Appendix B- Scenarios and Results

In order to investigate the behaviour of the system in different hydraulic conditions several scenarios were tested. In each scenario, the different processes that take place in the river system are described. For each process, the necessary changes in the boundary conditions and physical characteristics of the system are made in order to simulate the effect of these processes in the river system as realistically as possible.

B.1 Scenario 1- The waterdepth in Tigris and Euphrates before the development of the irrigation system with minimum flow

In this scenario the flow of Tigris and Euphrates is investigated before the construction of an irrigation system in ancient Mesopotamia. The results of this scenario are used to evaluate if the behaviour of the river system is adequately represented by the model. For this simulation:

- The minimum monthly flows of the decade 1958-1968 were used. The same flow is repeated for 11 consecutive years.
- The are no irrigation nodes-no lateral flows
- The branches of both Tigris and Euphrates are open

In Figure B.1.1 the water depth in Euphrates is shown:

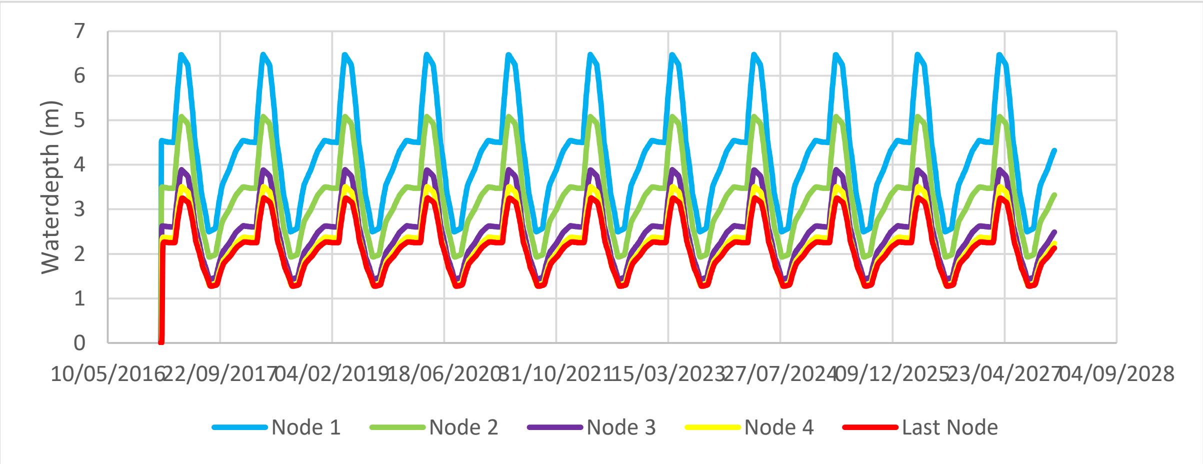

Figure B. 1.1 Water depth in Euphrates when there are no nodes and with minimum flow

In Figure B.1.2 the water depth in Euphrates branches is shown:

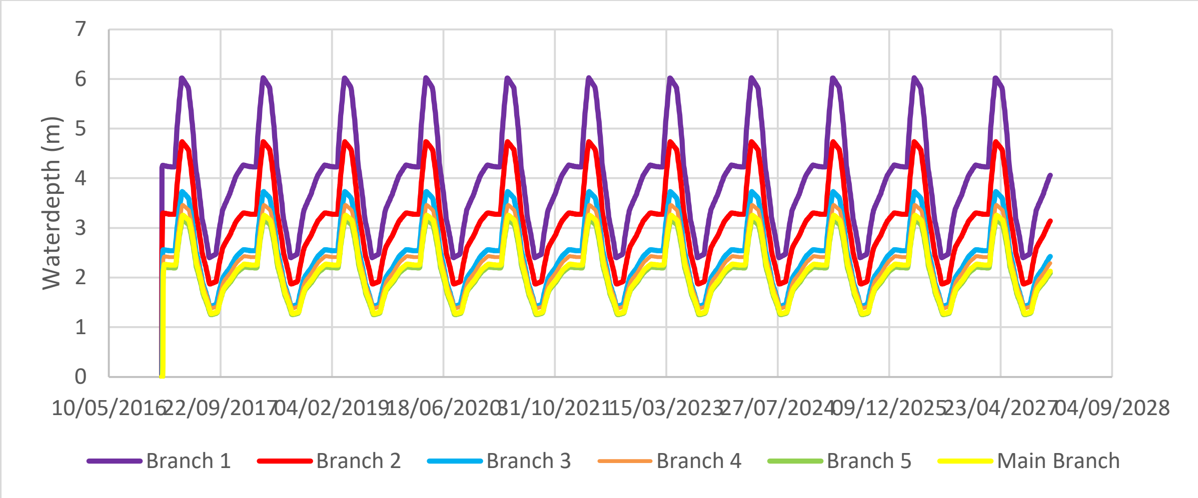

Figure B. 1.2 Water depth in Euphrates branches when there are no nodes and with minimum flow

In Figure B.1.3 the water depth in Tigris is shown:

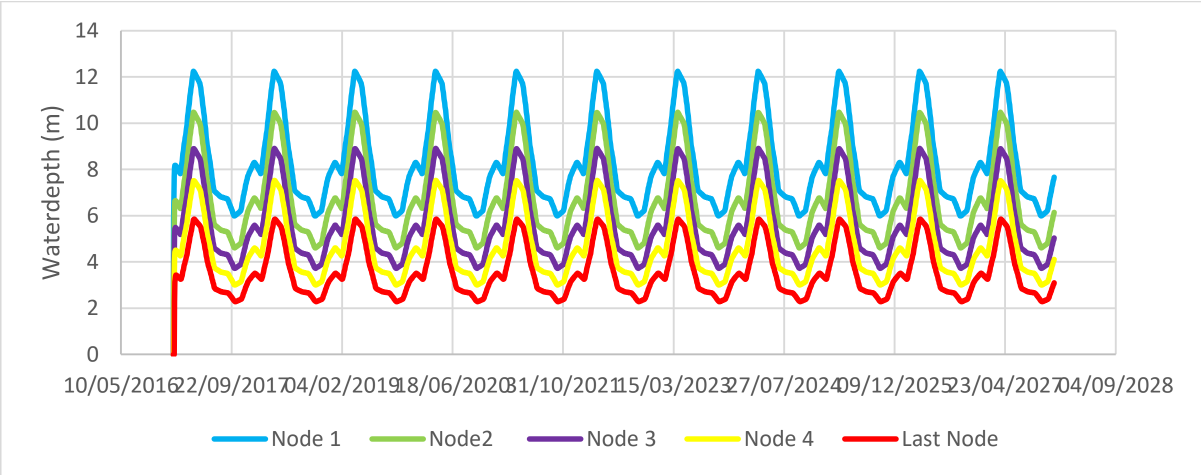

Figure B. 1.3 Water depth in Tigris when there are no nodes and with minimum flow

In Figure B.1.4 the water depth in Tigris branches is shown:

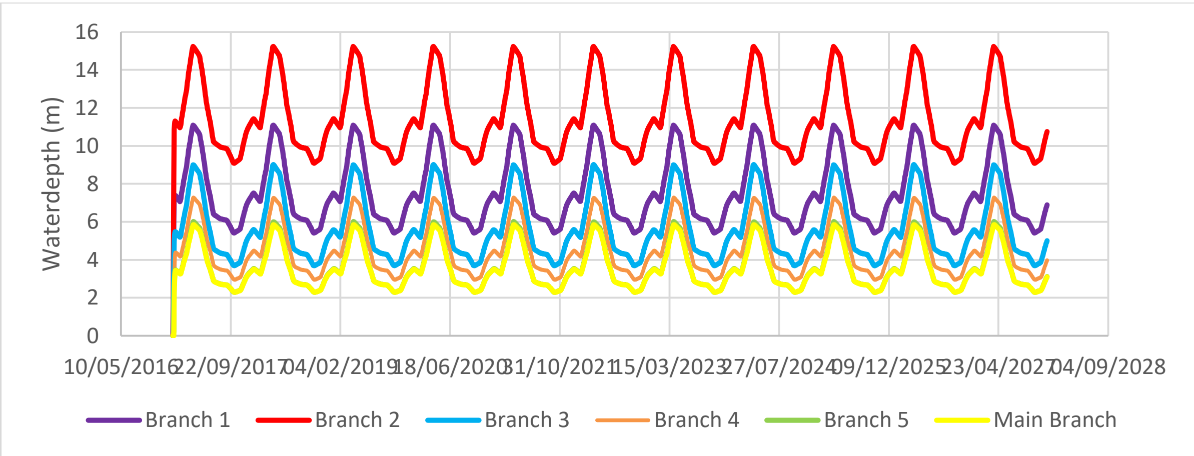

Figure B. 1.4 Water depth in Tigris branches when there are no nodes and with minimum flow

B.2 Scenario 2-The waterdepth in Tigris and Euphrates after the development of the irrigation system with average flow

In this scenario the flow of Tigris and Euphrates is investigated after the construction of the irrigation system in ancient Mesopotamia. It is considered that all the irrigation nodes are open in this scenario. The results of this scenario are compared with the results of other scenarios to define the effect of the irrigation demand on the river system.

For this simulation:

- The average monthly flows of the decade 1958-1968 were used. The same flow is repeated for 11 consecutive years.
- All irrigation nodes are open
- The branches of both Tigris and Euphrates are open

In Figure B.2.1 the water depth in Euphrates is shown:

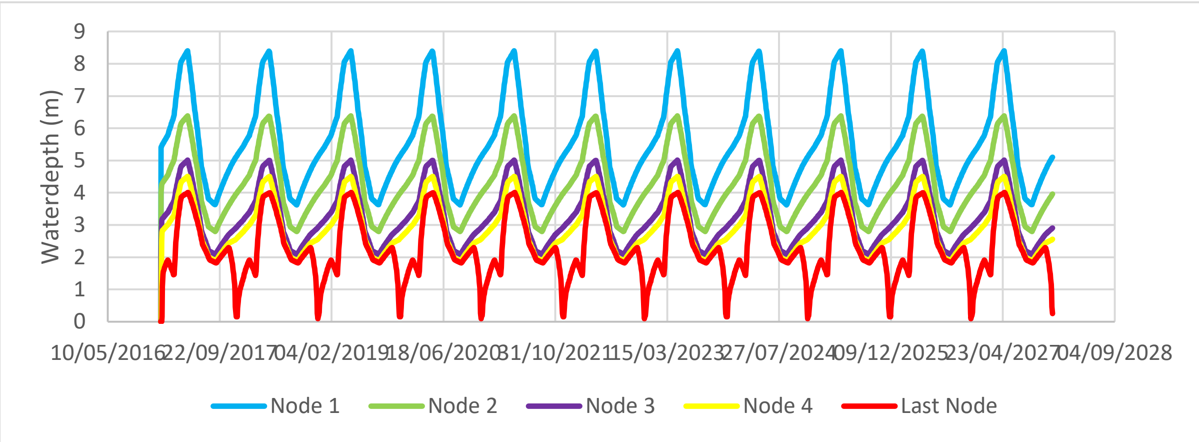

Figure B. 2.1 Water depth in Tigris branches when there are no nodes and with minimum flow

In Figure B.2.2. the water depth in Tigris is shown:

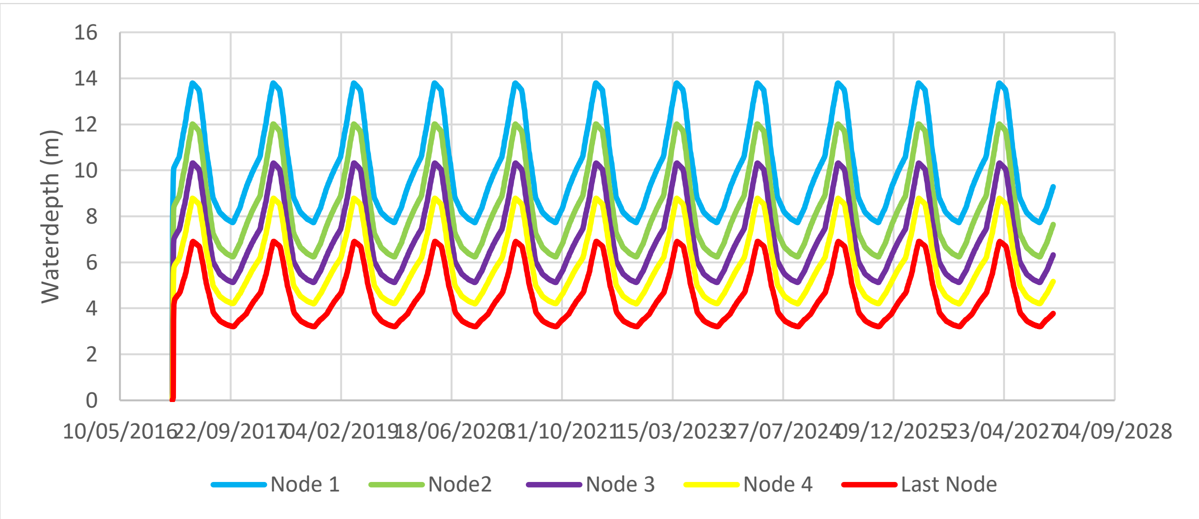

Figure B. 2.2 Water depth in Tigris when all nodes are open and with average flow

B.3 Scenario 3-The waterdepth in Tigris and Euphrates after the development of the irrigation system with minimum flow

In this scenario the flow of Tigris and Euphrates is investigated after the construction of an irrigation system in ancient Mesopotamia assuming that a series of dry years occur.

