Modelling of Attenuation Processes for Conservative Components in the River Catchment: a Case Study

Jarosław Kania, Stanisław Witczak

AGH—University of Science and Technology
al. Mickiewicza 30, 30-059 Krakow, Poland;
jkania@agh.edu.pl witczak@agh.edu.pl

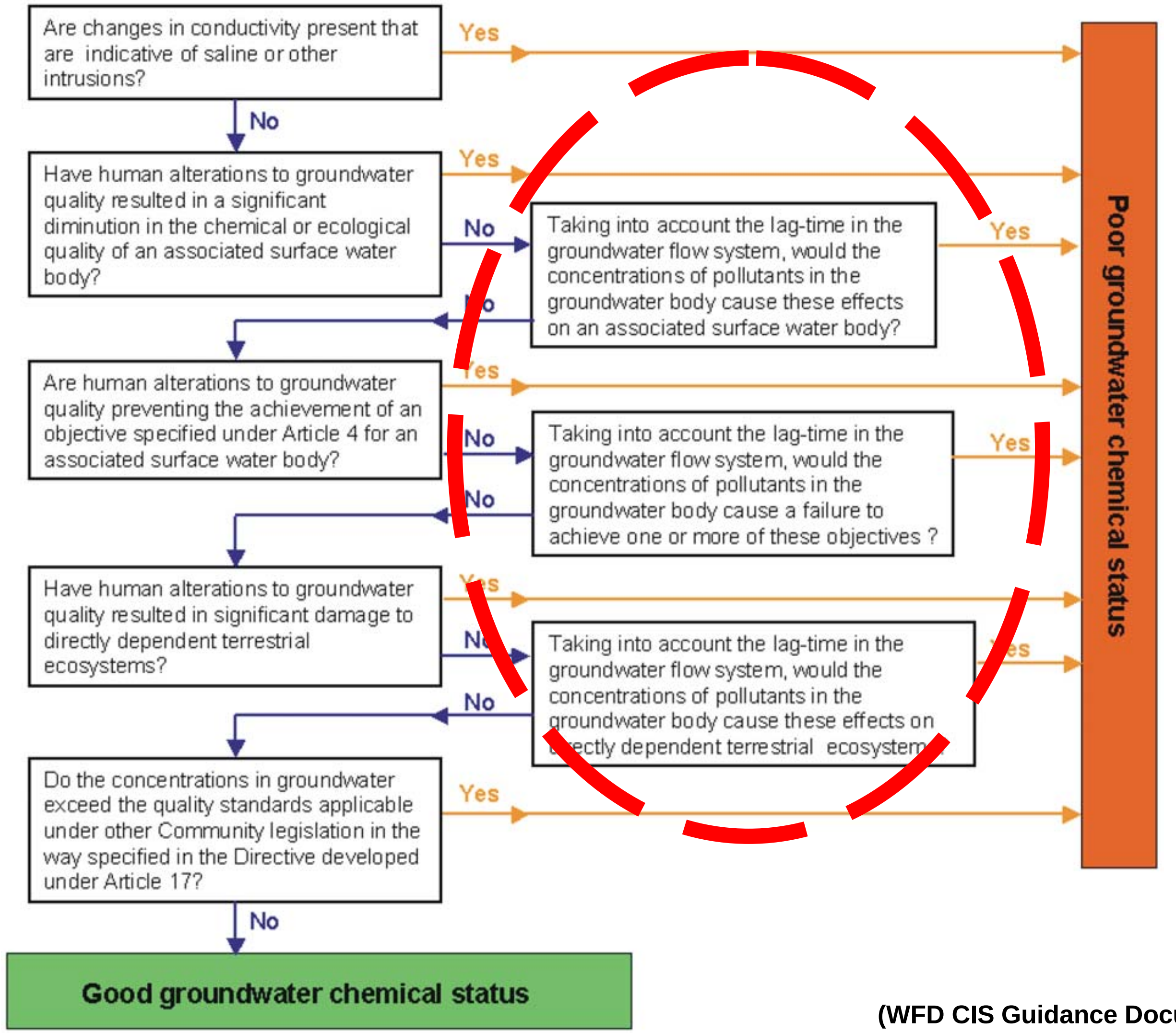
The Problem

(1) During mean low streamflow periods, rivers discharge mainly groundwater and wastewater. Therefore, quality of groundwater during baseflow is the main factor responsible of river water quality.

