An Experimental Setup for Stream-Aquifer Interaction Modeling

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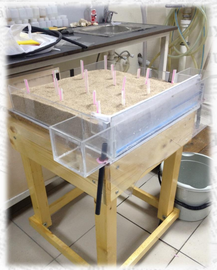
25-29th September 2016
Montpellier, France
CORUM CONFERENCE CENTER
43rd IAH congress

Abstract No: 2288

General

Groundwater modeling is important to understand the effect of the hydrogeological parameters. While the analytical and the numerical models represent the theoretical point of view of the problem, the experimental studies represent the physical insight and help improve the theory. An experimental setup is designed to model the groundwater flow in an unconfined aquifer which is in interaction with a stream.

About the Equipment



A plexiglass box, which has 50 cm length, 50 cm width, and 10 cm depth, is placed on a movable table whose slope may be adjusted depending upon the physical problem. Inflow and outflow pools are placed at the inlet and outlet points of the stream in order to establish constant water depth along the stream.

The pool also avoids the unwanted high turbulent flow and hydraulic jump.

The slope is carefully adjusted to horizontal.

At the left hand side of the aquifer, the sloping stream boundary is put along y-direction with a length of 50 cm and width of 1.5 cm. In some analysis gravels are used to create and stabilize the stream. A special filter is used to avoid the sediment transport between stream and aquifer

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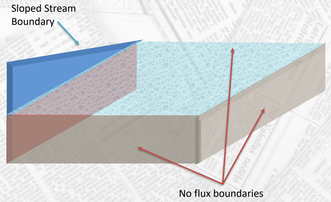
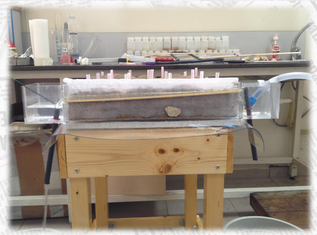
Problem



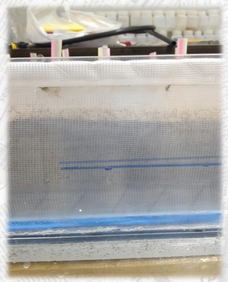
The setup is developed by considering a special 2-dimensional problem which includes a stream boundary with constant slope. The rest of the boundaries are no-flux boundaries which are represented by Neumann boundary conditions. The aquifer is selected as homogeneous and isotropic.

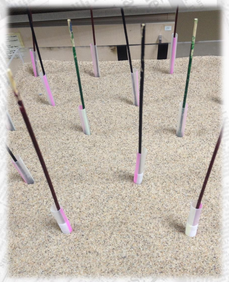


In order to adjust the constant bed slope, a wooden stick (50×1.5×0.4 cm) is placed on stream hole.

The rest of the box is filled with sand.

System is started to fed with water. Then aquifer saturation is ensured and steady state conditions are obtained.





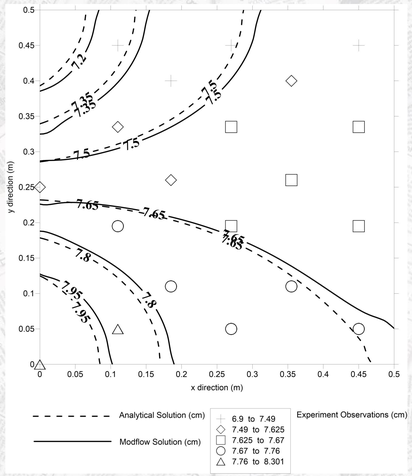
Several wells are placed into the aquifer to measure the groundwater head.

In this study, the measurements are done manually by using wooden sticks. For more sensitive needs, the system can be developed for automatic measurements by ideal sensors.

Note that, the system is very small for a time dependent analysis. This situation may be attributed to complexity of creating the assumptions made on the problem in such a small box. Therefore steady state comparisons are more presentable for this equipment.

Results & Conclusions

The experiment is run for selected sloped stream problem and head values and the groundwater levels in wells are measured. A numerical and analytical model are also prepared for the same problem.



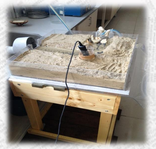
The observations are compared with the analytical & numerical model results. The comparison shows that the experimental measurements match with the analytical and numerical model results. It is concluded that the experimental setup represents the groundwater flow accurately and can be used for the other scientific studies.

Further Study Options with the Experimental Setup

In this study, a special problem is considered. But this equipment can be used in studies for different purpose.

Figures show a study which focuses on the contaminant transport between stream and wells.

The equipment is also very convenient for undergraduate study projects. It provides a practical view for stream-aquifer interaction, groundwater flow and well hydrodynamics.



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