Pre/Post Assessment Rubric for Unit: Urban Storm Hydrograph Modeling with the Rational Method for the Urban Desert Southwest USA

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Overview

The pre-post assessment includes short answer and context structured scenarios. The context structured scenarios prompt the learner to apply what is known and understood to a context that is similar but slightly different from the context in which the concepts were learned. This we will call transfer for assessment of understanding. In order to evaluate the responses a set rubrics were generated. The rubric instrumentation was designed on a three levels of quality format as follows; expert, apprentice and novice. The levels of quality indicate performance and reflect an evaluation of understanding and application. It is important to note that a mark of "missing" is also possible for any specific combination of indicator and question, because many of the nine indicators do not map to all ten questions asked. On a numerical scale, the marks are 3, 2, 1, or 0.

General Descriptions of Performance

Expert (E/3) - Explanations and applications are highly effective. Consistent and thorough performer throughout. Displays and explanations are clear and correct. Shows insights and perceptions.

Apprentice (A/2) - Explanations and applications are moderately effective. Inconsistent performer. Displays and explanations are not as clear and correct as they should be. Insights and perceptions may be lacking or undeveloped.

Novice (N/1) - Explanations and applications are ineffective or incorrect. Misconceptions and serious mistakes. Inconsistent performer. Displays and explanations are not clear and correct. Lacks insights and perceptions.

Missing (M/0) - No meaningful response is provided in relation to an indicator on this question's response. This could be for any reason, including an incomplete answer, or because the indicator is not applicable to this question. Many of the questions will be marked M/0 because the question does not map to a specific indicator.

Mapping Indicators to Outcomes

The study was designed with four learning outcomes as seen in the rubric that follows and in the table below. Nine indicators of performance were written and are also the basis of the rubric; these indicators are mapped to the unit's desired outcomes in the table below.

	Outcomes			
	1	**2**	**3**	**4**
Indicators (nine total)	Students demonstrate understanding of the physical cause of flood frequency and intensity, especially the roles of land use and climate	Students can identify the roles and responsibilities of the U.S. Federal hydrology and flood management organizations	Students demonstrate increased perception of the value of geosciences and hydrology education and information	Students demonstrate understanding of the utility of mathematical geosciences models, especially for prediction and risk management
(A) Effects of Urbanization and Impervious Cover on Flooding	**X**		**X**	**X**
(B) Physical Causes of Flood Frequency and Intensity	**X**			**X**
(C) Conceptual Vocabulary Applied in Context	**X**	**X**	**X**	**X**
(D) Effect of Decadal LULC Change on Flooding	**X**			**X**
(E) Maximum Discharge Rates Determine Flooding (hydrographs)	**X**			**X**
(F) Impacts of Flood Management	**X**	**X**	**X**	**X**
(G) Agency Roles & Responsibilities		**X**		
(H) Value of Geoscience Knowledge		**X**	**X**	**X**
(I) Utility of Mathematical Flood Models	**X**		**X**	**X**

Rubric for Indicators and Levels (code answers for each question against all indicators; E/A/N/M or 3/2/1/0 numerically)

	(A) Effects of Urbanization and Impervious Cover on Flooding	(B) Physical Causes of Flood Frequency and Intensity	(C) Conceptual Vocabulary Applied in Context	(D) Effect of Decadal LULC Change on Flooding	(E) Maximum Discharge Rates Determine Flooding (hydrographs)	(F) Impacts of Flood Management	(G) Agency Roles & Responsibilities	(H) Value of Geoscience Knowledge	(I) Utility of Mathematical Flood Models
Expert	Exhibits highly effective explanation of the effects of urbanization on the frequency and intensity of flooding; key concepts connected including the effects of impervious cover	Demonstrates thorough and complete understanding of the physical causes of flood frequency and intensity	Highly effective and consistent application of knowledge and vocabulary in the context of the problem	Clear and correctly drawn hydrograph representing the differences between H 2000 and H 2012; including peak discharge changes	Clearly and correctly displays flooding as an excess of discharge maximum at peak discharges	Highly effective explanation of the effects of flood control and management; key concepts connected	Highly effective explanation of the roles and responsibilities of U.S. Federal hydrology and flood managers	Exhibits increased perceptions of the value of geoscience education	Highly effective explanation of the utility of mathematical geosciences models; including prediction and risk management
Apprentice	Exhibits somewhat effective explanation of the effects of urbanization on the frequency and intensity of flooding; lacking some key concepts or connections	Demonstrates partial or incomplete understanding of the physical causes of flood frequency and intensity	Moderately effective or inconsistent application of knowledge and vocabulary in the context of the problem	Partially correct or less than clearly drawn hydrograph representing the differences between H 2000 and H 2012	Partially or less than clearly displays flooding as an excess of discharge maximum at peak discharges	Moderately effective explanation of the effects of the effects of flood control and management; lacking at least some key concept connections	Moderately effective explanation of the roles and responsibilities of U.S. Federal hydrology and flood managers	Exhibits some perceptions of the value of geoscience education	Moderately effective explanation of the utility of mathematical geosciences models
Novice	Exhibits misconceptions or incorrect explanations of the effects of urbanization on the frequency and intensity of flooding; lacks key concept connections	Exhibits misunderstandings or serious misconceptions about the physical causes of flood frequency and intensity	Ineffective application of knowledge and vocabulary in the context of the problem	Misconceptions evident from the drawn Hydrograph representing the differences between H 2000 and H 2012; or incorrect	Incorrectly displays peak discharges, flooding and maximum discharges	Misconceptions or incorrect explanation of the effects of effects of the effects of flood control and management; lacks key concept connections	Lacks an effective explanation of the roles and responsibilities of U.S. Federal hydrology and flood managers	Exhibits no perception of the value of geoscience education	Ineffective or lacking an explanation of the utility of mathematical geosciences models

