9-9-2024

Comparative Analysis of Muskingum Routing: Traditional vs. AI-Assisted Methods

Vida Atashi
University of North Dakota, vida.atashi@und.edu

Comparative Analysis of Muskingum Routing: Traditional vs. AI-Assisted Methods

Due date(s): November 14th, 2024

Purpose: This assignment aims to deepen your understanding of the Muskingum routing method in hydrology and introduce AI applications in hydrological analysis. You will download real-world discharge data, apply traditional Muskingum routing, and compare it with AI-assisted methods over a 10-day period. The assignment develops key skills in hydrological modeling and data analysis, essential for water resources engineering.

Skills: This assignment will help you practice the following skills:

- Understanding and applying Muskingum routing
- Acquiring and processing real-world hydrological data from USGS
- Conducting traditional Muskingum routing calculations
- Utilizing AI tools for Muskingum routing
- Analyzing and interpreting differences between traditional and AI-assisted methods
- Reporting scientific findings

Knowledge:
You will become familiar with:

- Principles and applications of Muskingum routing in hydrology
- Real-world hydrological data acquisition and processing
- Traditional and AI-assisted hydrological modeling techniques
- Comparative analysis of different modeling approaches

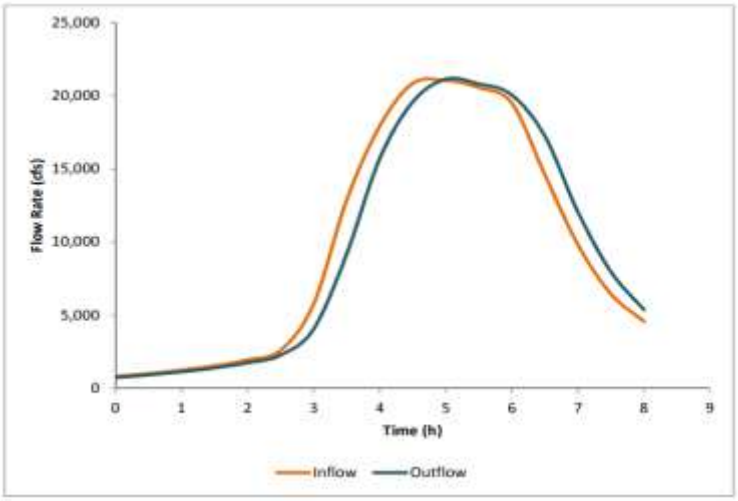
Tasks:

1. Download daily discharge data for two stations from the USGS website for a 10-day period.
2. Conduct a brief literature review on Muskingum routing, summarizing key findings from at least three sources.
3. Apply traditional Muskingum routing to the data.
4. Use an AI tool to perform Muskingum routing on the same data.
5. Compare the results from both methods.
6. Prepare a report summarizing your methodology, results, and findings (maximum 7 pages).

Note: The table and graph are just an example. Students will use actual USGS data in their assignments.
Note: You are allowed to use any AI platform, such as ChatGPT, ClaudeAI, etc., to propose a plan for using the above data to address the problem statement.

Example Data Table and Graph

(1) Time	(2) Inflow	(3) Outflow	(4) Storage	Weighted Flow (m^3/s)		
(d)	(m^3/s)	(m^3/s)	(m^3/s)-d	(5) x =0.1	(6) x =0.2	(7) x=0.3
1	3,007.0	4,461.7	7,928.5	4,316.2	4,170.8	4,025.3
2	2,357.5	3,744.5	6,507.7	3,605.8	3,467.1	3,328.4
3	1,779.0	3,066.0	5,170.7	2,937.3	2,808.6	2,679.9
4	1,405.0	2,457.7	4,000.8	2,352.4	2,247.2	2,141P.9
5	1,123.0	1,963.2	3,054.4	1,879.2	1,795.2	1,711.1
6	952.5	1,575.6	2,322.7	1,513.4	1,451.1	1,388.7
7	730.0	1,275.7	1,738.2	1,221.1	1,166.6	1,112.0
8	605.0	1,022.1	1,256.8	980.4	938.7	897.0
9	514.0	828.9	890.8	797.4	765.9	734.4
10	422.0	680.0	604.4	654.2	628.4	602.6



Students will revise the final report, ensuring it includes the following key elements:

1. Letter of Transmittal:

Draft a professional transmittal letter, addressed to your instructor as the editor of the ASCE Journal of Materials in Civil Engineering.

2. Title Page:

Include course details, report title, submission and completion dates, your name, instructor's name, group number, and list of group members.

3. Table of Contents:

List all major headings, tables, figures, and appendices with corresponding page numbers.

