Estimating groundwater recharge in post-mining and urban area using SWAT and FEFLOW models, case study from Poland

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Background and methods

Tarnowskie Góry is an area heavily transformed due to the ore mining and heavy industry. Impact of these activities caused irreversible changes in the groundwater resources beneath the city in the Triassic carbonate aquifer system. Groundwater from this aquifer is used as a primary source of drinking water supplying inhabitants of the western part of the Upper Silesian Industrial Region. Therefore, reliable information about the groundwater recharge were essential for the correct estimation of the renewable resources.

In the presented study watershed (SWAT) and groundwater (FEFLOW) models were applied in order to asses groundwater recharge in the area of the Major Groundwater Basin (MGWB) Gliwice with focus on the city of Tarnowskie Góry, southern Poland (fig.1).

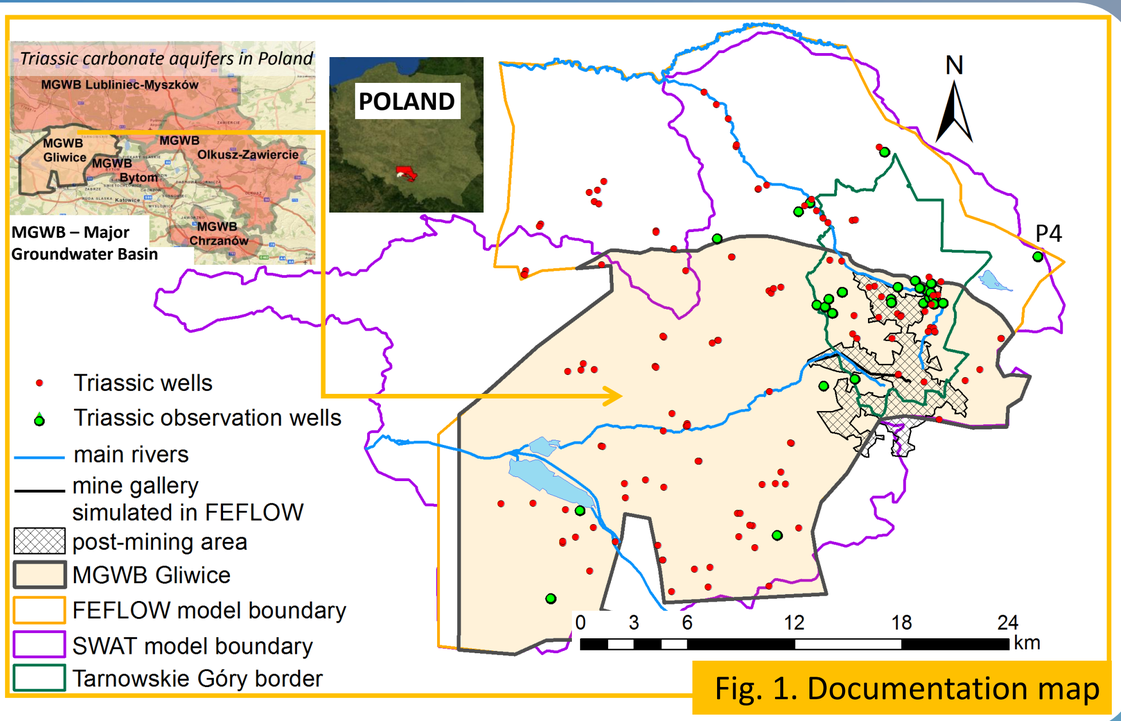

Fig. 1. Documentation map

Results

By means of SWAT, influences of land cover and meteorological conditions on groundwater recharge were estimated (fig.2 and fig.3). Moreover SWAT provided information about the relationships between the groundwater recharge and the remaining elements of a hydrologic cycle that were used at the FEFLOW model development stage (fig.4). Simulated groundwater recharge was used as an input to FEFLOW model.