(2) The important factors controlling baseflow water quality are the spatial diffuse source concentration in the river catchment, the mean initial condition in the aquifer, and the mean residence time (Duffy and Lee, 1992).

(3) The aim of presented study is to demonstrate the possibilities of groundwater flow and transport modelling for the prediction of time and space changes in ground and surface water quality in the Trzesniowka River catchment.

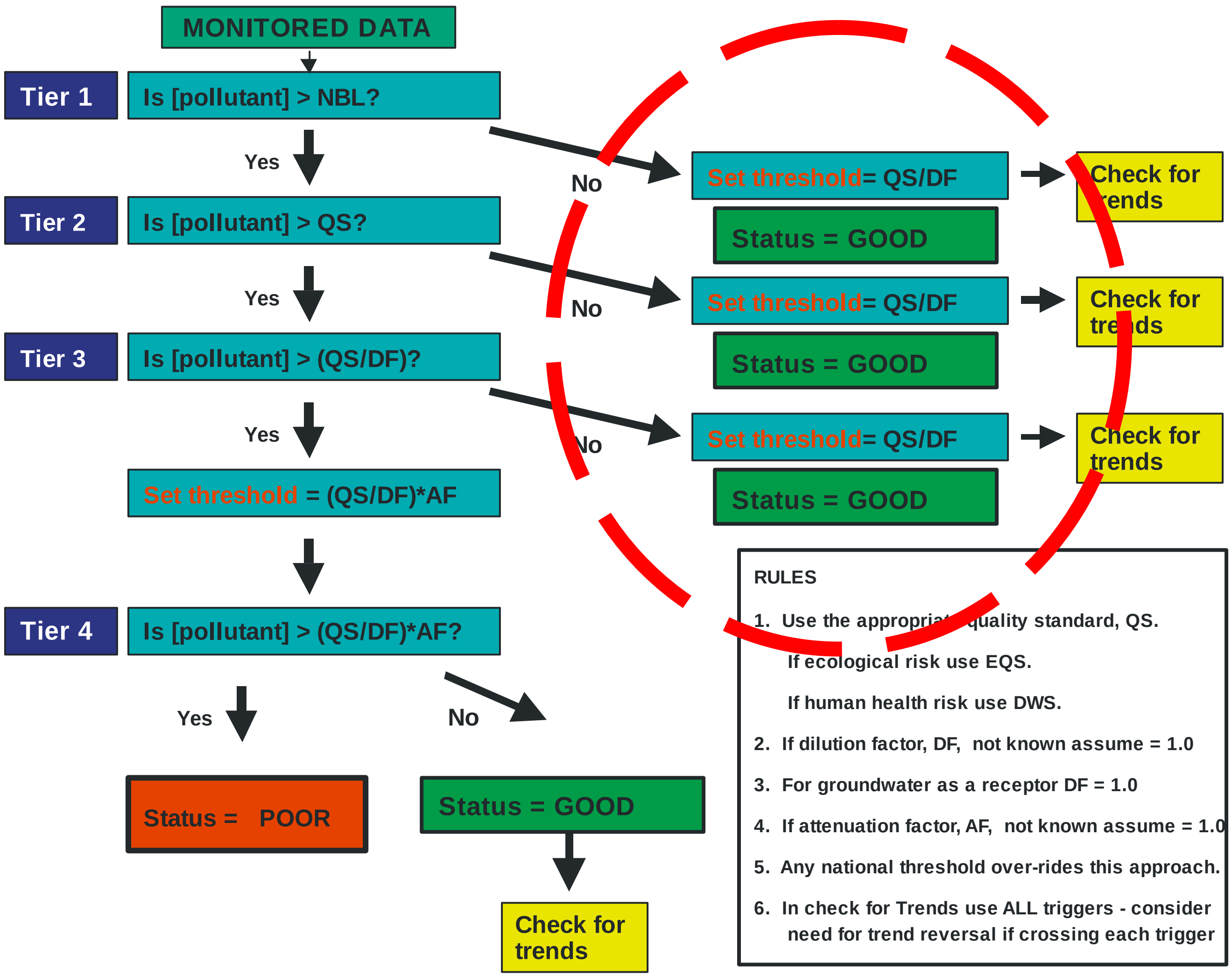
Important role of the lag time in the GWB chemical status assessment



(WFD CIS Guidance Document No. 7, 2003)