Model Answers for Questions

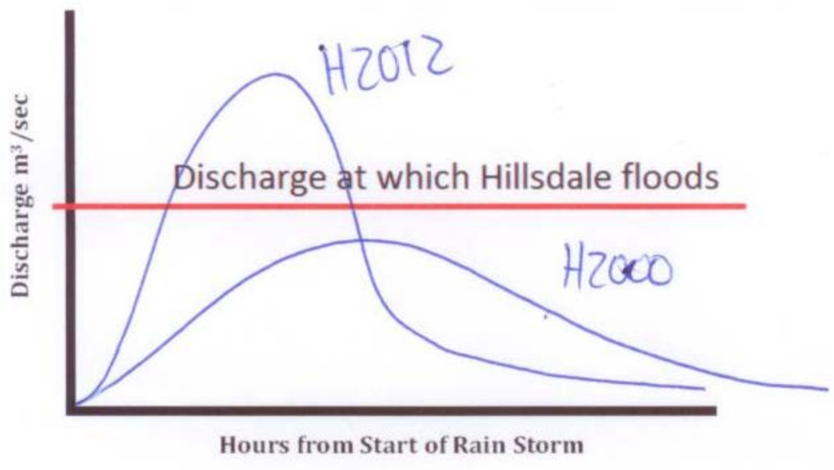
(This is an example of an assessment that receives a perfect "3" or "E" on all applicable indicators to each question.)

(1a)Compare Hillsdale 2000 with Hillsdale 2012: write a description of the effects of impervious cover and urbanization as the City has expanded.

As the city has expanded over time, open areas that produce relatively little runoff are being replaced with urban areas that are impervious to rainfall and therefore produce more runoff.

(1b) Complete a hydrograph analysis on the axes below by doing the following:

- Draw the flood hydrograph for an extreme rainfall event at the Hillsdale stream gage in 2000 before urban development expands; label this curve "H2000".
- Draw the flood hydrograph for an extreme rainfall event at the Hillsdale stream gage in 2012 after urban development expands; label this curve "H2012".



(2) List at least two policies or practices that water managers can pursue to reduce the damage caused by flood events.

- *Reducing urbanization*
- *Reducing impervious area upstream*
- *Enhancing retention of stormwater onsite*
- *Reducing development in the floodplain*
- *Building levees*

(3) What U.S. Federal agency is the primary provider of streamflow and surface water resource data?

The USGS is the best answer, but NOAA is a good second choice.

(4) What U.S. Federal agency is the primary provider of rainfall and weather data?

NOAA is the best answer, but the USGS is a good second choice.

(5)What U.S. Federal agency is the primary regulator and provider of flood control services?

US Army Corps of Engineers is the correct answer.

(6a) What kind of information are these hydrologists able to provide about the future risk, frequency, severity, or damages of flood events at your location, and what tools and knowledge make it possible to provide this information?

The hydrologists can use models to estimate the frequency and severity of floods at our location, based on assumptions about land cover change and urban development that control runoff and imperviousness, and simulations of future climate change that controls the frequency, intensity, and duration of future rainfall events.

(6b) What questions should you ask in the meeting?

- *In your expert opinion, is this a good place to build a 50 year factory project?*
- *If we build, what actions should we take when we build the factory to prevent flood damage?*
- *Can you provide us with adequate warning of imminent floods so we can take action to prevent damage?*
- *How could floods impact transportation, power, and other needs of our factory?*
- *What kind of insurance do we need, and can we save money on the premiums by taking actions to prevent damage?*

(6c) What might happen to Compumarket if the company does not consider hydrologic risk in its business plans?

A flood could destroy the factory, or shut down operations for a significant period of time, costing the business a large amount of money in direct losses and lost sales and reputation. Insurance would cover some of the direct losses but could not compensate the business for all the impacts.

(7) Explain the importance of streamflow and rainfall gages for flood management.

Hydrologists need streamflow and rainfall data in order to forecast the severity of current flood events downstream of a rainfall, and to develop accurate flood models to predict the impacts of flooding.

(8) What is a mathematical flood model, and why is it important?

Mathematical models of floods allow us to predict the intensity and frequency of flooding in a given location, so that we can take steps to prevent damage from floods at that location, such as a city.