For this simulation:

- The minimum monthly flows of the decade 1958-1968 were used. It is assumed that the same flow is repeated for 11 consecutive years.
- All irrigation nodes are open
- The branches of both Tigris and Euphrates are open

In Figure B.3.1 the water depth in Euphrates is shown:

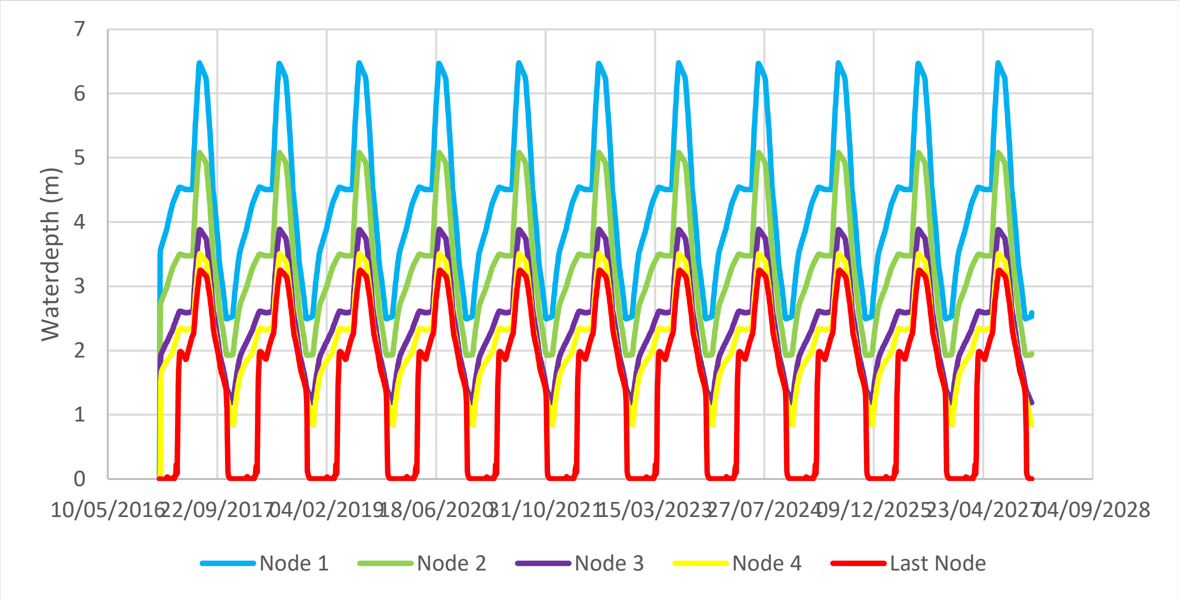

Figure B. 3.1 Water depth in Euphrates when all nodes are open and with minimum flow

In Figure B.3.2 the water depth in Euphrates branches is shown:

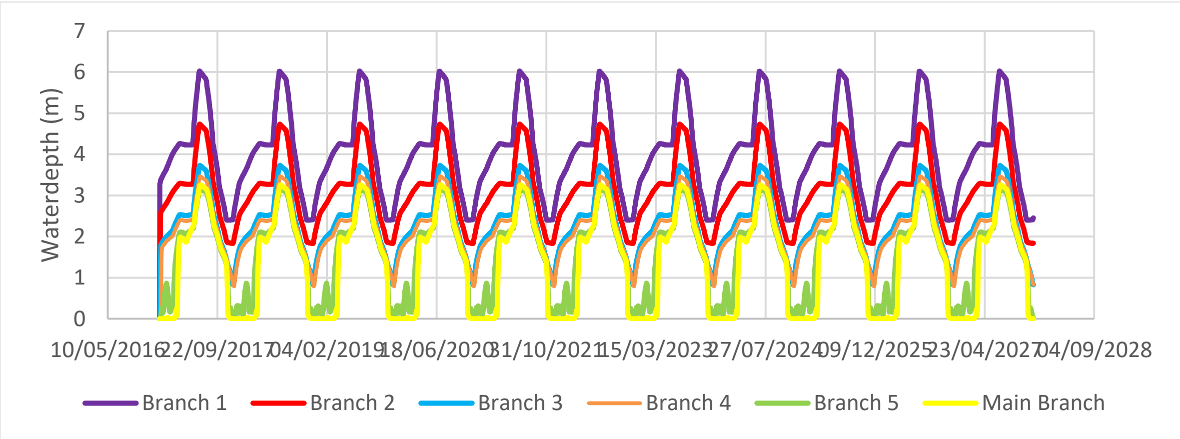

Figure B. 3.2 Water depth in Euphrates branches when all nodes are open and with minimum flow

In Figure B.3.3 and B.3.4 the water depth in Tigris and Tigris branches is shown.

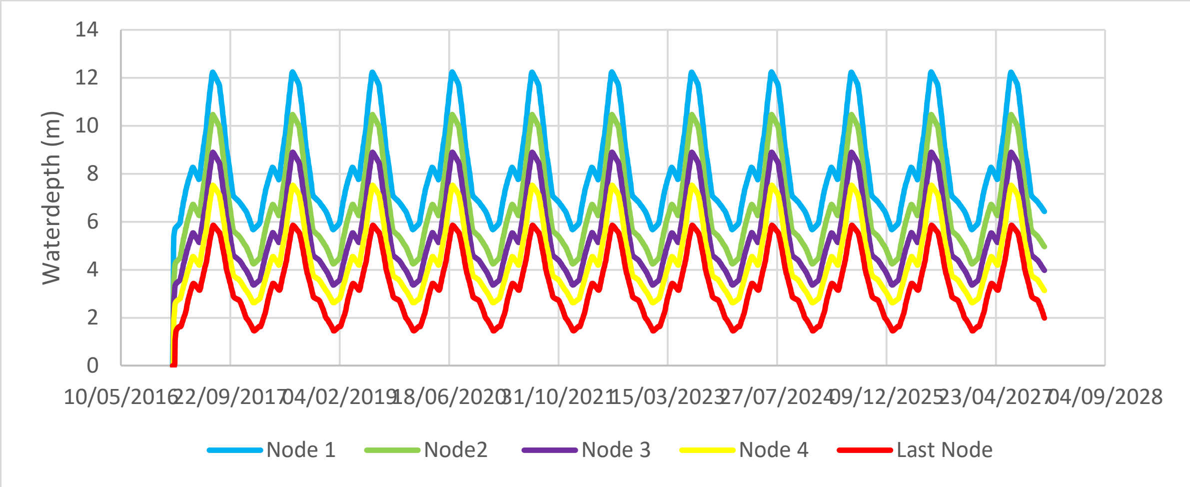

Figure B. 3.3 Water depth in Tigris when all nodes are open and with minimum flow

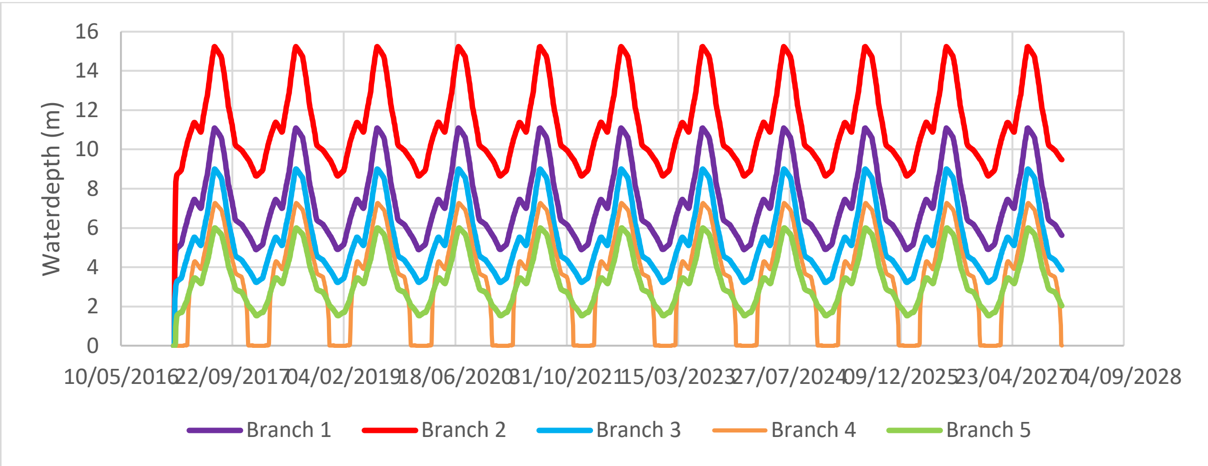

Figure B. 3.4 Water depth in Euphrates branches when all nodes are open and with minimum flow

B.4 Scenario 4- The waterdepth in Tigris and Euphrates when the boundary node of Branch 1 is closed

In this scenario the flow of Tigris and Euphrates is investigated after the construction of an irrigation system in ancient Mesopotamia. Aim of this scenario is to determine the effect on the waterdepth of the river when changing the boundary condition in the end of branch 1.

For this simulation:

- The minimum monthly flows of the decade 1958-1968 were used. The same flow is repeated for 11 consecutive years.
- All irrigation nodes are open
- The boundary node of Branch 1 is closed

In Figures B.4.1-B4.4. the water depth in Euphrates and Tigris and their branches is shown:

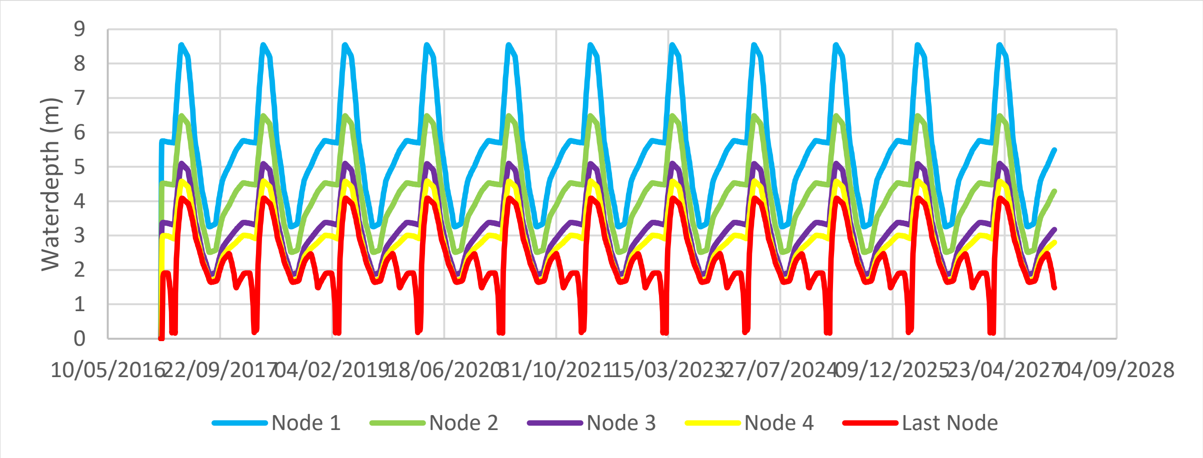

Figure B. 4.1 Water depth in Euphrates when all nodes are open and Branch 1 is closed

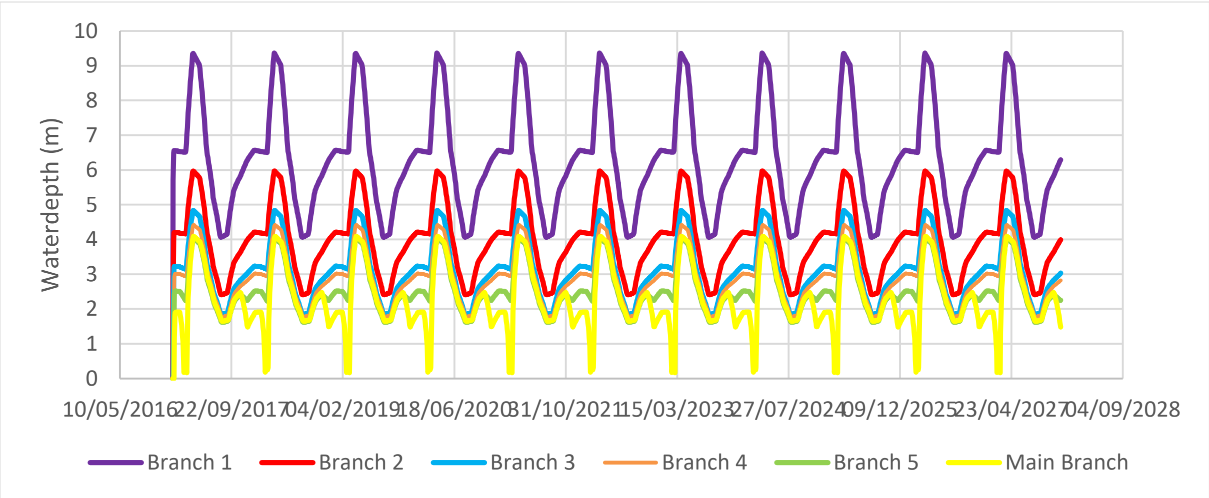

Figure B. 4.2 Water depth in Euphrates branches when all nodes are open and Branch 1 is closed

