



Name _____

Modeling Dynamic Earth Systems

Purpose: This assignment will help you visualize the factors that shape how natural hazards affect Earth surface processes and potential human impacts. You will explore how interactions between factors affect surface processes, and identify feedbacks and chain reactions to trace cascading impacts of surface processes.

Knowledge and Skills: You will develop a visual model of the hazard system with causal relationships and directionality. You will be able to differentiate between positive and negative feedbacks and explain hazard cascades based on the interactions of systems factors.

Task:

1. Part 1: Complete “systems modeling” questions
2. Part 2: Create a systems model, and improve through group feedback
3. Part 3: Complete “reflection” questions collaboratively (everyone submits)

Criteria for evaluation:

Your answers will be graded for completeness (3 pts), and specific items within your systems model will be checked for accuracy (3 pts):

Completion criteria

- 1 point = minimal answers provided
- 2 points = answers provided are incomplete or do not address the questions
- 3 points = answers are complete and are written in complete sentences

Accuracy criteria

- 1 point = <6 system factors and/or lacking in complexity and/or with errors in causality or directionality
- 2 points = ≥6 system factors with accurate directionality PLUS branches/chains OR feedbacks
- 3 points = ≥8 system factors with accurate directionality PLUS branches/chains & feedbacks

Description of Activities

Part 1. Your instructor will present a short lecture illustrating a systems model. Answer the “systems modeling” questions based on the lecture.

Part 2. You will create your own systems model. When prompted by your instructor, you will share your systems model with your assigned group, and use feedback from your group to improve your model by checking for accuracy and adding complexity through the addition of branches and feedbacks.

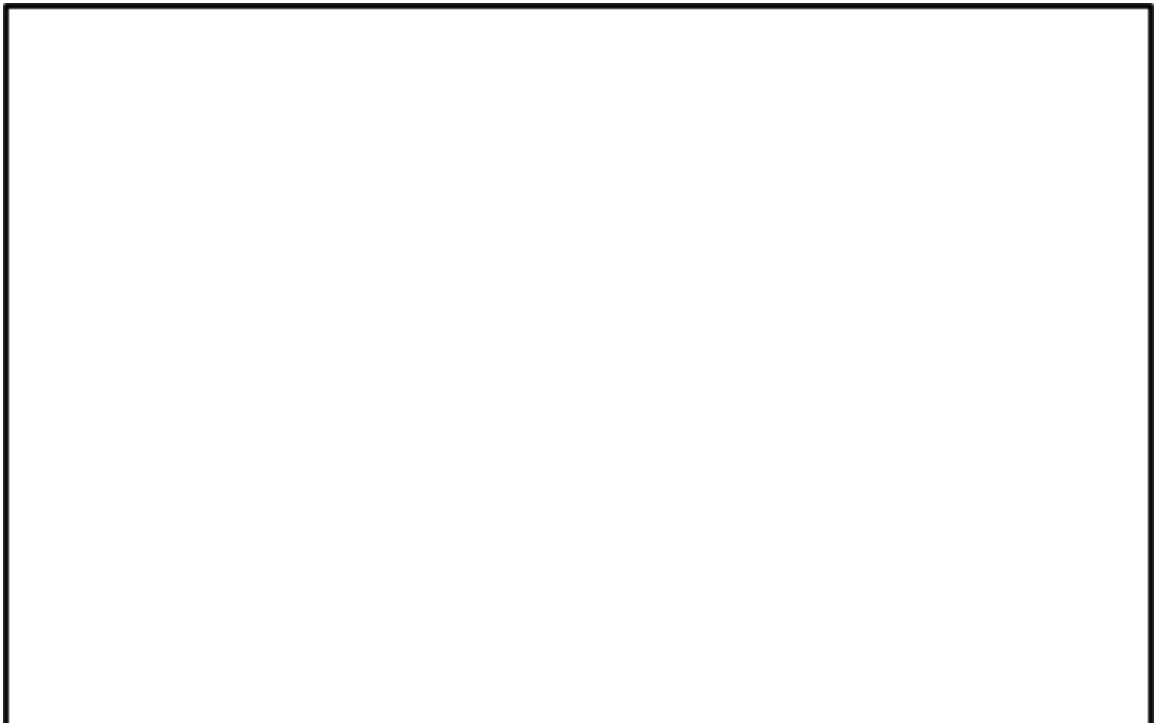
Part 3. Then, you will answer the reflection questions after discussion with your group. Each person needs to answer the questions on their own paper, but you are free to discuss answers with others and write answers collaboratively.