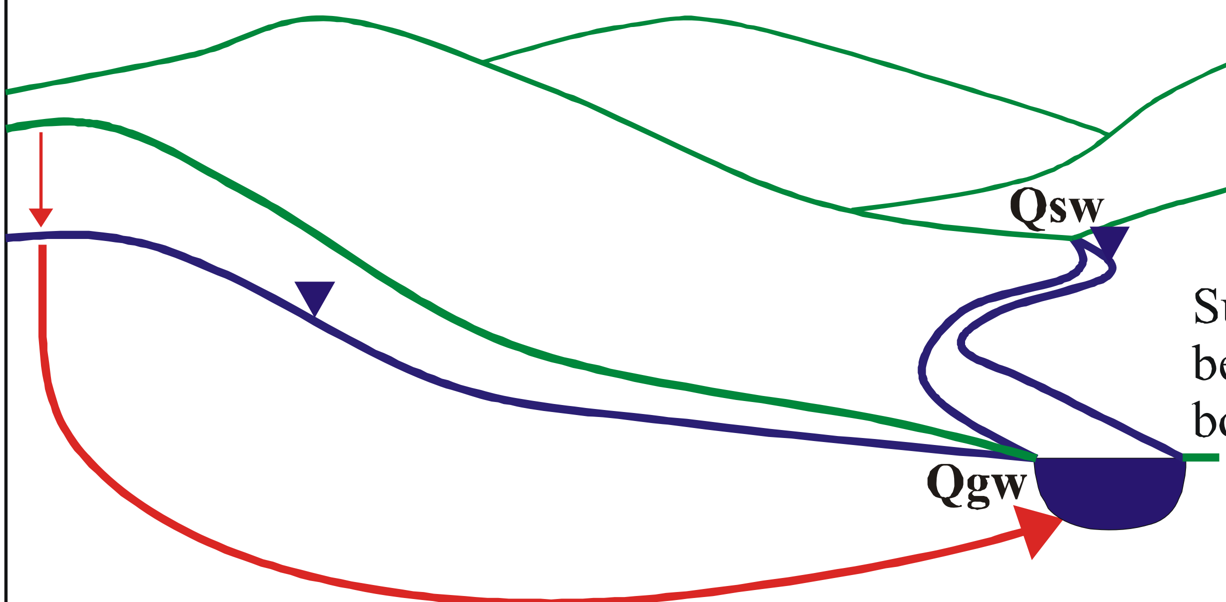
Tiered approach for derivation of threshold values of groundwater – surface water interaction

(Hart, Müller et al., 2006)



Groundwater contribution to total flow of the river

(Hookey et al., 2006)



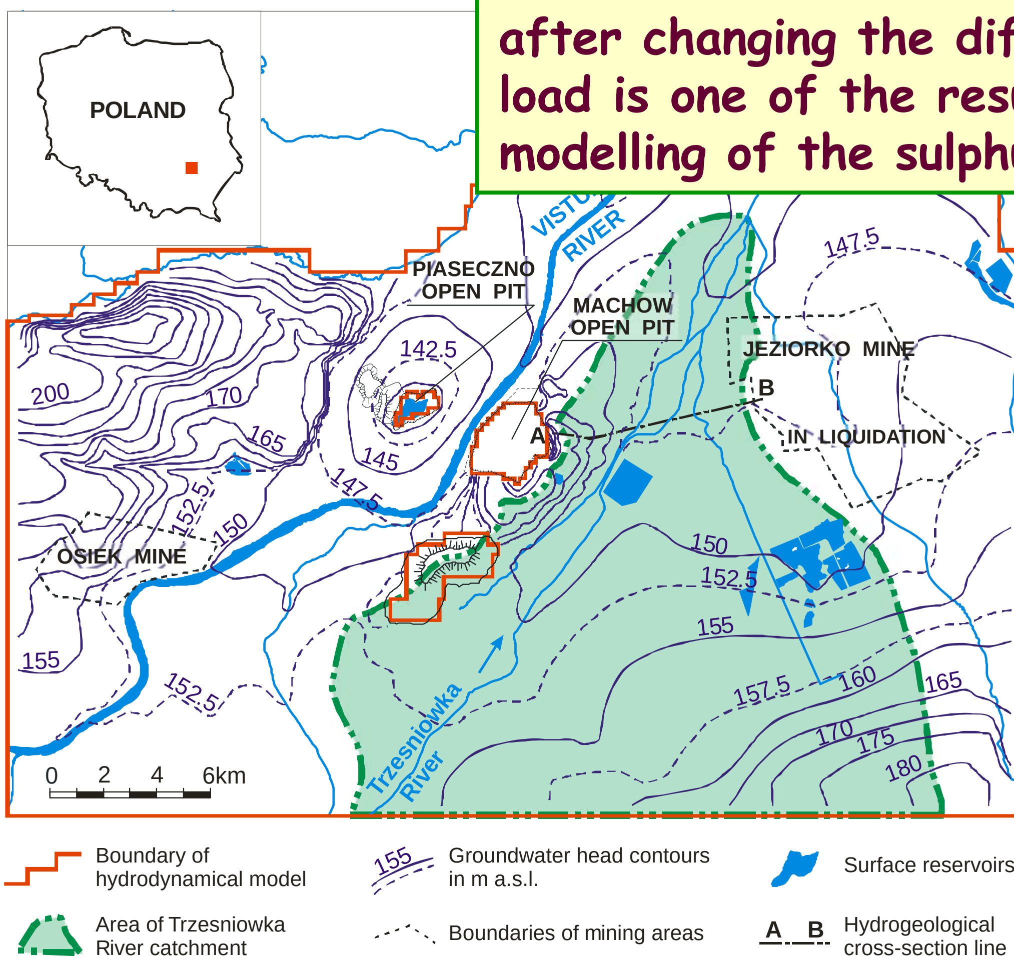
Surface flow from beyond the body boundary Qsw