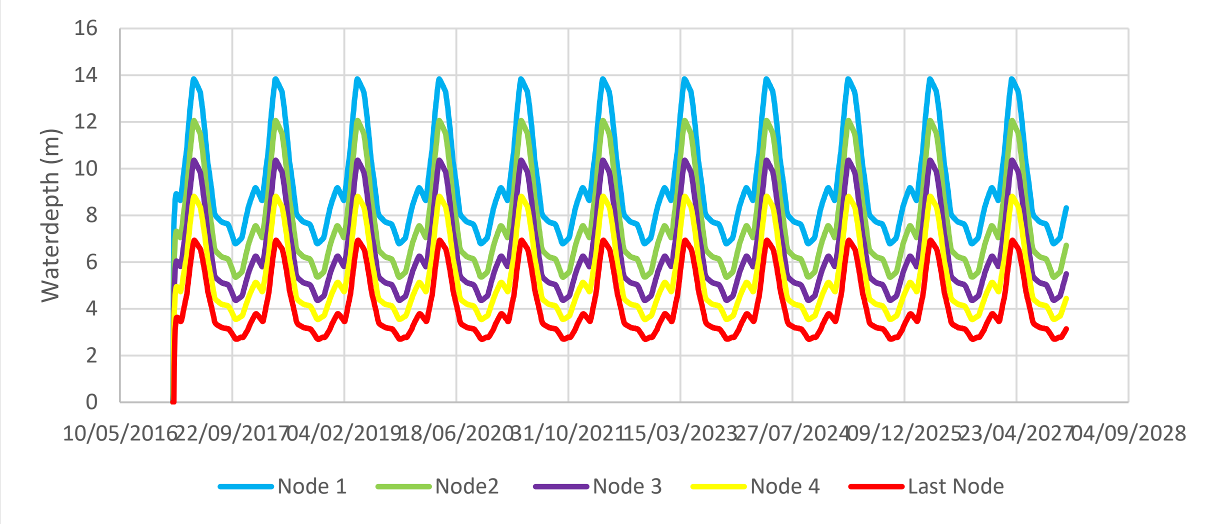

Figure B. 4.3 Water depth in Tigris when all nodes are open and Branch 1 is closed

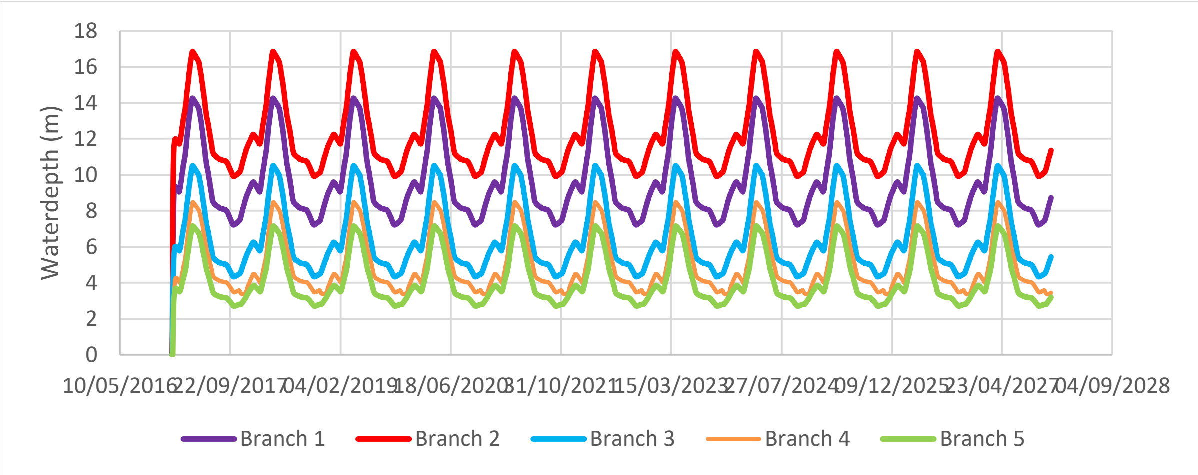

Figure B. 4.4 Water depth in Tigris branches when all nodes are open and Branch 1 is closed

B.5 Scenario 5- The waterdepth in Tigris and Euphrates when the boundary node of Branch 1 and Branch 2 is closed

In this scenario the flow of Tigris and Euphrates is investigated after the construction of an irrigation system in ancient Mesopotamia. Aim of this scenario is to determine the effect on the waterdepth of the river when changing the boundary condition in the end of branch 1 and branch 2.

For this simulation:

- The minimum monthly flows of the decade 1958-1968 were used. The same flow is repeated for 11 consecutive years.
- All irrigation nodes are open
- The boundary node of Branch 1 and Branch 2 is closed

In Figures B.5.1-B.5.4.the water depth in Euphrates and Tigris and their branches is shown:

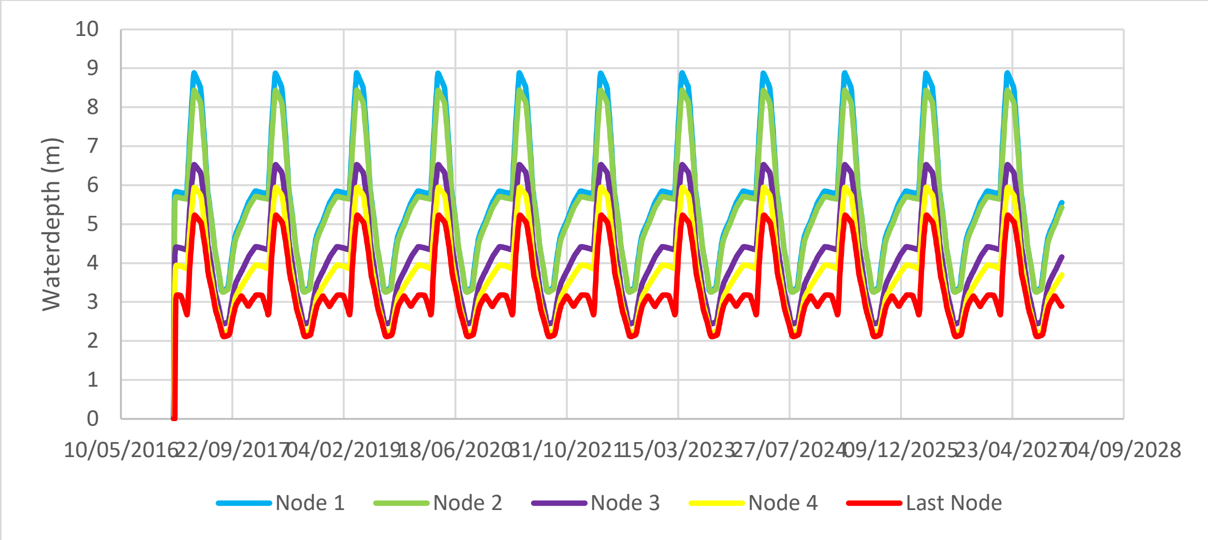

Figure B. 5.1 Water depth in Euphrates when all nodes are open and branch 1 and 2 are closed

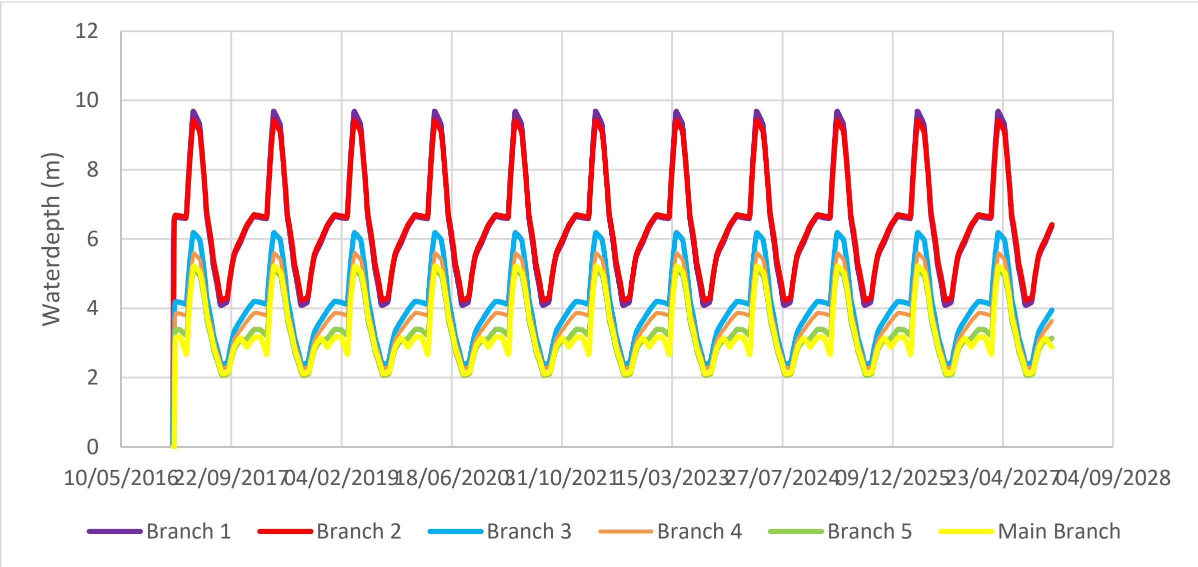

Figure B. 5.2 Water depth in Euphrates branches when all nodes are open and branch 1 and 2 are closed

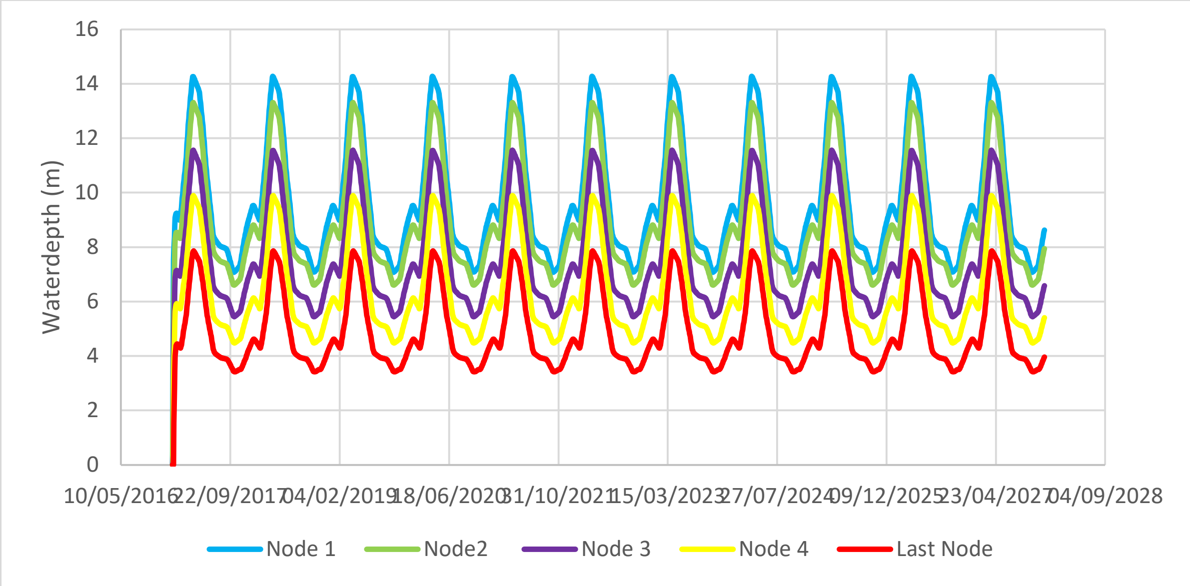

Figure B. 5.3 Water depth in Tigris when all nodes are open and branch 1 and 2 are closed

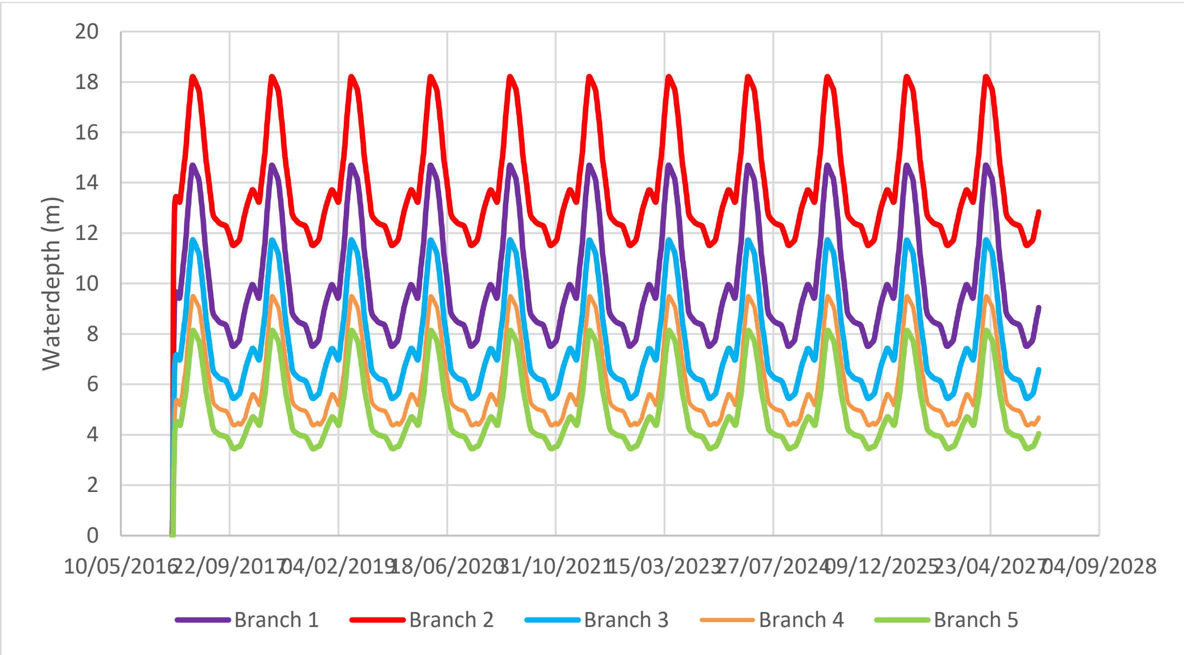

Figure B. 5.4 Water depth in Tigris branches when all nodes are open and branch 1 and 2 are closed

B.6 Scenario 6- The waterdepth in Tigris and Euphrates when the boundary node of Branch 5 is closed

In this scenario the flow of Tigris and Euphrates is investigated after the construction of an irrigation system in ancient Mesopotamia. Aim of this scenario is to determine the effect on the waterdepth of the river when changing the boundary condition in the end of branch 5.

