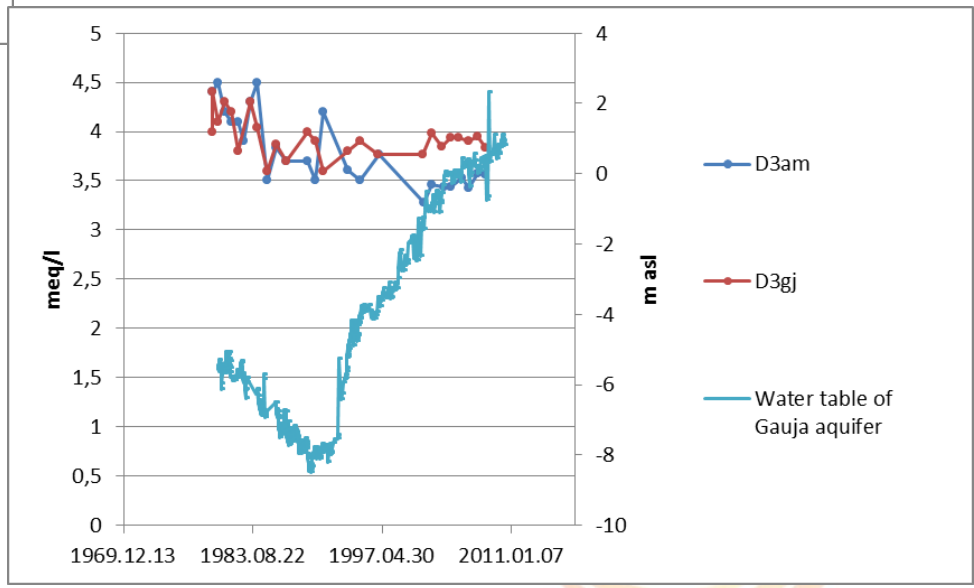


HCO_3^- ion change in monitoring station «Imanta»



HCO_3^- ion change in monitoring station «Mārupe»

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Firsts conclusions

- The downward oreinted flows from Salaspils aquifer caused rapid water composition change in uderlying Plavinas aquifer, but the water composition changes in Gaujas aquifer are very slowly and with time lag.

- Chemical composition of water from Arukilas-Amatas multi aquifer system significantly changed in Amata and Gauja aquifer, in central and middle part of cone of depression.

- 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.

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Thank you for your attention!

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