Part 1. Systems Modeling Questions

Answer these questions based on the information provided in the Dynamic Earth Systems Modeling slides.

1. *(Diagram)* Draw an example of a simple systems model with 2 factors. Illustrate which factor can affect another by drawing an arrow from the “causal” factor to the “effect” factor. Choose your initial factor from this list:

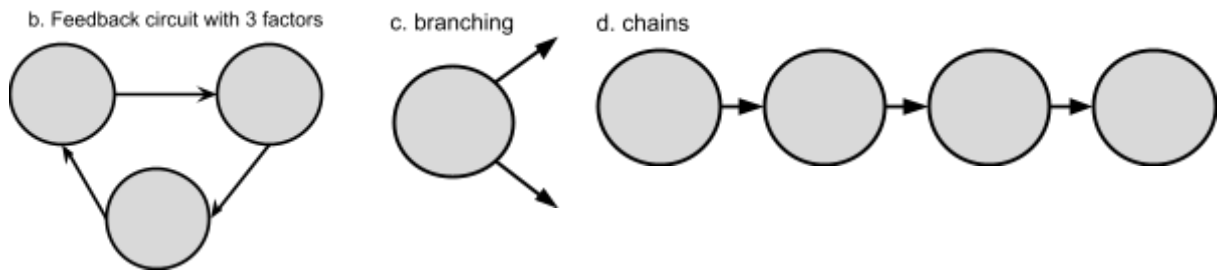
- River channel incision
- Volcanic eruption
- Debris Flow
- Wildfire
- Coastal Flooding
- Flash flooding



2. *(Circle correct answers below)* To indicate directionality, a '+' or '-' symbol can be added above the arrow.
 - a. A '+' indicates positive correlation, which means that increasing the 'causal' factor will cause a(n) (*increase / decrease*) in the 'effect' factor. It also means that decreasing the 'causal' factor will cause a(n) (*increase / decrease*) in the 'effect' factor.
 - b. A '-' indicates a negative correlation, which means that increasing the 'causal' factor will cause a(n) (*increase / decrease*) in the 'effect' factor. It also means that decreasing the 'causal' factor will cause a(n) (*increase / decrease*) in the 'effect' factor.
3. *(Diagram)* Add a '+' or '-' symbol to your systems model drawing from #1 to indicate directionality.
4. *(Short Answer)* Define feedback and differentiate between positive and negative feedback.
5. *(Diagram & short answer)* Expand your example in #1 by adding positive or negative feedback(s). Note: it may be possible for you to add feedback without adding additional factors! Describe your feedback in words below.

- 4 Development of this resource was supported by the [Center for Land Surface Hazards \(CLaSH\)](#) - NSF Award ID #2224871.

3. (*diagram*) Add factors that affect or are affected by your central factor, connecting these factors to the central factor and other factors using causal arrows illustrating directionality.
4. (*diagram*) Show your diagram to other members of your group. Working together, add complexity to your models:
 - a. Including a minimum of 8 factors
 - b. Including at least one (positive or negative) feedback: a closed chain of arrows in which a factor acts as a cause and effect in the same circuit.
 - c. Including branches: factors that act as causal factors or effect factors for more than one other system factor
 - d. Including chains: sequence of factors connected by at least three arrows in the same direction



Draw your systems model here! Once you get to step 4, consult with others in your group to improve your systems model by adding complexity.

Part 3. Reflection questions

1. Describe in words one of the hazard cascades that is illustrated in your model. (In systems models, hazard cascades are typically illustrated by chains of events visualizing how a primary event can trigger a series of additional hazard events)
2. Where in your model could humans impact the rate, direction or extent of a factor or process included in your systems model? Give at least one specific example.
3. Identify one area in your model where human influence could mitigate a hazard cascade (e.g., removing landslide debris from a river basin to decrease future flooding)
4. Effective computer modeling used to predict the impact of hazard events requires quantifying the factors and processes you've illustrated in your model. Identify one factor or process you think would be difficult to collect data on and describe how missing or faulty data would impact our ability to predict the impact of a specific hazard.