For this simulation:

- The minimum monthly flows of the decade 1958-1968 were used. The same flow is repeated for 11 consecutive years.
- All irrigation nodes are open
- The boundary node of Branch 5 is closed

In Figures B.6.1-B.6.4. the water depth in Euphrates and Tigris and their branches is shown:

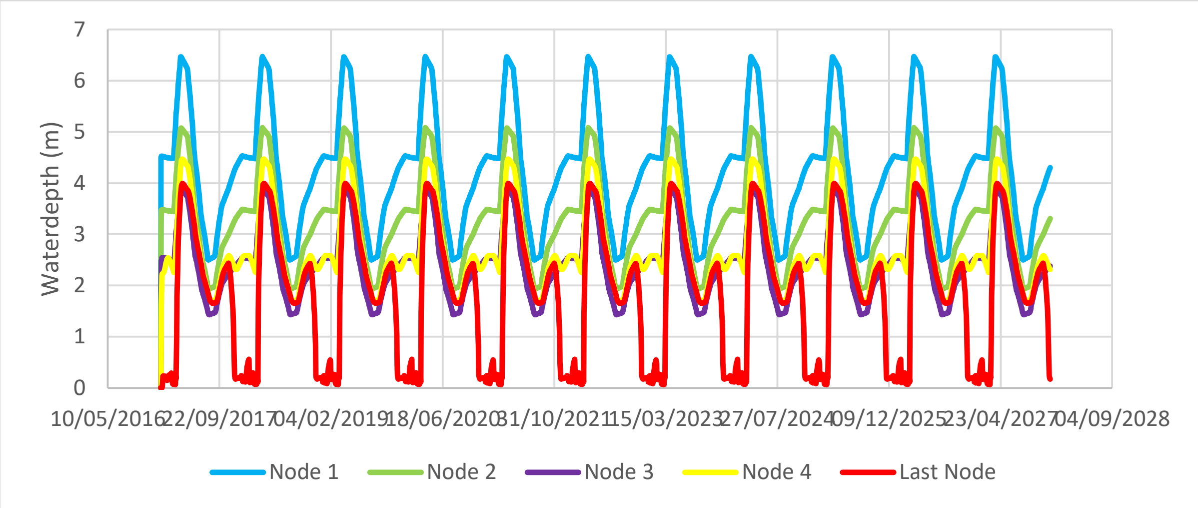

Figure B. 6.1 Water depth in Euphrates when all nodes are open and branch 5 is closed

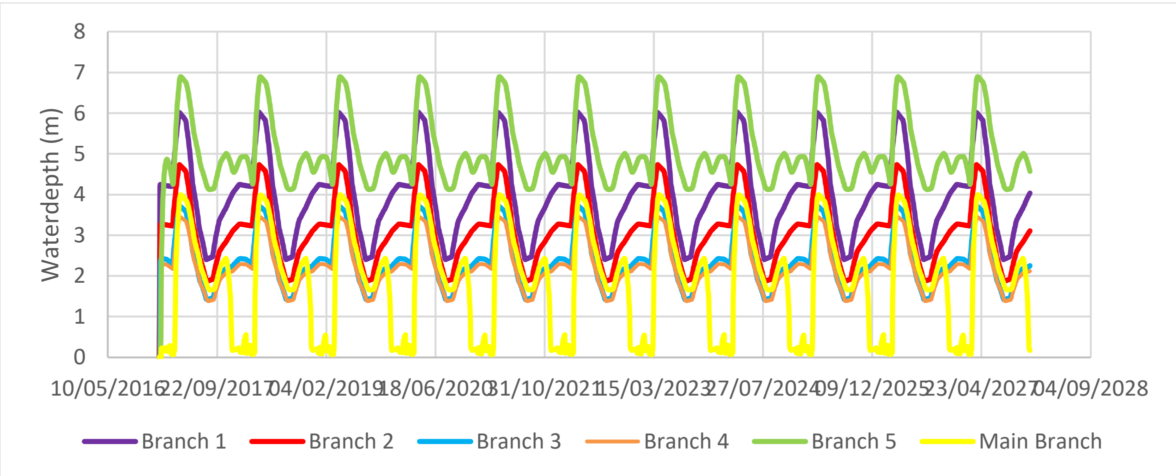

Figure B. 6.2 Water depth in Euphrates branches when all nodes are open and branch5 is closed

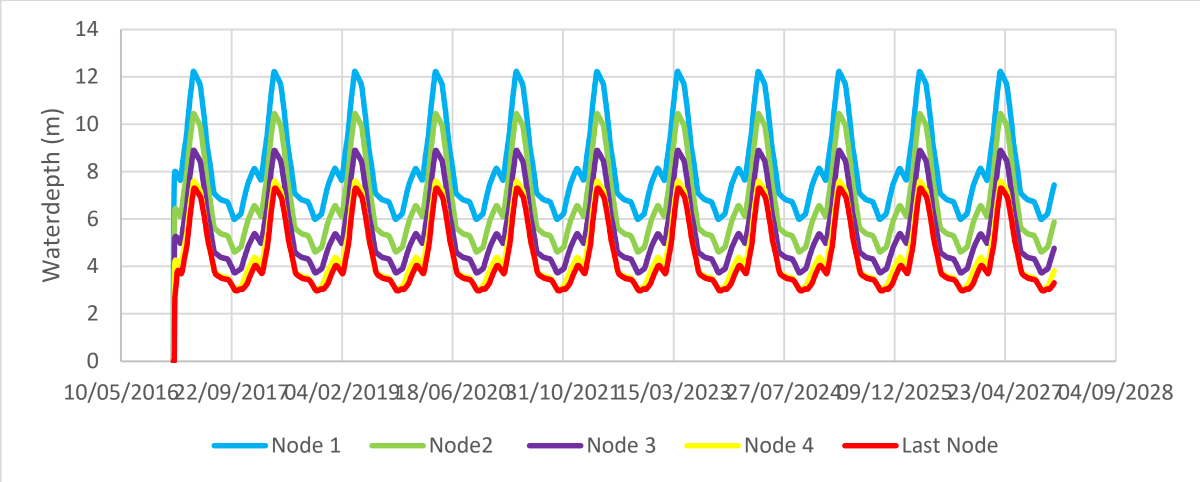

Figure B. 6.3 Water depth in Euphrates when all nodes are open and branch 5 closed

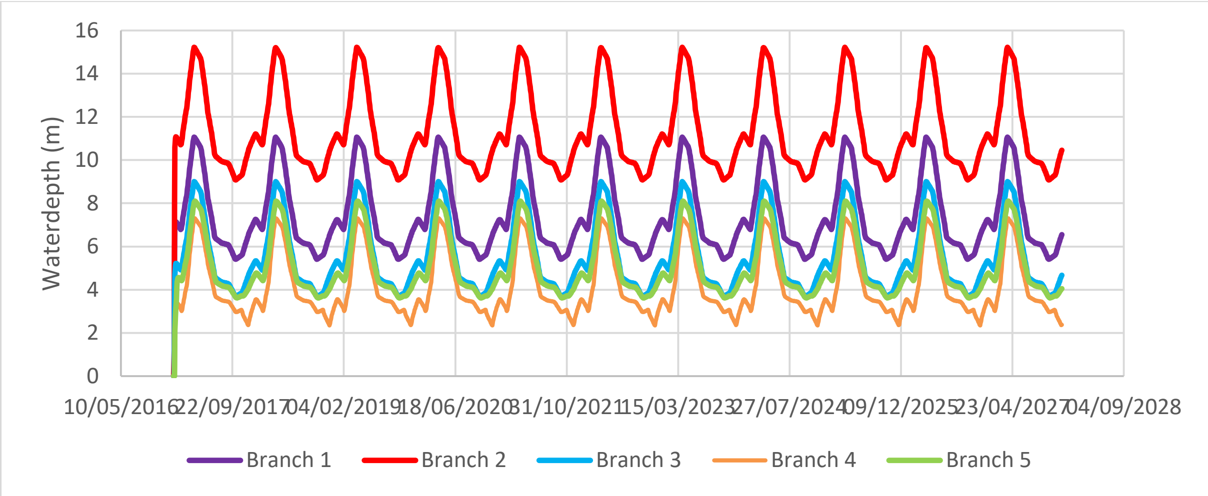

Figure B. 6.4 Water depth in Euphrates when all nodes are open and branch 5 closed

B.7 Scenario 7- The waterdepth in Tigris and Euphrates when the boundary node of Branch 5 and Branch 6 is closed

In this scenario the flow of Tigris and Euphrates is investigated after the construction of an irrigation system in ancient Mesopotamia. Aim of this scenario is to determine the effect on the waterdepth of the river when changing the boundary condition in the end of branch 5 and branch 6.

For this simulation:

- The minimum monthly flows of the decade 1958-1968 were used. The same flow is repeated for 11 consecutive years.
- All irrigation nodes are open
- The boundary node of branch 5 and brand 6 is closed

In Figures B.7.1-B.7.4. the water depth in Euphrates and Tigris and their branches is shown:

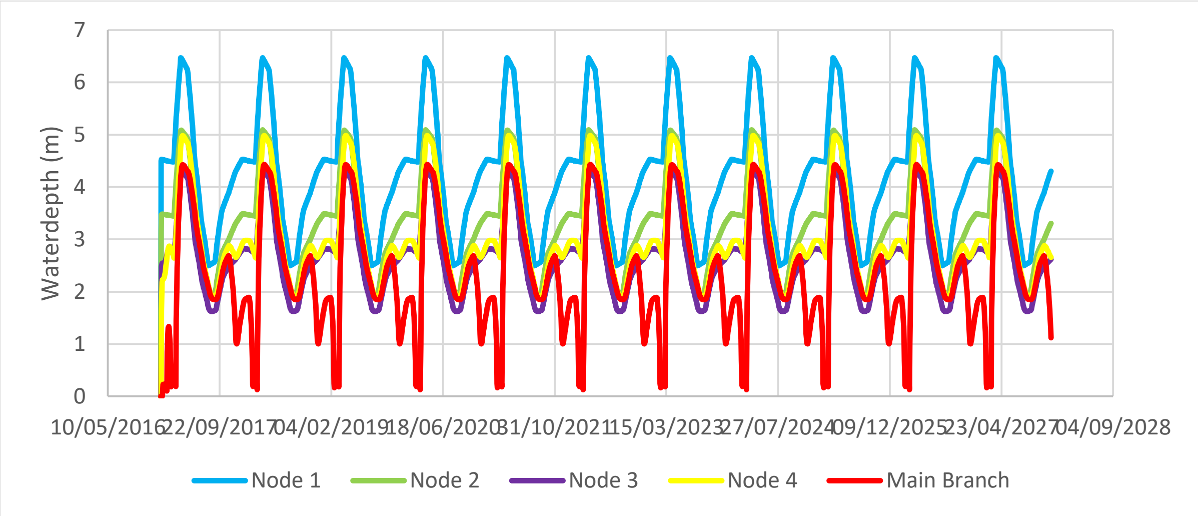

Figure B. 7.1 Water depth in Euphrates when all nodes are open and branch 5 and branch 6 are closed

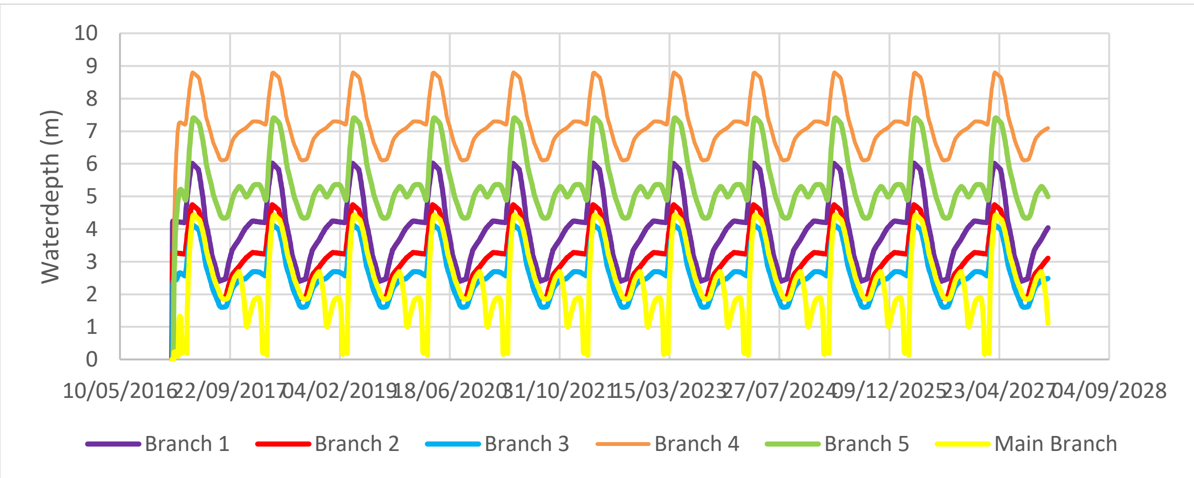

Figure B. 7.2 Water depth in Euphrates branches when all nodes are open and branch 5 and branch 6 are closed