Baseflow from groundwater Qgw

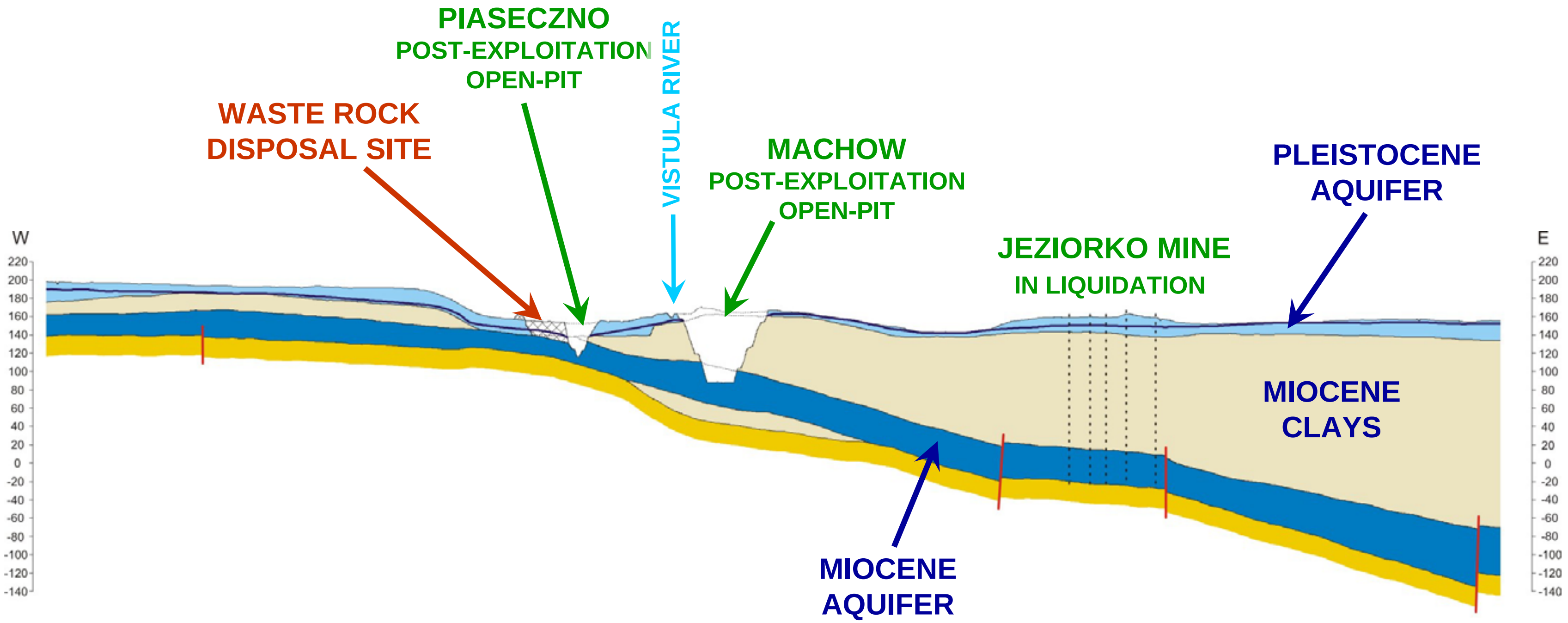
Dilution factor (DF) = Qgw/(Qgw + Qsw)

