Module 7 WSE-HI River basin modelling 2019-2021

Assignment in Groundwater modelling

Three sets of questions are introduced from three different models developed during the exercises. Each student will need to answer *some selected questions from the three sets*, *as indicated in the table at the end of the assignment*.

Set 1: Model of unconfined aquifer with recharge and pumping well

This model was developed in MODFLOW as presented in your Groundwater Exercise solution report in pages 17-28 (please revise this part). The final model was with recharge, constant head boundaries, and with a pumping well that was introduced in cell (15,15). Using trial and error it was determined that this well can pump about 1110 m3/day without taking water from any of the boundaries. This is a starting model for answering the questions of this assignment.

Questions:

1. Change the hydraulic conductivity in the original model from K=16 m/day to K=5 m/day. Can the pumping rate of the well at cell (15,15) be increased from the value of 1110 m3/day, while still not taking water from any of the boundaries? What can you say about the groundwater heads under these new conditions, especially at cell (15,15) where the pumping well is located? What is limiting the maximum pumping rate from the well in these conditions? Explain your answers and support them with whatever results you find appropriate, such as water balance, groundwater head distribution, particle tracking.
2. In the original model introduce a second pumping well at location of cell (5,15). Using trial and error estimate the maximum total pumping rate (from both wells at locations (15,15) and (5,15)), that is larger than the single pumping rate at cell (15,15) in the original model estimated at 1110 m3/day, still ensuring that no water is pumped from any of the boundaries. Explain your answers and support them with whatever results you find appropriate, such as water balance, groundwater head distribution, particle tracking.
3. In the original model reduce the upstream (western) boundary from 20m to 19m. Can the maximum pumping rate the well at cell (15,15) be increased under these conditions, while still not taking water from any of the boundaries? Estimate the new maximum possible pumping rate without the well taking water from any boundary and compare this with the rate obtained in the original model of 1110 m3/day. Explain your answers and support them with whatever results you find appropriate, such as water balance, groundwater head distribution, particle tracking.
4. In the original model increase the downstream (eastern) boundary from 16m to 17m. Can the maximum pumping rate the well at cell (15,15) be increased under these conditions, while still not taking water from any of the boundaries? Estimate the new maximum possible pumping rate without the well taking water from any boundary and compare this with the rate obtained in the original model of 1110 m3/day. Explain your answers and support them with whatever results you find appropriate, such as water balance, groundwater head distribution, particle tracking.

Set 2: Model of a polluted aquifer

This model was developed during the exercises and its analysis is presented in your Groundwater Exercise solution report in pages 29-40 (please revise this part). Questions 5-8 relate to the original model (when all pumping wells are still functioning). Question 9 relates to the updated model when all wells close to the southern river are switched off and Well No. 10 is reduced to pumping rate of 1500 m3/day.

Questions:

5. Suppose that the natural recharge to this aquifer is 50% larger. Explain the differences in water balance components compared to the original model (think about the changes in groundwater heads). Will the polluted zone be larger or smaller than in the original model? Support your answer with results in terms of appropriate particle tracking analysis results.
6. Suppose that the natural recharge to this aquifer is 50% smaller. Explain the differences in water balance components compared to the original model (think about the changes in groundwater heads). Will the polluted zone be larger or smaller than in the original model? Support your answer with results in terms of appropriate particle tracking analysis results.
7. Suppose that the inflow from the neighboring aquifer in the north (the underflow) is 50% larger. Explain the differences in water balance components compared to the original model (think about the changes in groundwater heads). Will the polluted zone be larger or smaller than in the original model? Support your answer with results in terms of appropriate particle tracking analysis results.
8. Suppose that the inflow from the neighboring aquifer in the north (the underflow) is 50% smaller. Explain the differences in water balance components compared to the original model (think about the changes in groundwater heads). Will the polluted zone be larger or smaller than in the original model? Support your answer with results in terms of appropriate particle tracking analysis results.
9. In the second version of the model, after the wells close to the southern river have been switched off, and the Well No.10 has been reduced to 1500 m3/day pumping rate, the total available water for water supply has been significantly reduced (from 13,500 to 6000 m3/day). Can you introduce new wells that will pump total additional water of as close as possible to 2,000 m3/day, while still not taking any water from the polluted zone of the aquifer? Use as small number of wells as possible, with a maximum of five additional wells. You can modify (reduce) the pumping rate of most critical Well No 10 (on the east), but the total pumping rate should be increased by as close as possible to 2000 m3/day, i.e should be equal to 8000 m3/day. Present the new well configuration indicating the pumping rate of each well. Provide support for the solution that you have found (confirming that you have provided additional water without pumping any polluted water) with water balance and particle tracking results.

Set 3: Profile model – flow under a dam

This model was developed during the exercises and its analysis is presented in your Groundwater Exercise solution report in pages 41-47 (please revise this part). Three versions of the model were analysed: Model a) – original setup without any interventions for reducing the flow or head under the dam; Model b) – original setup + a vertical flow barrier that reduces the flow under the dam; Model c) Original setup + vertical flow barrier + drainage gallery. Question 10 refers to Model a), question 11 refers to Model b) and question 12 refers to model c).