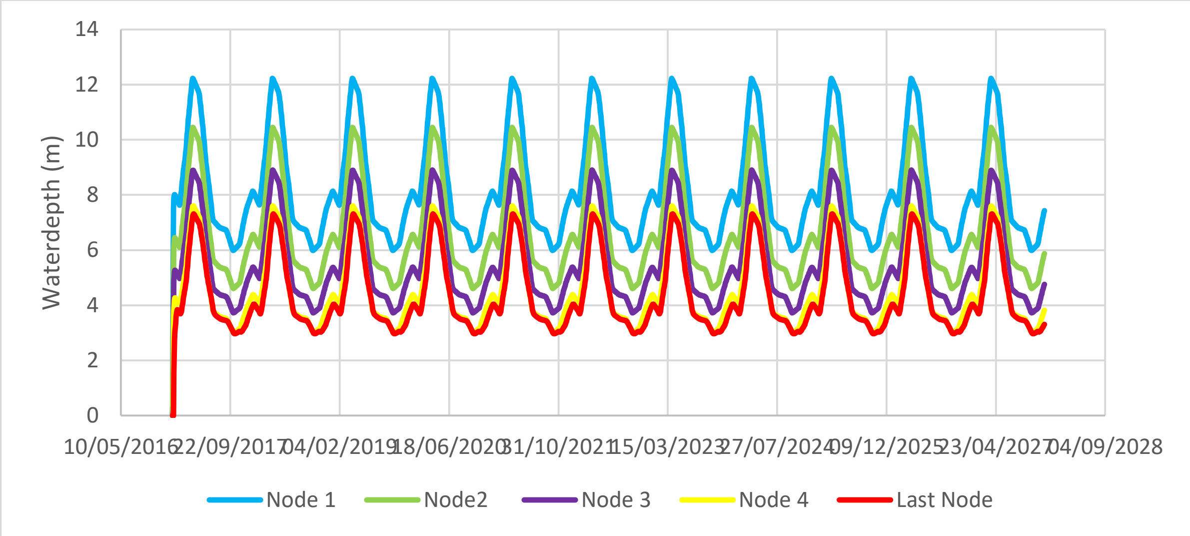

Figure B. 7.3 Water depth in Tigris when all nodes are open and branch 5 and branch 6 are closed

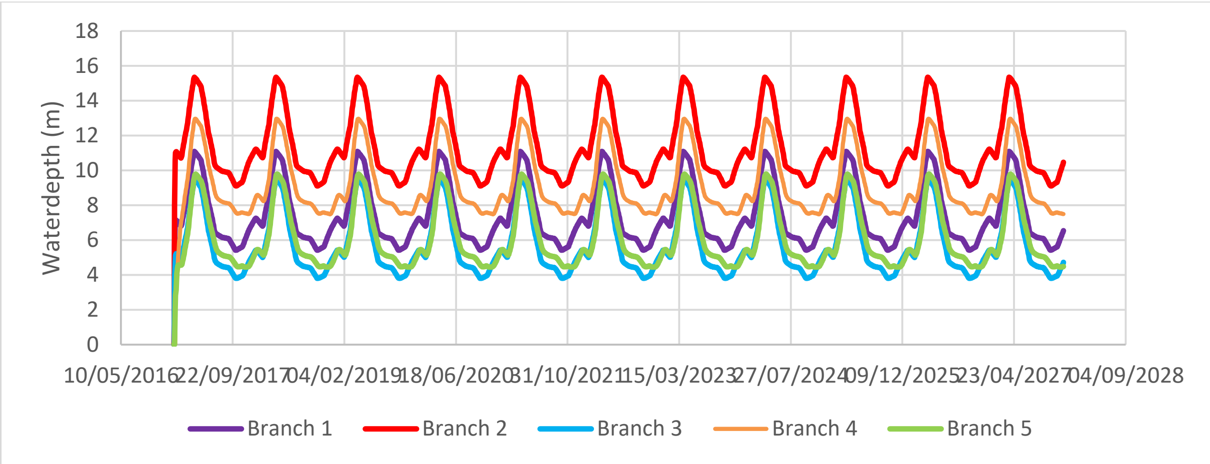

Figure B. 7.4 Water depth in Tigris branches when all nodes are open and branch 5 and branch 6 are closed

B.8 Scenario 8- The waterdepth in Euphrates after the development of the irrigation system

In this scenario the flow measurements of Euphrates during the decade 1958-1968 are used. The results of this simulation are going to be compared with the results of the following scenarios to determine the effect on the waterdepth of the river of the development of settlements and the growth of irrigation need in the Mesopotamian valley.

For this simulation:

- The discharge measurements from 1958 till 1968 are used.
- All Nodes are open.
- All branches are open

In Figure B.8.1 the waterdepth in Euphrates when no nodes are open:

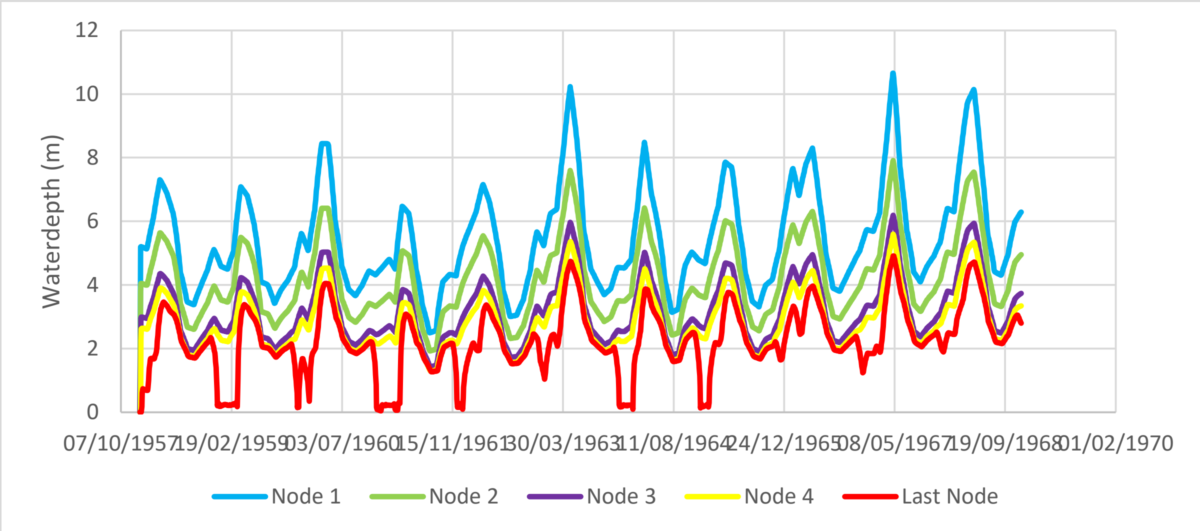

Figure B. 8.1 Water depth in Euphrates when all nodes are open

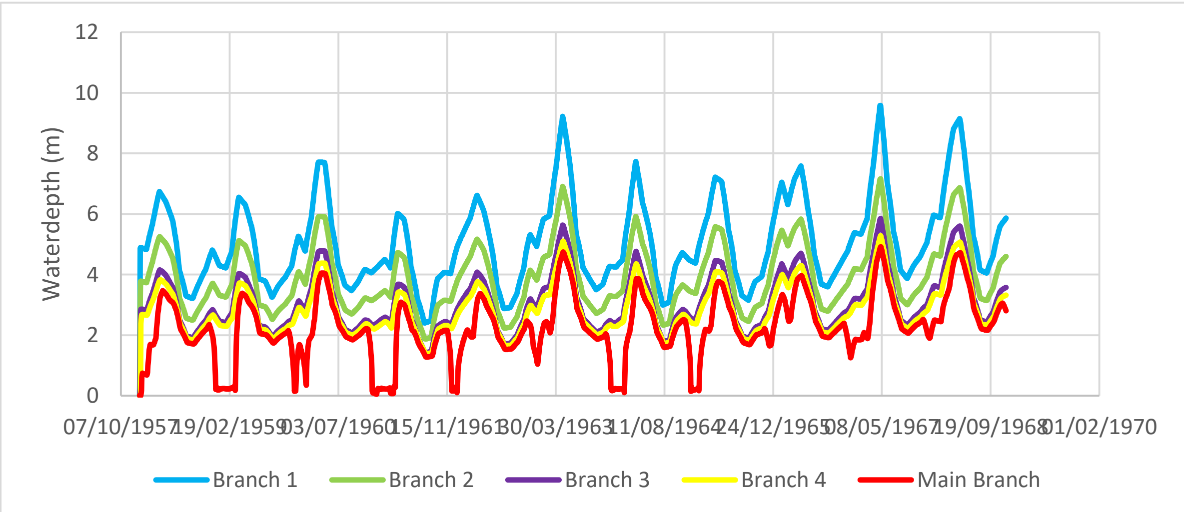

Figure B. 8.2 Water depth in Euphrates branches when all nodes are open

B.9 Scenario 9- The vulnerability of the lower part of Euphrates to a gradual development of the irrigation system

In this scenario the vulnerability of Euphrates to the development of settlements in the lower part of the Mesopotamian valley is tested. Aim of the simulation is to determine at which stage of the development of the irrigation system, the problem of low water depth in Euphrates appeared.

For this simulation:

- The discharge measurements from 1958 till 1968 are used.
- Only The last 3 irrigation nodes are open
- All branches are open

In Figures B.9.1-B.9.2.the water depth in Euphrates when only the last 3 irrigation nodes of the system are open is shown:

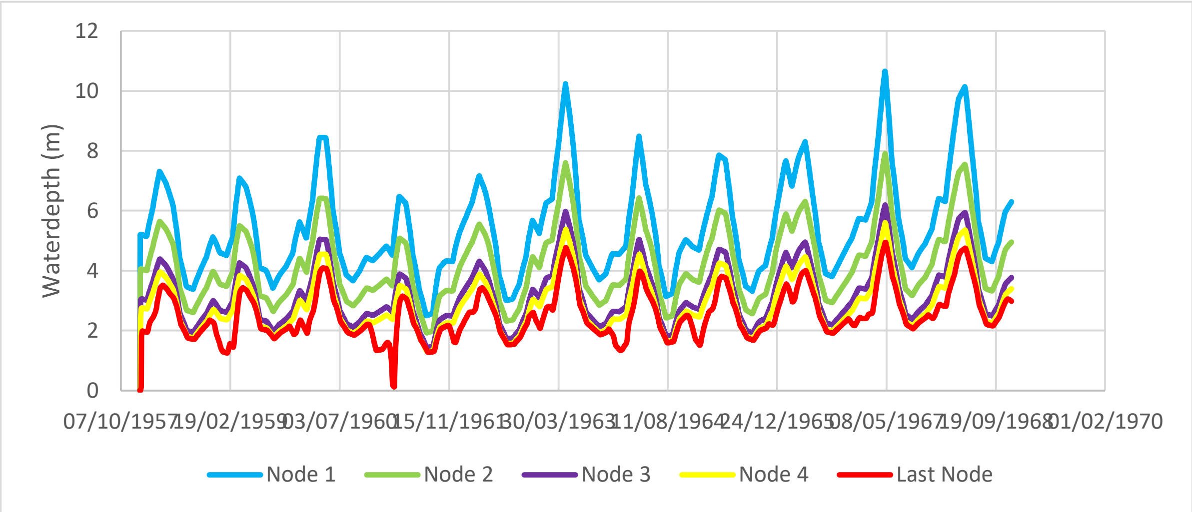

Figure B. 9.1 Water depth in Euphrates when the last 3 irrigation Nodes are open

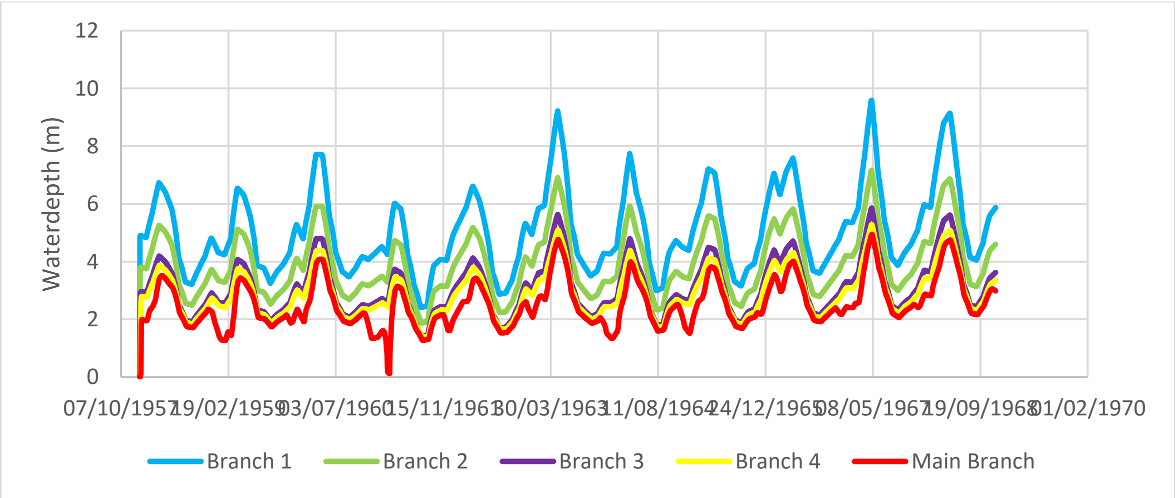

Figure B. 9.2 Water depth in Euphrates branches when the last 3 irrigation Nodes are open

In Figures B.9.3.-B.9.4. the water depth in Euphrates when only the last 2 irrigation nodes of the system are open is shown:

