

Fortran project: Submitted by Md Nurul Kadir
A model for the steady state 1-D shallow water equations

For 1st order Euler Scheme

Number of cells	Delta X	L2 Norm	Order	Lmax Norm	Order
10	40000	3.89E-02	1.00E+00	5.27E-02	1.06E+00
20	20000	1.95E-02	9.98E-01	2.52E-02	1.03E+00
40	10000	9.74E-03	9.98E-01	1.23E-02	1.01E+00
80	5000	4.88E-03	9.99E-01	6.11E-03	1.01E+00
160	2500	2.44E-03	9.99E-01	3.04E-03	1.00E+00
320	1250	1.22E-03	1.00E+00	1.51E-03	1.00E+00
640	625	6.10E-04		7.57E-04	

For 2nd order Runge Kutta Scheme

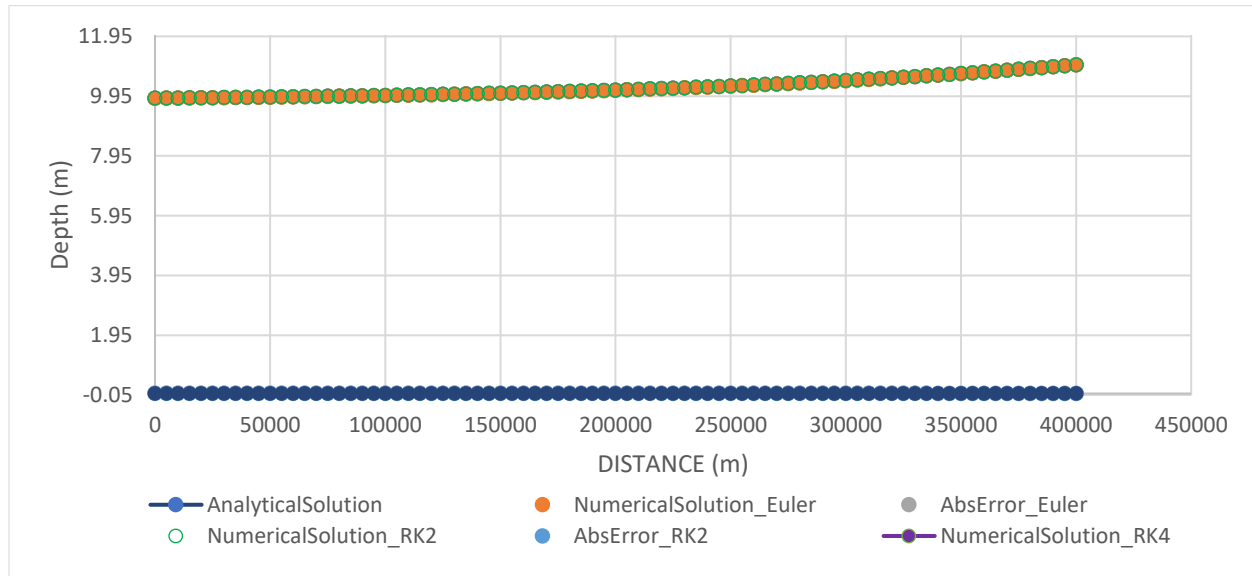
Number of cells	Delta X	L2 Norm	Order	Lmax Norm	Order
10	40000	3.51E-03	2.09E+00	4.65E-03	2.13E+00
20	20000	8.27E-04	2.04E+00	1.06E-03	2.06E+00
40	10000	2.01E-04	2.02E+00	2.53E-04	2.03E+00
80	5000	4.97E-05	2.01E+00	6.19E-05	2.02E+00
160	2500	1.23E-05	2.00E+00	1.53E-05	2.01E+00
320	1250	3.08E-06	2.00E+00	3.81E-06	2.00E+00
640	625	7.68E-07		9.49E-07	