The Case Study: Trzesniowka River Catc[hment]

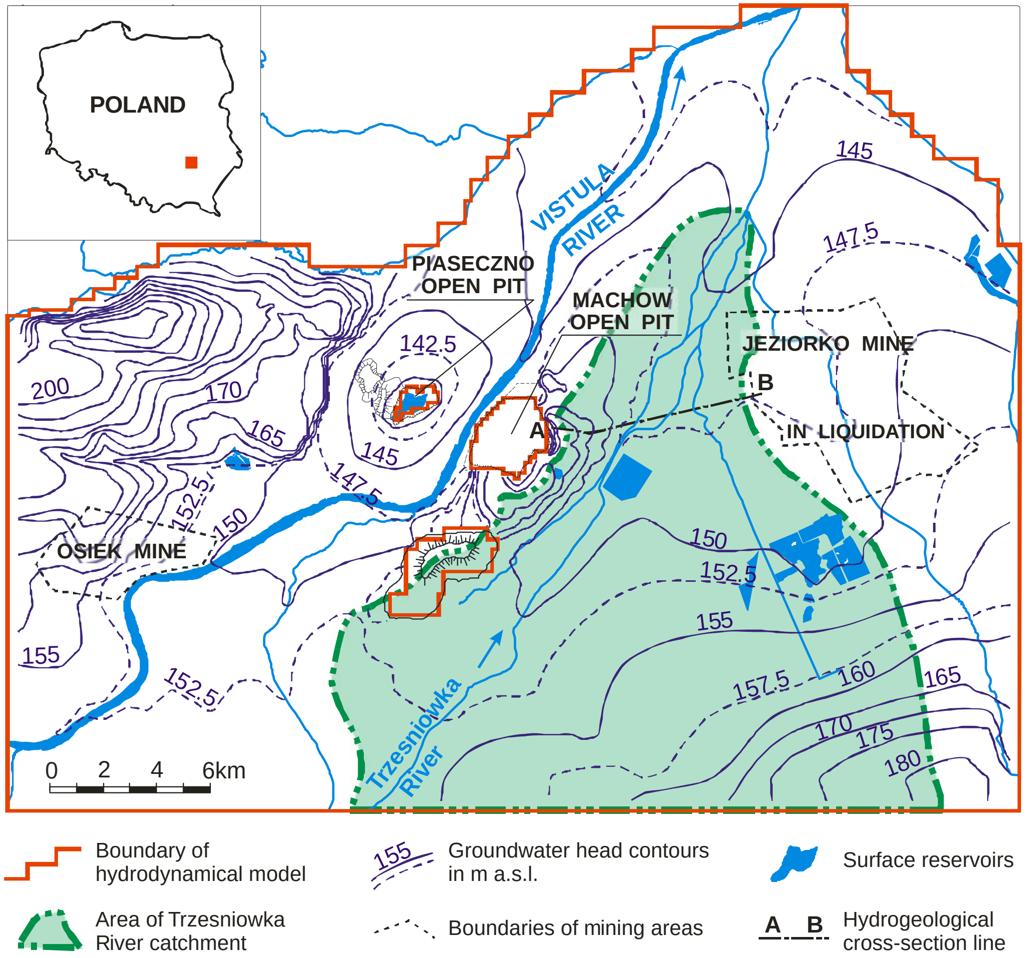
The behaviour of shallow aquifer supplying the Trzesniowka River after changing the diffuse pollutant load is one of the results of 3-D modelling of the sulphur mining area