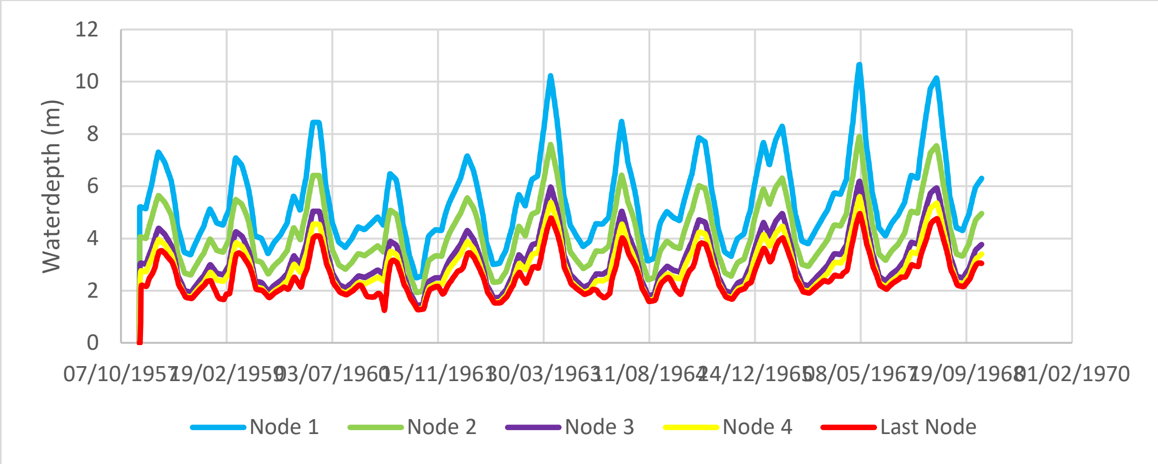

Figure B. 9.3 Water depth in Euphrates when the last 2 irrigation Nodes are open

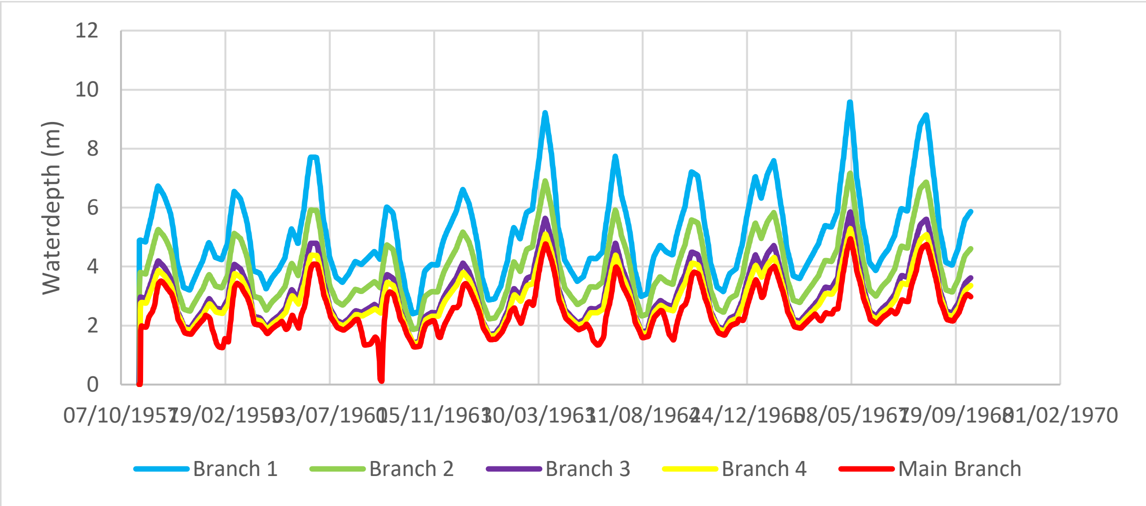

Figure B. 9.4 Water depth in Euphrates branches when the last 2 irrigation nodes are open

B.10 Scenario 10- The vulnerability of the upper part of Euphrates to a gradual development of the irrigation system

In this scenario the vulnerability of Euphrates to the development of settlements in the upper part of the Mesopotamian valley is tested. Aim of the simulation is to determine at which stage of the development of the irrigation system, the problem of low water depth in Euphrates appeared.

For this simulation:

- The discharge measurements from 1958 till 1968 are used.
- Only the last 3 irrigation nodes are open.
- All branches are open.

In Figures B.10.1-B.10.2.the water depth in Euphrates when only the first 16 irrigation nodes of the system are open is shown:

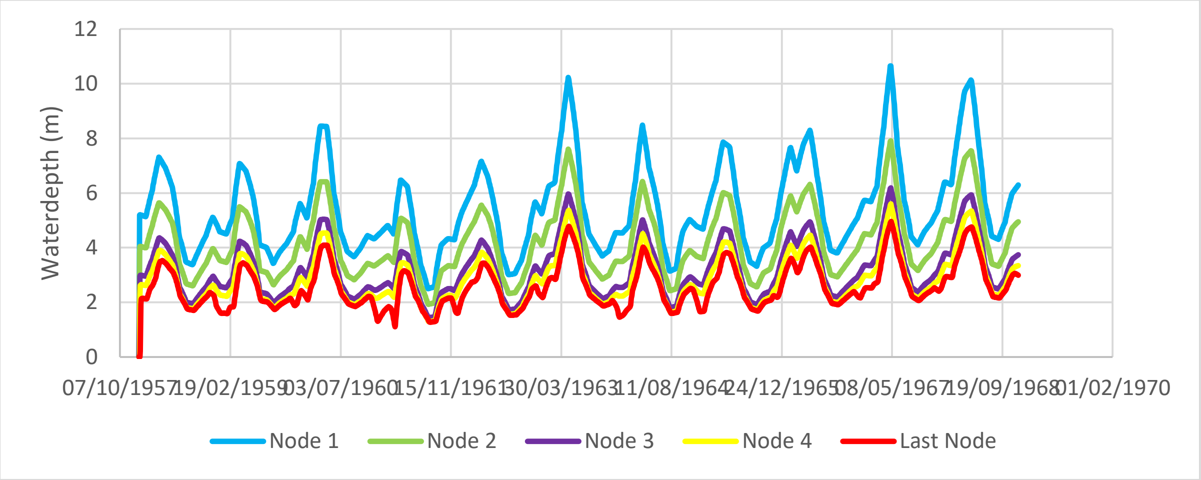

Figure B. 10.1 Water depth in Euphrates when the first 16 irrigation nodes are open

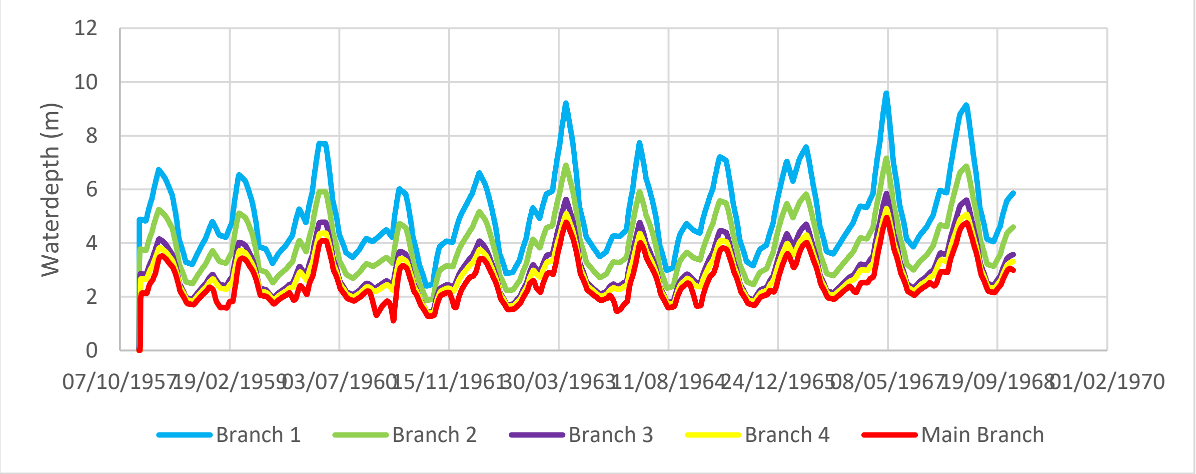

Figure B. 10.2 Water depth in Euphrates branches when the first 16 irrigation nodes are open

B.11 Scenario 11- The waterdepth in Euphrates when the cross-section of branch 1 gradually decreases due to sediment deposition

In this scenario the effect of sediment deposition in Euphrates branches is going to be investigated.

For this simulation:

- The discharge measurements from 1958 till 1968 are used.
- The cross-section of branch 1 is gradually decreased 20%, 80% and finally 100%.

In Figures B.11.1-B.11.4. the water depth in Euphrates is shown as the cross-section of branch 1 decreases.

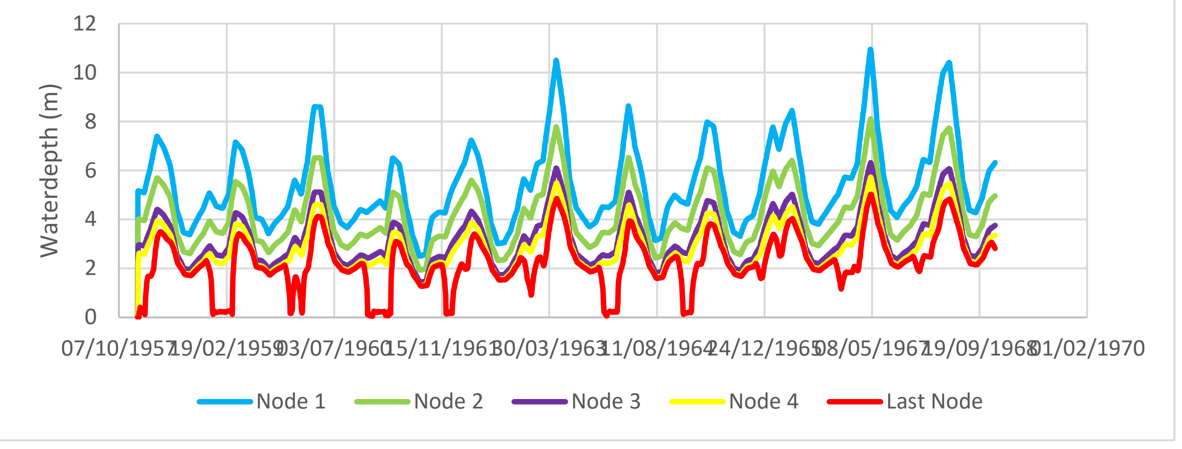

Figure B. 11.1 Water depth in Euphrates when the cross-section of branch 1 decreases 20%

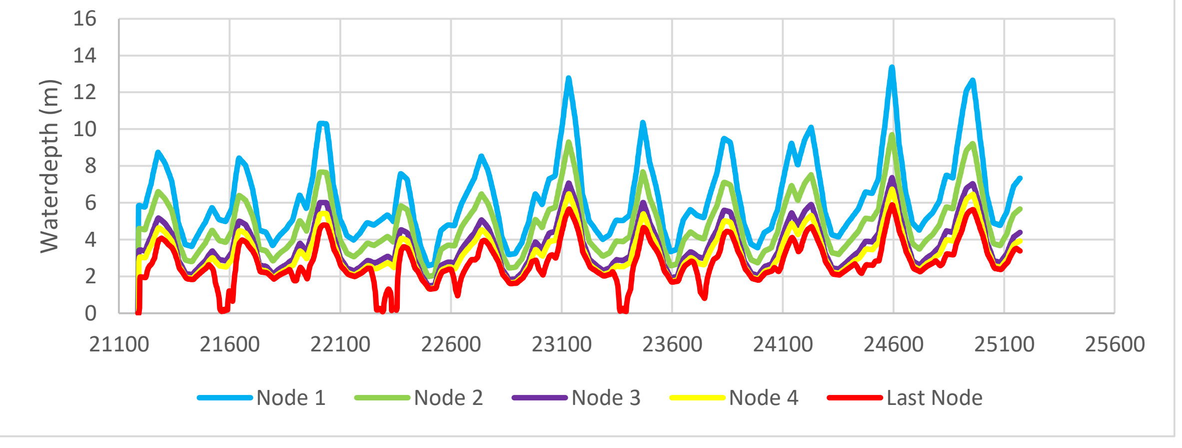

Figure B. 11.2 Waterdepth in Euphrates when the cross-section of branch 1 decreases 80%

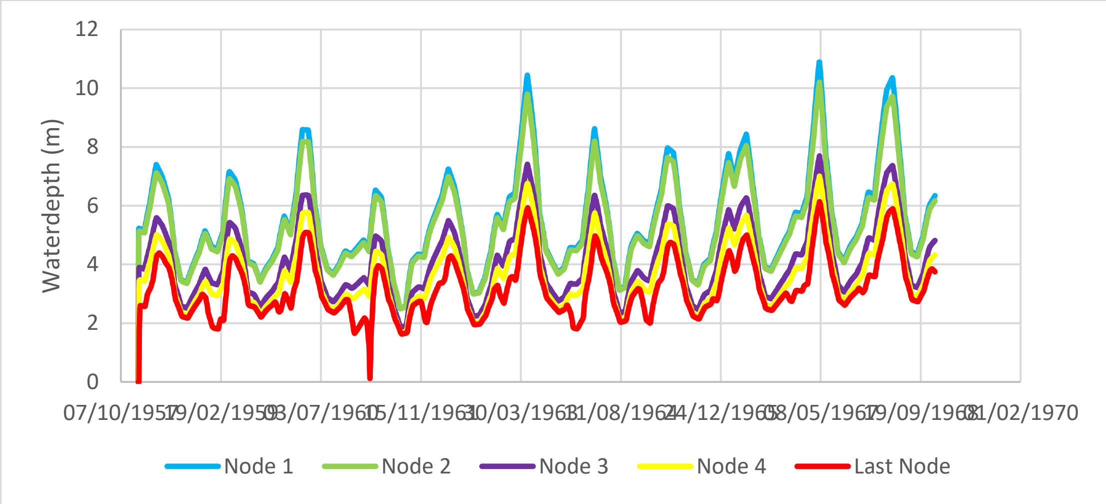

Figure B. 11.3 Water depth in Euphrates when the cross-section of branch 1 is closed

B.12 Scenario 12- The waterdepth in Euphrates when the cross-section of branch 2 gradually decreases due to sediment deposition

In this scenario the effect of sediment deposition in Euphrates branches is going to be investigated.