For 4th order Runge Kutta Scheme

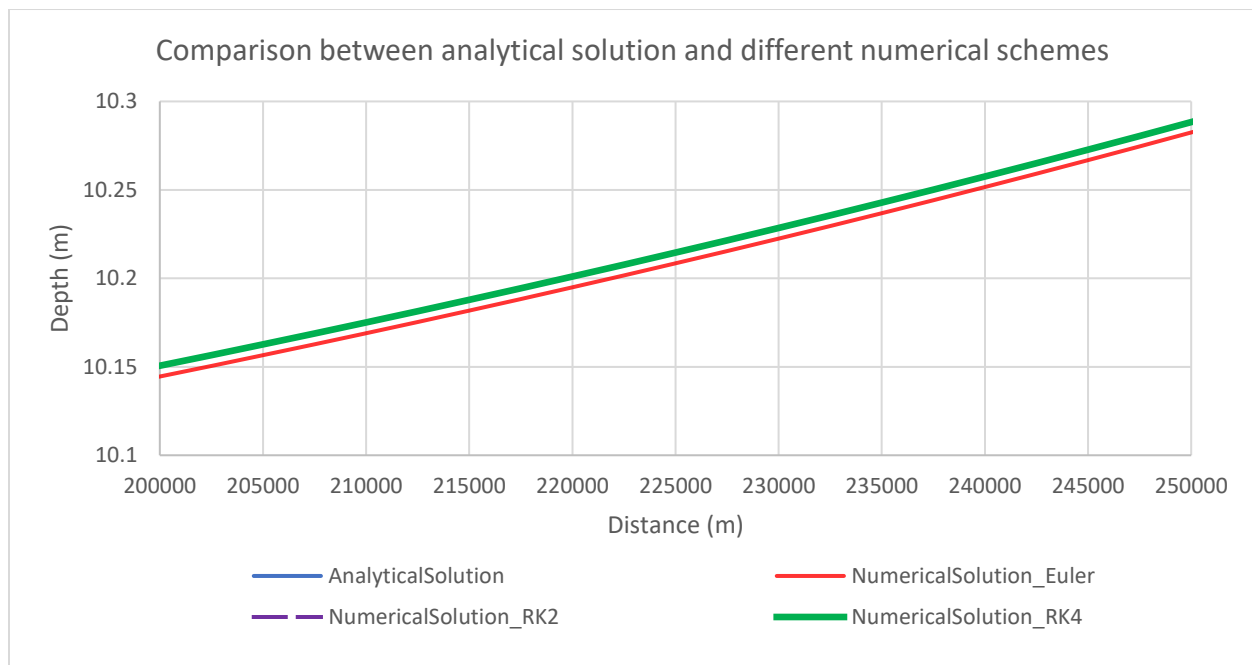
Number of cells	Delta X	L2 Norm	Order	Lmax Norm	Order
10	40000	9.95E-06	4.09E+00	1.32E-05	4.13E+00
20	20000	5.86E-07	4.04E+00	7.54E-07	4.07E+00
40	10000	3.56E-08	4.02E+00	4.50E-08	4.03E+00
80	5000	2.20E-09	4.01E+00	2.75E-09	4.02E+00
160	2500	1.36E-10	4.00E+00	1.70E-10	3.94E+00
320	1250	8.54E-12	3.77E+00	1.11E-11	3.16E+00
640	625	6.26E-13		1.24E-12	

Plotting the results for dx value of 5000.

Here the depth obtained by solving the ODE with each different scheme(Euler, Runge kutta 2 and Runge Kutta 4) and compared with the analytical solution of Venutelli.



All the schemes are present quite satisfactory results with the values close to the analytical solution. But when we took the smallest reach length (between 200000 to 250000) it is found that RK2 and RK4 are mostly close to the analytical solution rather than Euler method.



Based on the above-mentioned table and graphs, we can conclude that Higher Order Schemes gives us better results, and more importantly, the Higher Order ODE schemes will allow us to reach the results more accurately and quickly compared to the lower Order ODE scheme.