Hydrogeological cross-section

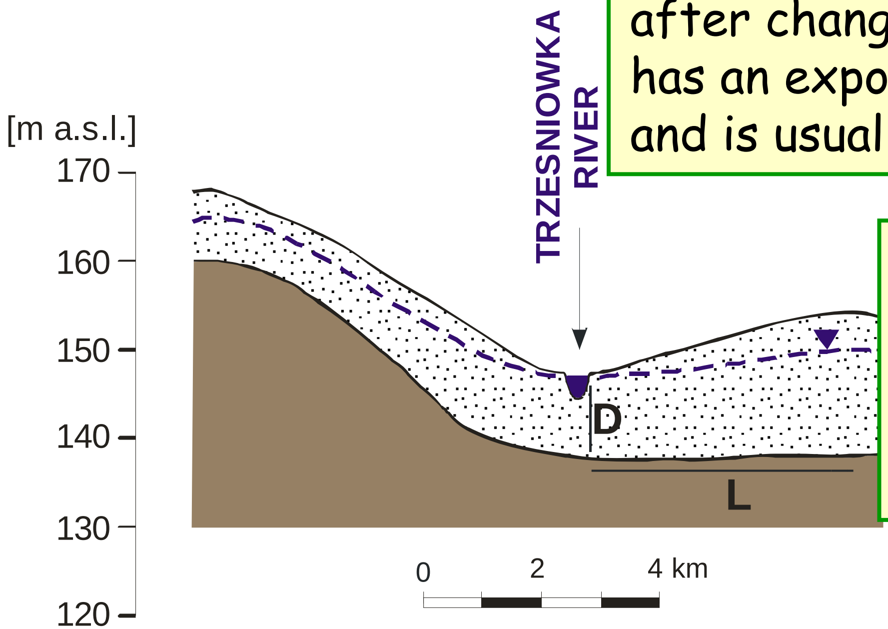


The Case Study: Trześniówka River Catchment



Simplified hydrogeological cross-section A–B

In the case of river's catchments with shallow open groundwater systems the response of the system after changing the contaminant load has an exponential character, and is usually measured in tens of years.



Such typical response of the system was confirmed using modelling for the part of the Trzesniowka River catchment (Kania et al., 2006).

aspect ratio of the flow is L/D>10,
L – the average length of the aquifer in the direction of subsurface flow,
D – the saturated thickness of the aquifer at the stream),

Flow and transport modelling

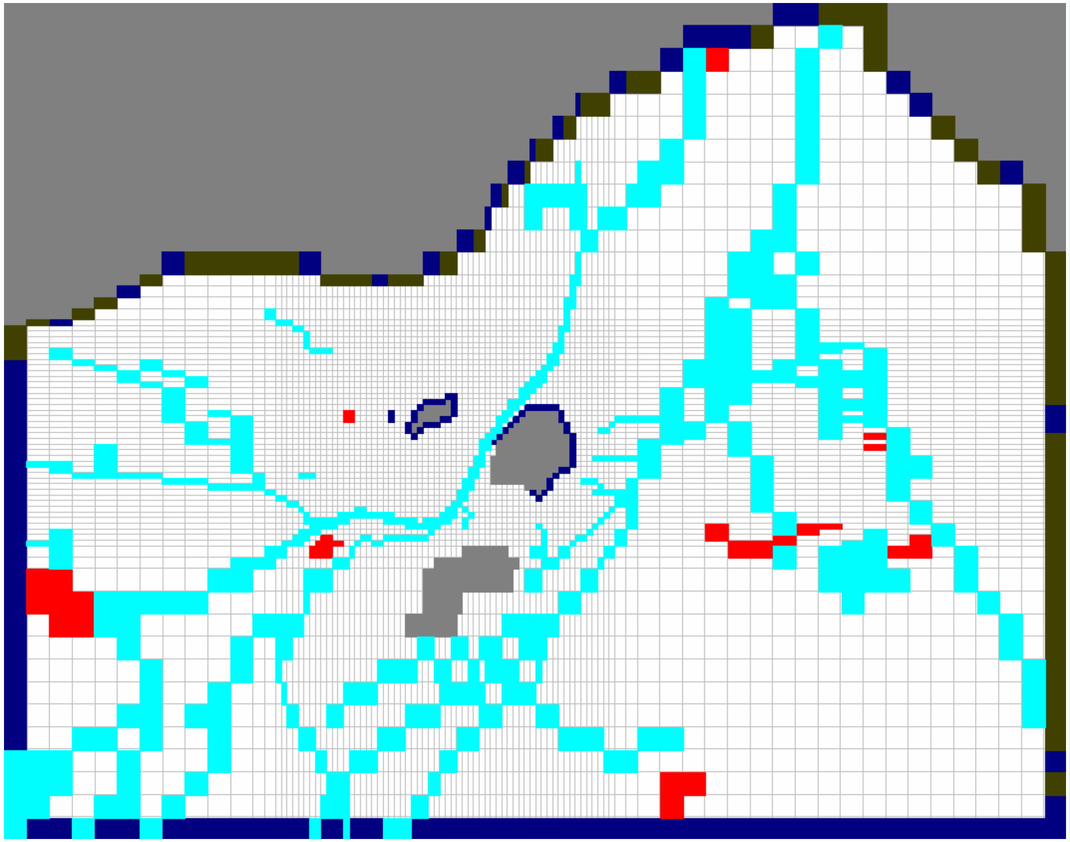
For the investigated area exist flow and transport models which were used for solving several problems related to the exploitation and closing mine operations