For this simulation:

- The discharge measurements from 1958 till 1968 are used.
- The cross-section of branch 2 is gradually decreased 20%, 80% and finally 100%.

In Figures B.12.1-B.12.4. the water depth in Euphrates as the cross-section of branch 2 decreases.

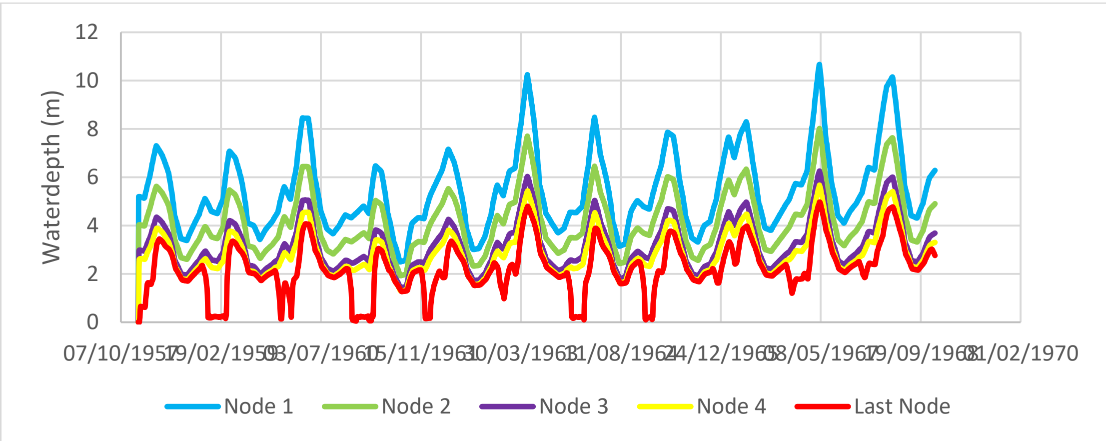

Figure B. 12.1 Water depth in Euphrates when the cross-section of branch 2 decreases 20%

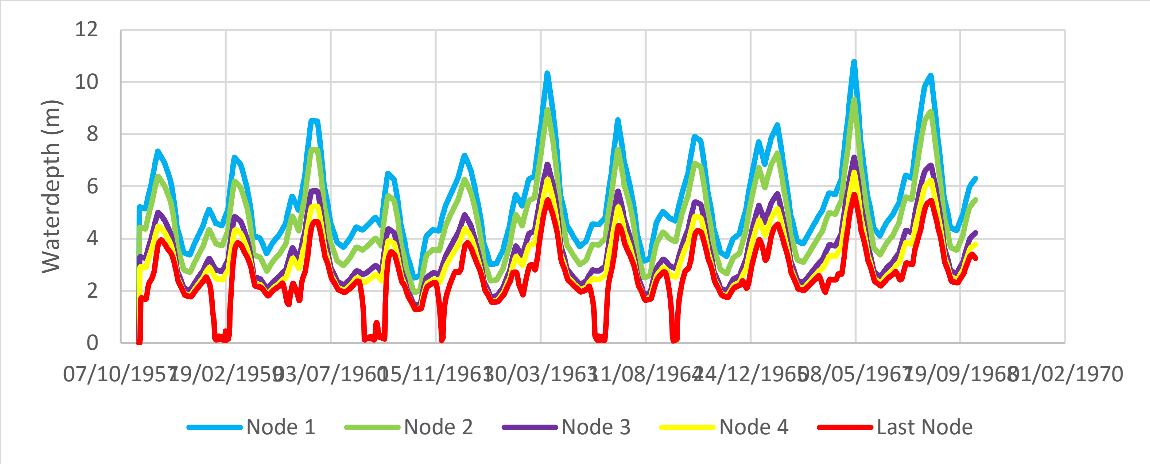

Figure B. 12.2 Discharge of Euphrates when the cross-section of branch 2 decreases 80%

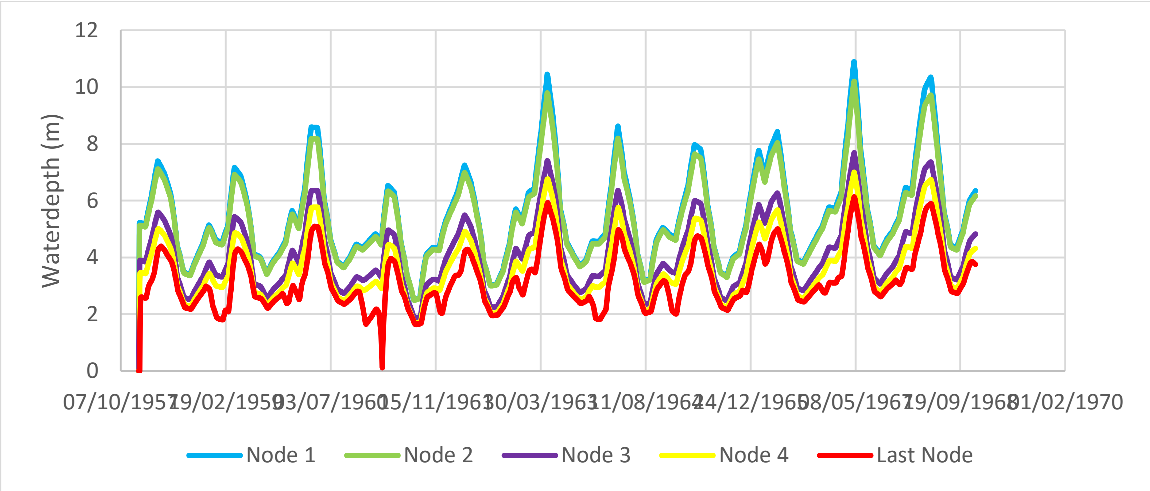

Figure B. 12.3 Water depth in Euphrates when the cross-section of branch 2 is closed

B.13 Scenario 13- The waterdepth in Euphrates when the cross-section of branch 3 gradually decreases due to sediment deposition

In this scenario the effect of sediment deposition in Euphrates branches is going to be investigated.

For this simulation:

- The discharge measurements from 1958 till 1968 are used.
- The cross-section of branch 3 is gradually decreased 20%, 80% and finally 100%.

In Figures B.12.1-B.12.4.the water depth in Euphrates as the cross-section of branch 2 decreases.

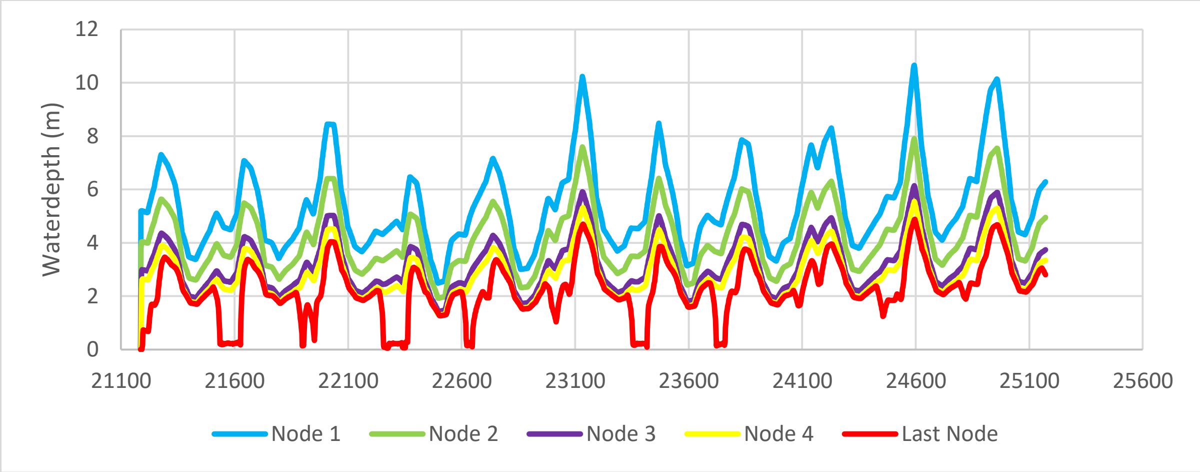

Figure B. 13.1 Water depth in Euphrates when the cross-section of branch 3 decreases 20%

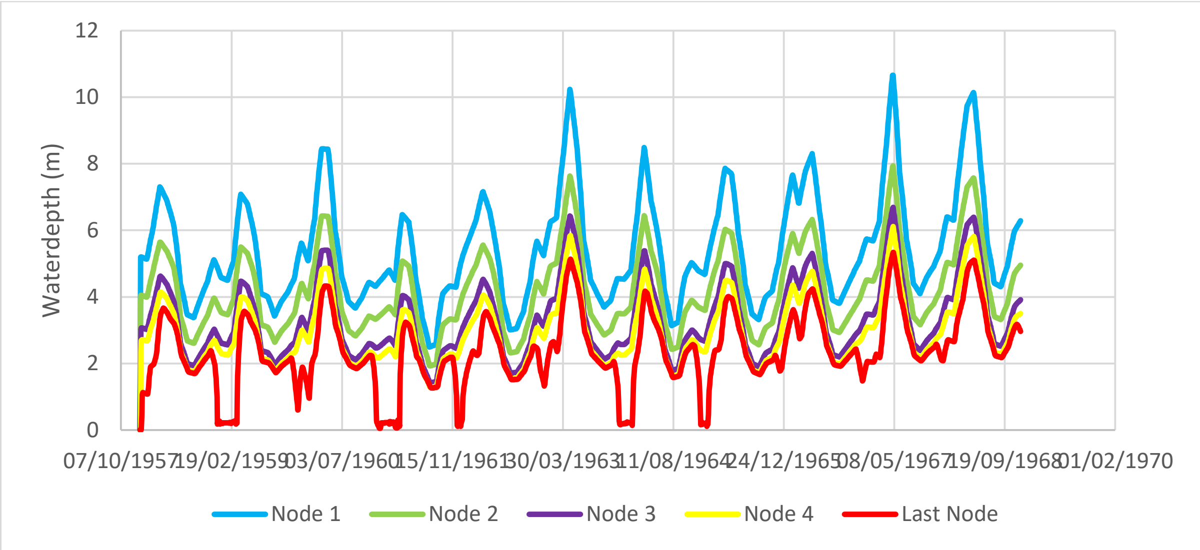

Figure B. 13.2 Waterdepth in Euphrates when the cross-section of branch 3 decreases 80%

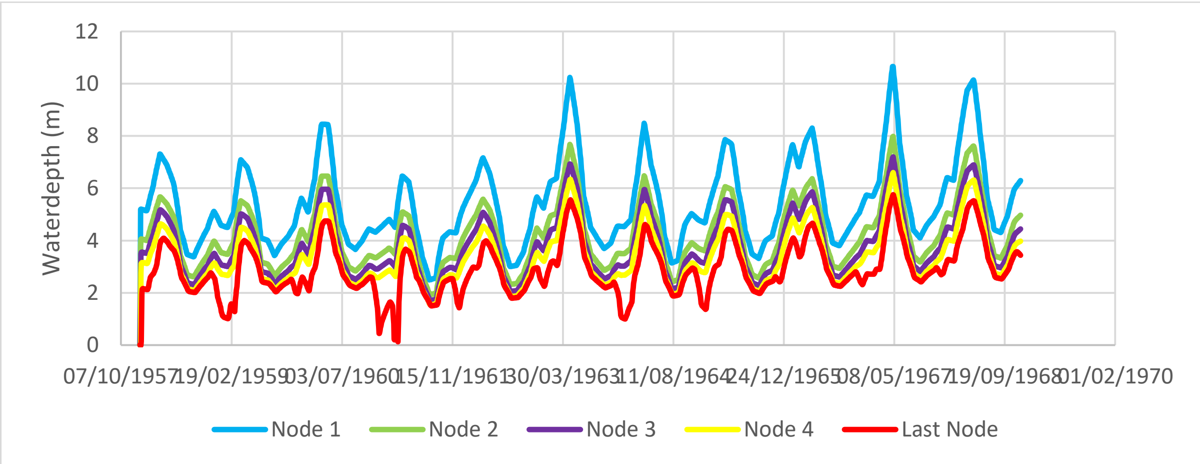

Figure B. 13.3 Water depth in Euphrates when the cross-section of branch 3 is closed

B.14 Scenario 14- The waterdepth in Euphrates when the cross-section of branch 4 gradually decreases due to sediment deposition

In this scenario the effect of sediment deposition in Euphrates branches is going to be investigated

For this simulation:

- The discharge measurements from 1958 till 1968 are used.
- The cross-section of branch 4 is gradually decreased 20%, 80% and finally 100%.

In Figures B.14.1-B.14.4.the water depth in Euphrates as the cross-section of branch 4 decreases.