Questions:

10. In Model a) reduce the hydraulic conductivity of the aquifer below the dam from 1 m/day to 0.2 m/day. Present analysis of the obtained results in terms of head distribution under the dam, flow under the dam and uplift force (per unit width). Explain the differences compared to the original Model a). Use whatever results you find appropriate in your explanations.
11. In Model b) reduce the hydraulic conductivity of the aquifer below the dam from 1 m/day to 0.2 m/day. Present analysis of the obtained results in terms of head distribution under the dam, flow under the dam and uplift force (per unit width). Explain the differences compared to the original Model b). Use whatever results you find appropriate in your explanations.
12. In Model c) extend the vertical barrier to cover the total thickness of the aquifer. Present analysis of the obtained results in terms of head distribution under the dam, flow under the dam and uplift force (per unit width). Explain the differences compared to the original Model c). Why is there still flow under the dam, even though the vertical barrier covers the whole thickness of the aquifer under the dam? From where comes the water that flow out through the drainage gallery (upstream or downstream part)? Use whatever results you find appropriate in your explanations.

Allocated questions to students for Groundwater modelling assignment

Module 7-WSE-HI River basin modelling

Number	Mr/Ms	Name	Allocated questions			
1069195	Mr	Cui Zhewei	2	5	9	10
1066931	Mr	Dong Zhuowen	3	8	9	12
1072186	Mr	Rodrigo Edwin Esquivel Esquivel	1	6	9	11
1072885	Ms	Huang Yiying	4	7	9	12
1069158	Ms	Yue Jia	3	6	9	10
1065576	Mr	Tharindu Udasri Sampath Manamperi	2	8	9	11
1068727	Mr	Sun Tianyi	4	7	9	10
1069406	Mr	Victor Alejandro Arcia Castro	1	5	9	11
1066462	Ms	Vindhya Basnayake Basnayake Mudiyanselage	2	7	9	12
1062906	Ms	Valéria Cristina Prando	4	5	9	12
1066695	Mr	Steven Richard Brazda	3	8	9	10
1060300	Mr	Sivarama Krishna Reddy Chidepudi	1	6	9	11
1066355	Mr	Siamak Farrokhzadeh	4	8	9	11
1070284	Mr	Liang Shuoyuan	3	7	9	12
1064735	Mr	Zheng Shaoxu	2	6	9	10
1066901	Ms	Nowrina Rahim	1	5	9	12
1068950	Ms	Paula Santandreu Vicens	3	6	9	10
1068144	Ms	Nadia Natasha Jethoo	1	7	9	11
1057438	Mr	Masood Rasoli	4	5	9	11
1052068	Mr	Mostafa Mostafa Emam Saleh	2	8	9	10
1059981	Mr	Joaquin Vicente Consunji Ferrer	2	8	9	12
1066817	Mr	Juan Felipe Velandia Ramos	4	7	9	11
1071842	Mr	Jiaxin Wen	3	5	9	12
1041829	Ms	Fatmata Kolliatu Kamara	1	6	9	10
1069728	Mr	Kshitiz Gautam	2	5	9	12
1071079	Mr	Karel Aldrin Sanchez Hernandez	1	8	9	10
1068238	Ms	Kamilla Zhalmurziyeva	3	7	9	11
1069431	Ms	Lidya Lulseged Assefa	4	6	9	10
1069160	Mr	Luiz Eduardo Lucena Justino	4	6	9	11
1075505	Mr	Luis Felipe Sierra Ponguta	2	7	9	12
1067143	Ms	Umutoni Lisa	3	5	9	12
1066417	Mr	Mark Bryan Alivio	1	8	9	10
1072402	Mr	Manuel Antonio Alvarez Chaves	1	8	9	11
1074057	Mr	Alexopoulos Marcos Julien	3	7	9	10
1068718	Mr	Manoel Marcelino De Sá Junior	2	6	9	12
1069191	Mr	Mario Alberto Fuentes Monjaraz	4	5	9	11
1068076	Ms	Mazriha Islam	2	7	9	11
1061032	Mr	Muhammad Jawad	3	5	9	12
1068402	Ms	Le Minh Nguyet	4	6	9	10
1060031	Mr	Hudson Ebadonoi Irivbogbe	1	8	9	10
1070039	Mr	Hemant Servia	3	8	9	12
1058931	Mr	Camilo Andres Gonzalez Ayala	2	5	9	11
1074947	Mr	Carlos Alfredo Mesa Zuluaga	4	6	9	11
1068411	Mr	Dereje Endalkachew Tiruneh	1	7	9	12
1068601	Mr	Daniel Eduardo Villarreal Jaime	2	5	9	10
1052768	Mr	Eugen Balilaj	4	6	9	12
1068292	Mr	Edgar Andres Lopez Garcia	3	7	9	10
1053459	Mr	Faisal Mahmood	1	8	9	11
1067229	Ms	Angie Araya Lescouflair	3	5	9	12
1042956	Mr	Amit Daiman	2	8	9	11
1068260	Ms	Alejandra Lobo Chavarria	4	6	9	10
1008784	Mr	Ahmed Essam Fawky Ramadan Mohammed	1	7	9	10
1067911	Mr	Anietie Edet Okon	2	8	9	11
1066059	Mr	Amin Shakya	1	6	9	12
1057883	Mr	Ammanuel Bekele Tilahun	3	7	9	12
1069689	Ms	Buse Onay	4	5	9	10