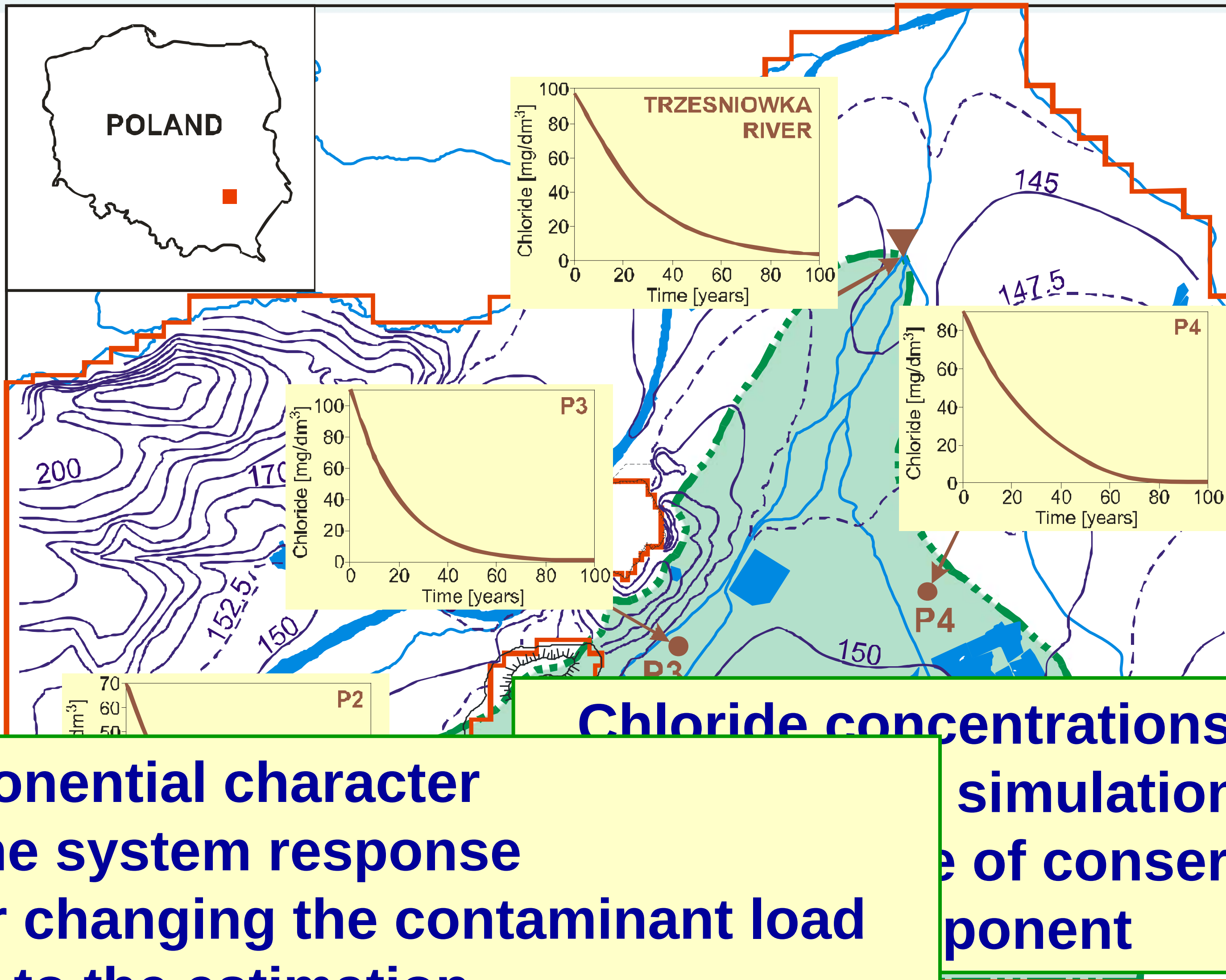
Processing Modflow Pro v.7

- MODFLOW
- MT3D

3D – three layers

Area: 900 km^2

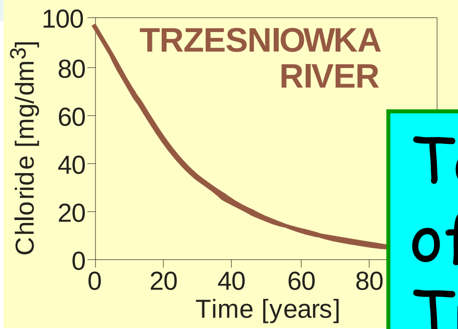




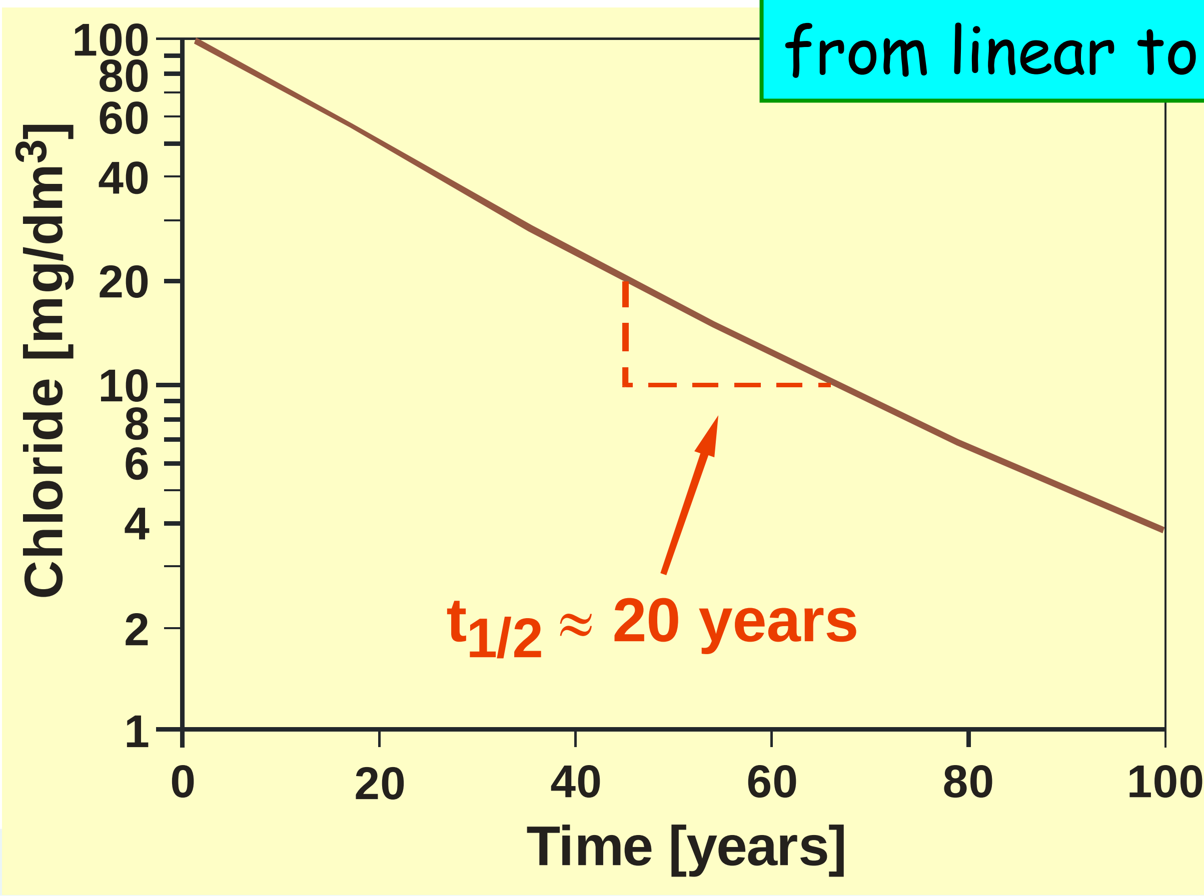
Chloride concentrations were
simulation
e of conservative
ponent

ce water system
to zero

Exponential character
of the system response
after changing the contaminant load
lead to the estimation
of the half-time of attenuation
for conservative components



To find the half-time of attenuation for the Trzesniowka River, it is better to change the concentration scale from linear to logarithmic.



Concluding Remarks

- The presented example indicates undoubtedly usefulness of groundwater flow and transport modelling for the evaluation of the interaction between groundwater and surface water systems.

- The half-time of conservative contaminant attenuation seems to be a good indicator of the lag time in groundwater and surface water interaction, necessary during GWB status assessment.