4. Introduction/Theory:

Briefly discuss key principles related to the experiment, supported by at least three references.

5. Objectives:

Clearly state the purpose of the experiment.

6. Procedure:

1. **Define the Problem:** Start by stating the objective of the project or assignment.
2. **Data Collection:** Explain how and where you obtained the necessary data (e.g., downloading real-world discharge data from USGS for hydrologic analysis).
3. **Methodology:** Briefly describe the methods used for analysis (e.g., applying traditional Muskingum routing, using AI tools for comparison).
4. **Data Analysis:** Summarize how the data was processed and analyzed (e.g., comparing results from both traditional and AI-assisted methods).
5. **Conclusion:** Conclude with how you interpreted the results and addressed the initial objective.

7. Results:

Present data in tables and figures, with brief narratives explaining their significance.

8. Discussion and Conclusions:

Interpret the results, comparing them with expected outcomes. Discuss accuracy, precision, and possible errors. State whether objectives were met.

9. References:

List all sources cited in the report using proper citation format. Ensure that a minimum of three sources are included, and that all are from after 2015.

10. Appendices:

Include calculations with detailed units.

Criteria for Success:

A successful assignment will demonstrate:

- Thorough understanding of Muskingum routing
- Proficiency in both traditional and AI-assisted hydrological modeling
- Critical analysis and comparison of different modeling approaches
- Clear communication of findings in the report and presentation
- Active engagement in peer review and discussions

Grade:

The assignment will be graded based on the following criteria:

- Data Collection and Literature Review (20 points)
- Traditional Muskingum Routing (30 points)
- AI-Assisted Muskingum Routing (30 points)
- Comparative Analysis and Reflection (10 points)
- Report and Peer Review (10 points)

Students should submit their summary, data table, calculations, AI prediction analysis, and reflection essay in a single PDF document.

Problem Solving VALUE Rubric*

	Capstone	**Milestones**		**Benchmark**
	4	3	2	1
Define Problem	Demonstrates the ability to construct a clear and insightful problem statement with evidence of all relevant contextual factors.	Demonstrates the ability to construct a problem statement with evidence of most relevant contextual factors, and problem statement is adequately detailed.	Begins to demonstrate the ability to construct a problem statement with evidence of most relevant contextual factors, but problem statement is superficial.	Demonstrates a limited ability in identifying a problem statement or related contextual factors.
Identify Strategies	Identifies multiple approaches for solving the problem that apply within a specific context.	Identifies multiple approaches for solving the problem, only some of which apply within a specific context.	Identifies only a single approach for solving the problem that does apply within a specific context.	Identifies one or more approaches for solving the problem that do not apply within a specific context.
Propose Solutions/ Hypotheses	Proposes one or more solutions/hypotheses that indicates a deep comprehension of the problem. Solution/hypotheses are sensitive to contextual factors as well as all of the following: ethical, logical, and cultural dimensions of the problem.	Proposes one or more solutions/hypotheses that indicates comprehension of the problem. Solutions/hypotheses are sensitive to contextual factors as well as the one of the following: ethical, logical, or cultural dimensions of the problem.	Proposes one solution/hypothesis that is "off the shelf" rather than individually designed to address the specific contextual factors of the problem.	Proposes a solution/hypothesis that is difficult to evaluate because it is vague or only indirectly addresses the problem statement.
Evaluate Potential Solutions	Evaluation of solutions is deep and elegant (for example, contains thorough and insightful explanation) and includes, deeply and thoroughly, all of the following: considers history of problem, reviews logic/reasoning, examines feasibility of solution, and weighs impacts of solution.	Evaluation of solutions is adequate (for example, contains thorough explanation) and includes the following: considers history of problem, reviews logic/reasoning, examines feasibility of solution, and weighs impacts of solution.	Evaluation of solutions is brief (for example, explanation lacks depth) and includes the following: considers history of problem, reviews logic/reasoning, examines feasibility of solution, and weighs impacts of solution.	Evaluation of solutions is superficial (for example, contains cursory, surface level explanation) and includes the following: considers history of problem, reviews logic/reasoning, examines feasibility of solution, and weighs impacts of solution.
Evaluate Outcomes	Reviews results relative to the problem defined with thorough, specific considerations of need for further work.	Reviews results relative to the problem defined with some consideration of need for further work.	Reviews results in terms of the problem defined with little, if any, consideration of need for further work.	Reviews results superficially in terms of the problem defined with no consideration of need for further work.

* Association of American Colleges and Universities. (2009). *Inquiry and analysis VALUE rubric.* https://www.aacu.org/initiatives/value-initiative/value-rubrics/value-rubrics-inquiry-and-analysis