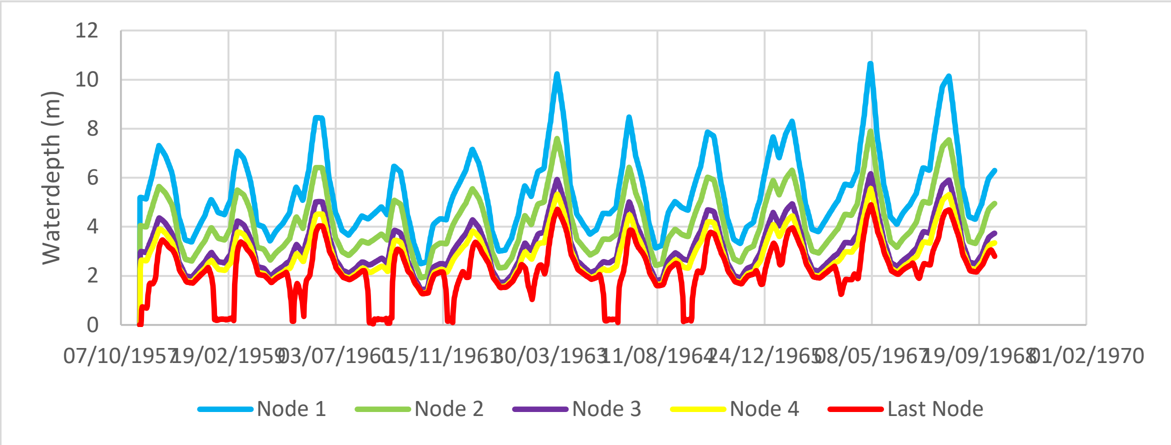

Figure B. 14.1 Water depth in Euphrates when the cross-section of branch 4 decreases 20%

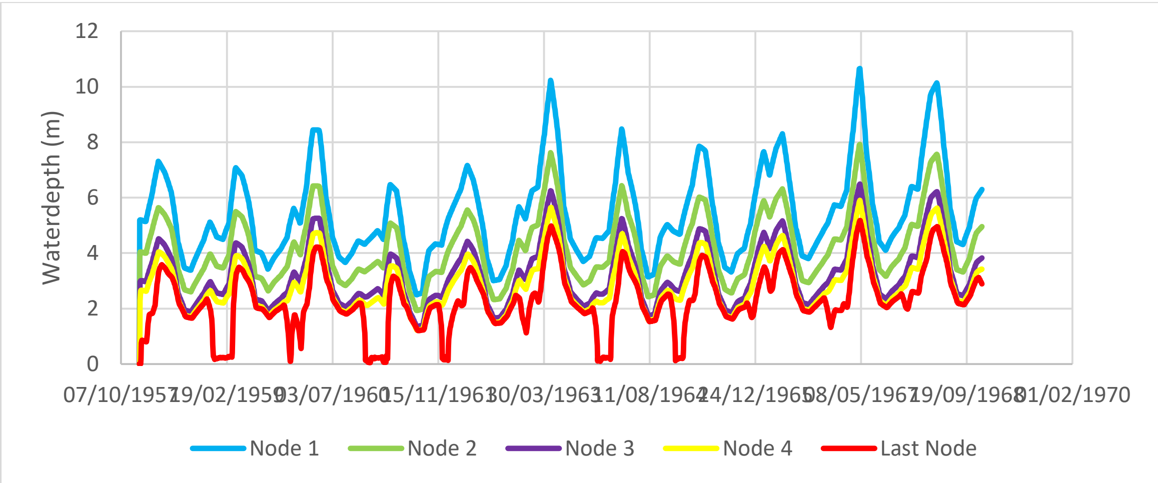

Figure B. 14.2 Waterdepth in Euphrates when the cross-section of branch 4 decreases 80%

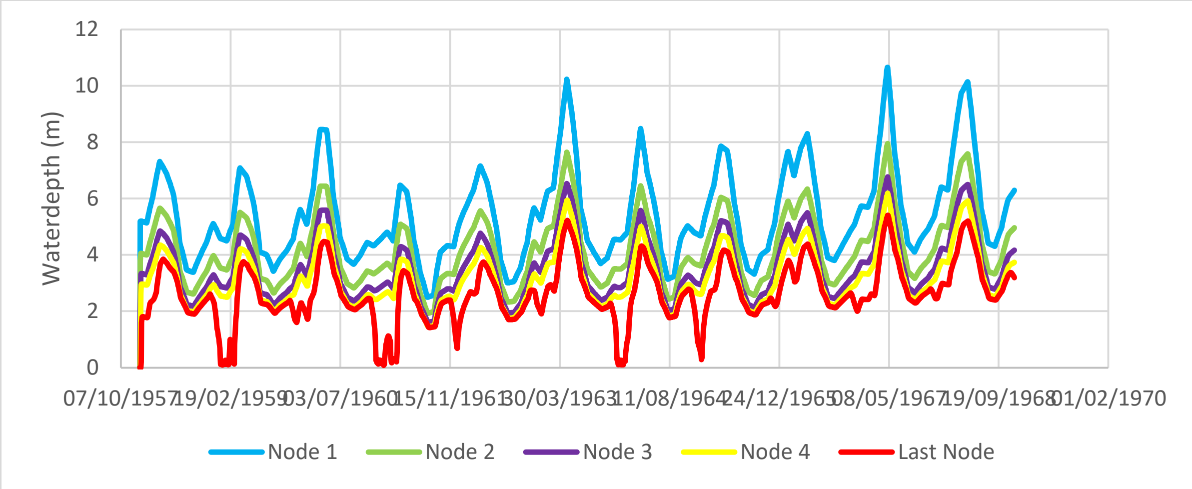

Figure B. 14.3 Water depth in Euphrates when the cross-section of branch 4 is closed

B.15 Scenario 15- The waterdepth in Euphrates when the cross-section of branch 5 gradually decreases due to sediment deposition

In this scenario the effect of sediment deposition in Euphrates branches is going to be investigated

For this simulation:

- The discharge measurements from 1958 till 1968 are used.
- The cross-section of branch 5 is gradually decreased 20%, 80% and finally 100%.

In Figures B.15.1-B.15.4. the water depth in Euphrates as the cross-section of branch 2 decreases.

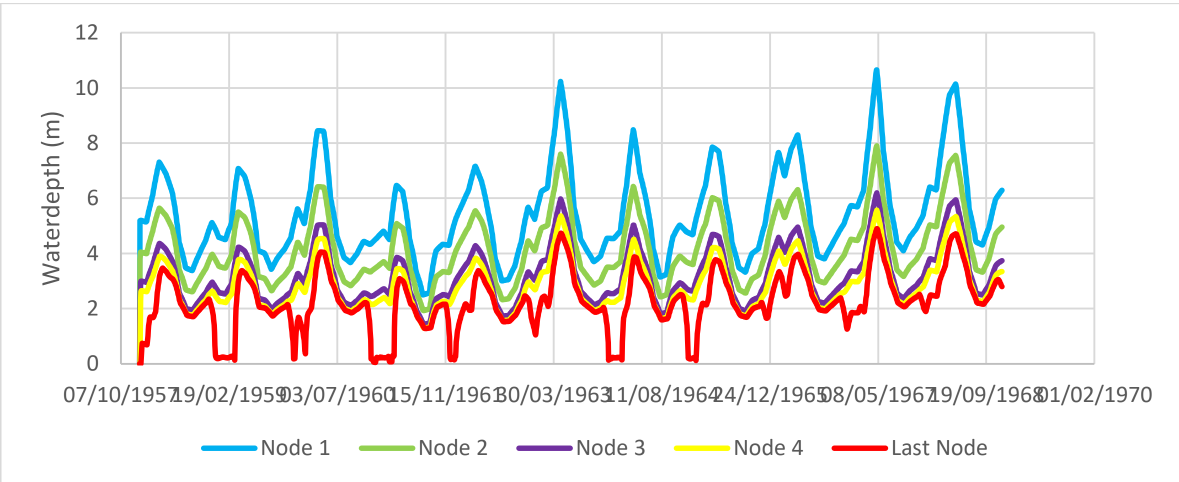

Figure B. 14.4 Water depth in Euphrates when the cross-section of branch 5 decreases 20%

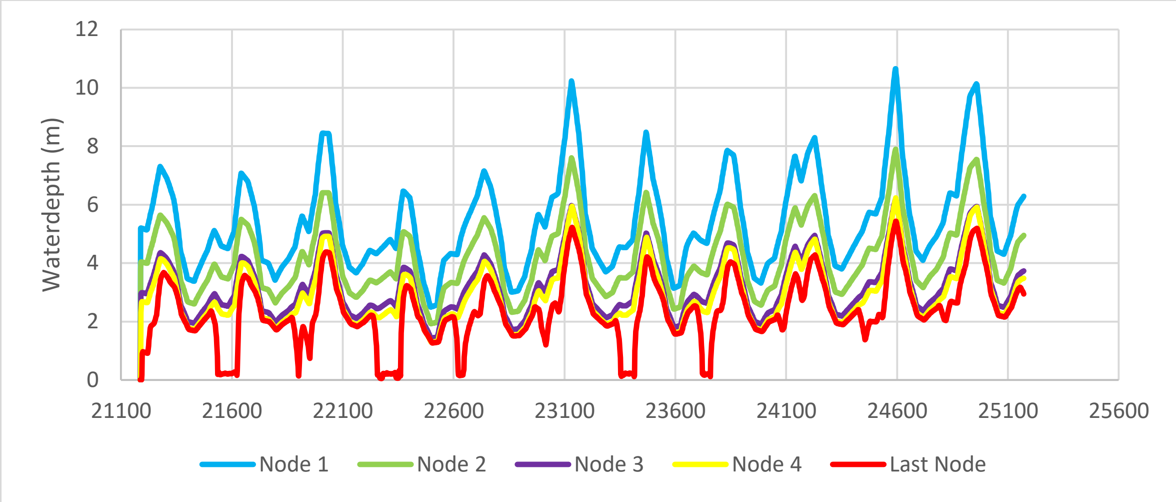

Figure B. 14.5 Waterdepth inEuphrates when the cross-section of branch 5 decreases 80%

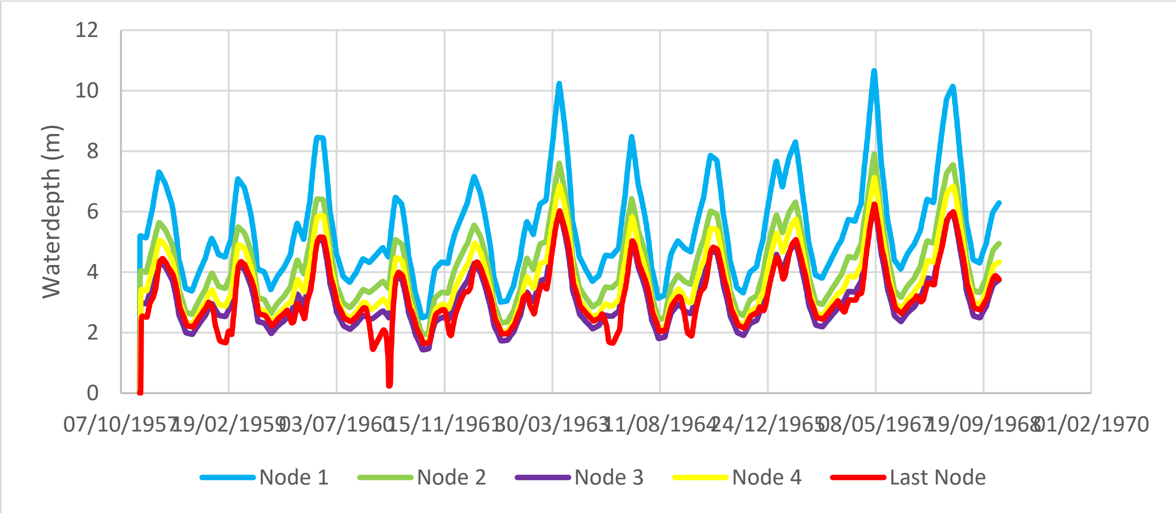

Figure B. 14.6 Water depth in Euphrates when the cross-section of branch 5 is closed

B.16 Scenario 12- The waterdepth in Euphrates assuming that there are no branches

In this scenario, the waterdepth in Euphrates assuming that there are no branches is examined.

For this simulation:

- The discharge measurements from 1958 till 1968 are used.
- There are no branches

In Figure B.16.1 the water depth in Euphrates is shown

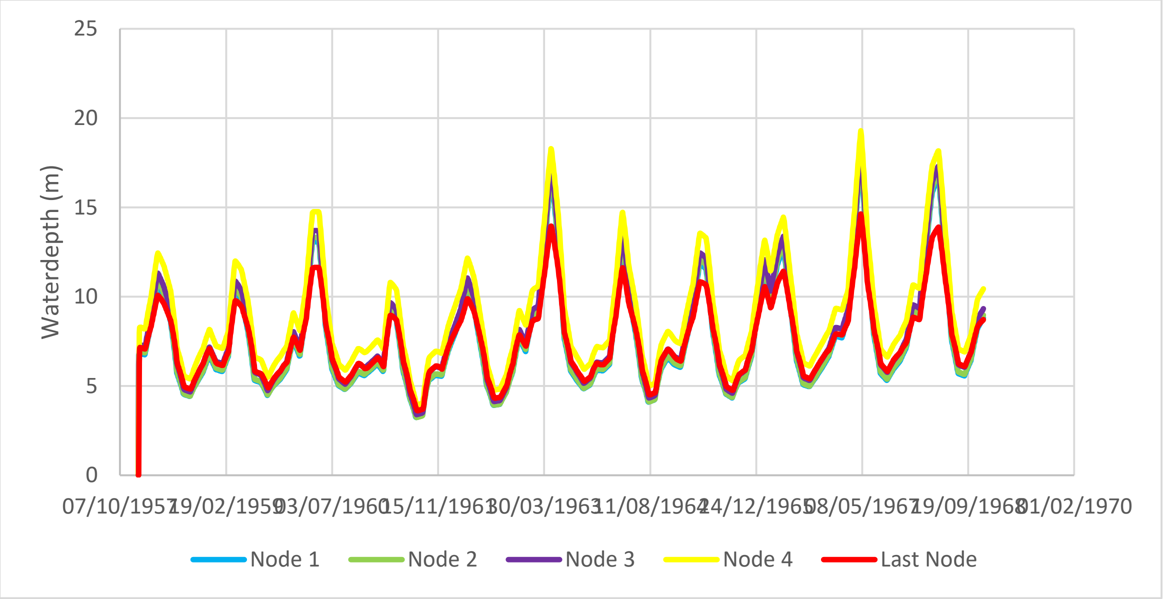

Figure B. 16.1 Water depth in Euphrates when there are no branches