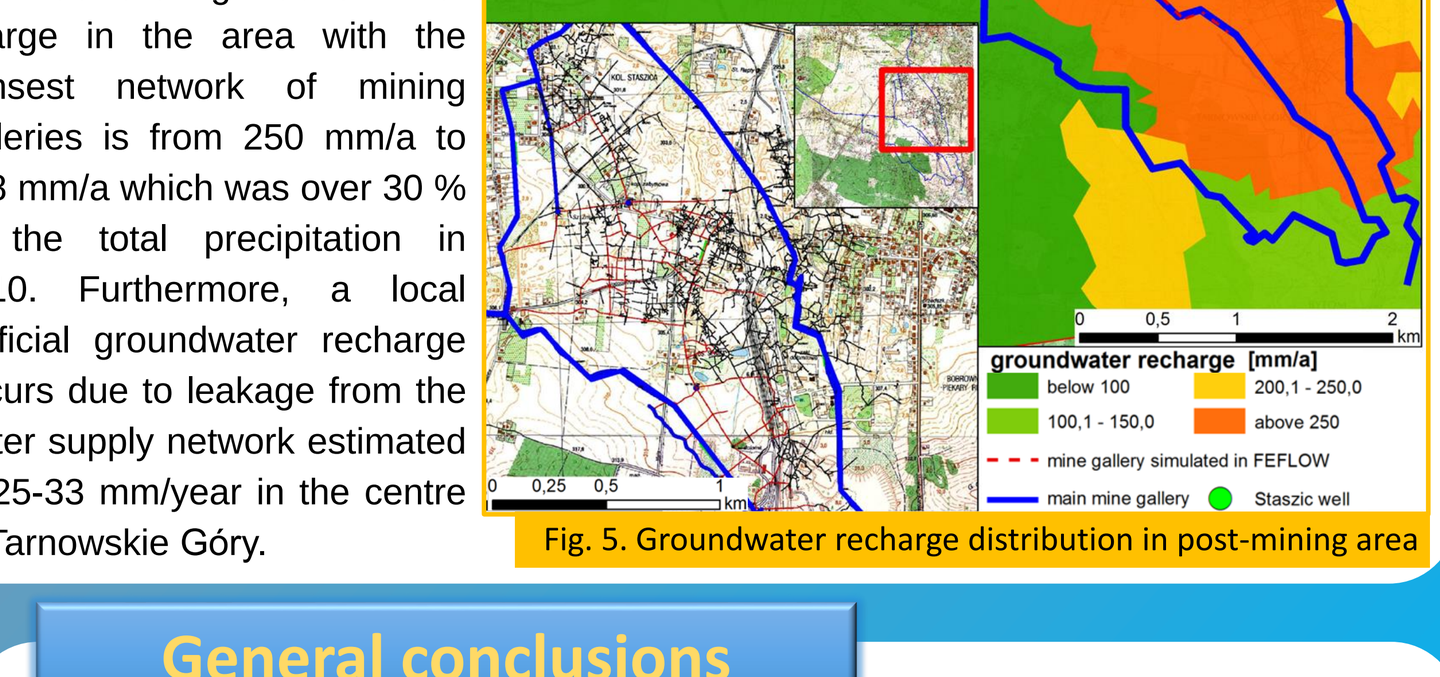

Fig. 4. Monthly fluctuation of selected elements of water balance.

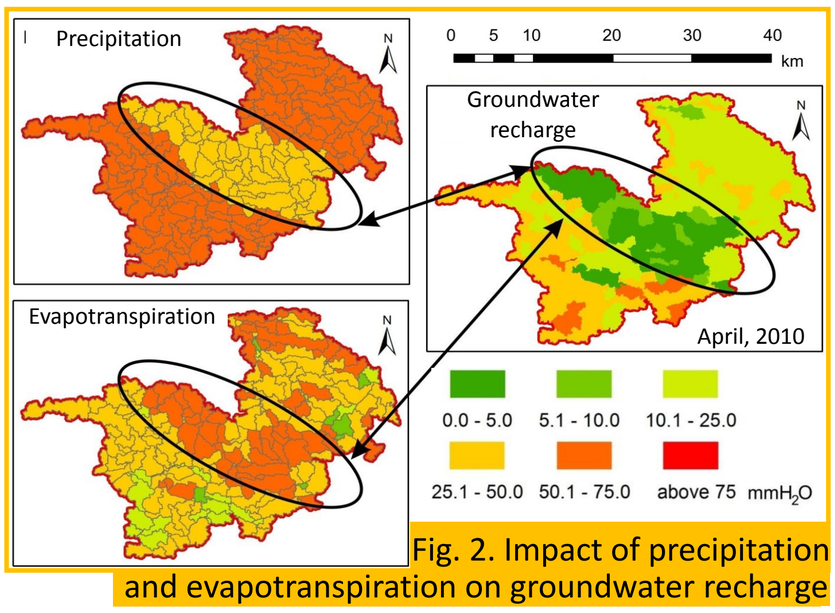

Fig. 2. Impact of precipitation and evapotranspiration on groundwater recharge

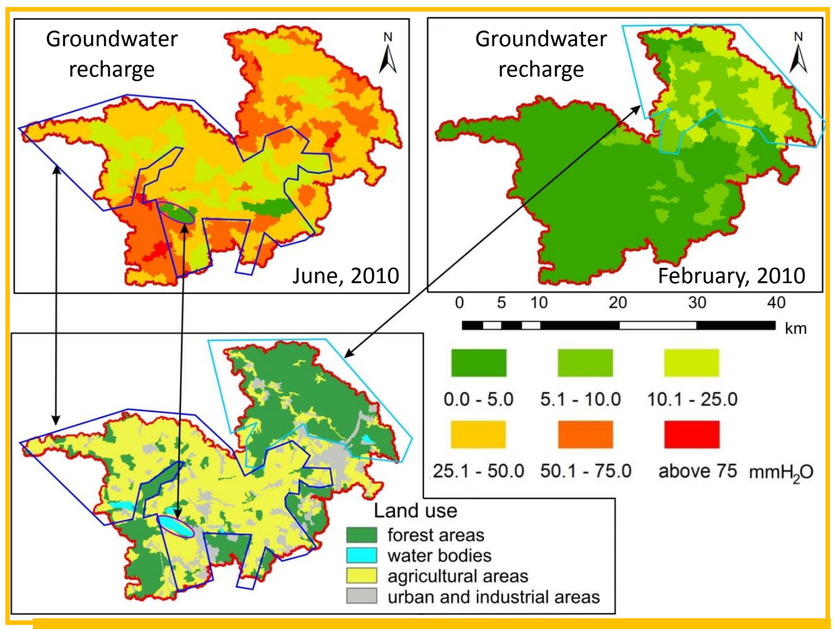

Fig. 3. Influence of land use on groundwater recharge

FEFLOW output highlights significant impact of post mining area on groundwater recharge (fig.5) due to increase of the permeability of rock mass and dewatering adits. Re-charge in the area with the densest network of mining galleries is from 250 mm/a to 318 mm/a which was over 30 % of the total precipitation in 2010. Furthermore, a local artificial groundwater recharge occurs due to leakage from the water supply network estimated at 25-33 mm/year in the centre of Tarnowskie Góry.

Fig. 5. Groundwater recharge distribution in post-mining area

General conclusions

The most important benefit from application of two different modelling techniques is significant reduction of the uncertainty in the simulation of groundwater recharge. This fundamental parameter in assessing groundwater resources has a great importance for the city of Tarnowskie Góry where groundwater is the only source of potable water.

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