Water management in the Amazon

Lesson on water management in the Amazon

DynaLearn level 4 | Version 0.9

Summary	
This lesson is about the water management of an area such as the Amazon. Which processes are important here? What influence do these processes have on water management? The lesson focuses particularly on the role of trees in the rainforest.	
Given name	
Surname	
Class	
Date	
Comments by teacher	

1. Starting DynaLearn

There are several ways to log in. Use one of the two options below. Then check whether the login was successful (see 'Let's check!').

Via a code:

1. Go to DynaLearn (https://create.dynalearn.nl/).
2. Click on 'log in with code', at the bottom left.
3. Enter the project code and your (school) email address.
4. Copy the code from the confirmation email received from *dynalearn.nl* (see spam folder if needed) and fill in the other details.
5. Log in to DynaLearn.

By email invitation:

1. Copy the login details from the invitation email received from *dynalearn.nl*.
2. Go to DynaLearn (https://create.dynalearn.nl/).
3. Log in to DynaLearn.

Let's check!

After logging in, you will automatically enter in the white workspace of the assignment. You can recognize it by the question mark on the right side of the screen . Is the question mark missing? Then first do the following:

- In DynaLearn, click . Click on 'Select template'.
- Choose 'Water management' and press 'Load'. You see the model shown in Figure 1.

Save model file and start:

1. Click on top left. Change the name to 'Water management' and click 'Save'.
2. How do you proceed? Just follow the steps in this workbook. Note! You can't skip steps. Ask for help if you do not understand a certain step. The video function in DynaLearn shows how a model ingredient can be created. The sources contain information about the greenhouse effect and the boxes contain a brief explanation about the model ingredient. Put a check mark √ next to the step you completed. This way you keep track of where you are in the assignment.

2. Drainage of water

1. Note: After launching DynaLearn, and then logging in, you will see the model as shown in **Figure 1**. If you still haven't done this, go back to ***Check on*** the previous page and follow the steps described there.

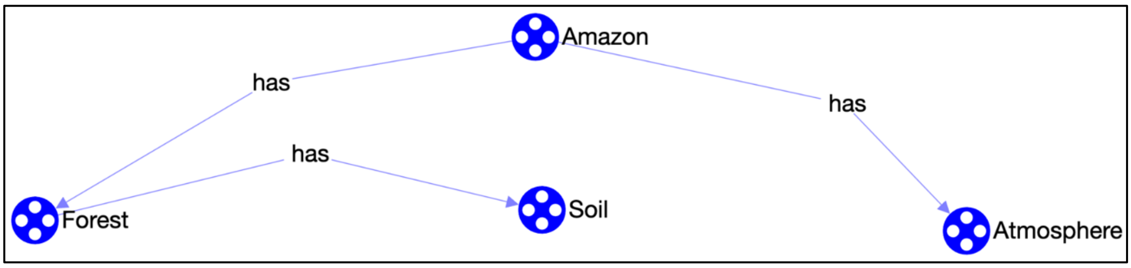
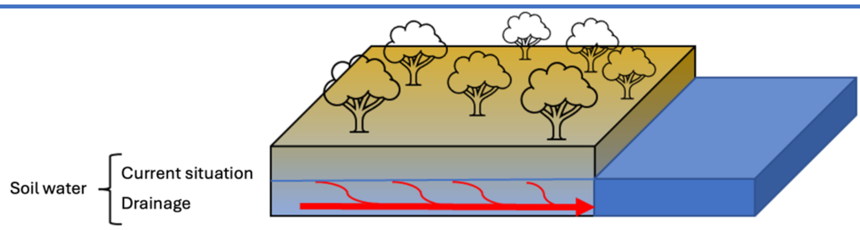


Figure 1. Start of the lesson on water management in the Amazon.

2. Read Source 1.



Source 1. In the Amazon, the soil water is drained into rivers.

3. Read Box 1.

Box 1. Entity and quantity.

An entity is usually a physical thing in a system (e.g., car, human).

A quantity is a measurable property of an entity (e.g., temperature, length).

4. Create the quantity *Water* of the *entity Soil* (see →).

5. Read Box 2.

Box 2. Change of a quantity.

A quantity can change. This is indicated by δ ▲ Ø ▼ . The delta symbol (δ) is the mathematical sign for change (also called the derivative). The down arrow (▼) is decrease, the zero (Ø) is constant and the up arrow (▲) is increase.

6. Lees Box 3.

Box 3. Quantity space.

A newly created quantity does not yet have a quantity space. By adding a quantity space, you can indicate which values a quantity can take on. A quantity space consists of alternating points (■) and intervals (▮).

- A *point value* is only one value. For example, a *boiling point*. A special point is zero, for which there is a separate symbol (Ø) in DynaLearn.
- An *interval value* is a set of values. The liquid phase of a substance is an example of an interval. In the case of water, the interval 'liquid' contains all values between 0 °C and 100 °C. The values 0 °C and 100 °C are respectively the 'melting *point*' and the 'boiling *point*' between which the interval 'liquid' is located.

7. Create a quantity space (see →) for the quantity *Water* of the entity *Soil* with a point (Current situation). Above the point is an interval *Wet* and below the point is an interval *Dry*. It will then look like this:

8. Read Box 4.

Box 4. Help function.

If the question mark or an ingredient in your model is red, then something is wrong. Click the question mark for a hint. Then click on a number, for example to see where the error is in your model. Only use the question mark if you can't figure it out yourself!

9. Create the Quantity *Drainage* of the *entity Soil*.

10. Create a quantity space (see →) for the quantity *Drainage* with point zero (Ø). Above zero there is a positive interval *(+)*. It will then look like this:

11. Lees Box 5.

Box 5. A relationship of type influence.

Some quantities in a system are processes. A process is a quantity that adds or subtracts something to the system per unit of time (e.g., per second, per year). Simple examples of processes that **add** something are: (i) water from a tap that flows (L/s) into a bath and (ii) an oven that provides a certain power (J/s) to heat a dish. The outflow (L/s) of water through the drain is an example of a process that removes something from the system.

In DynaLearn, the relationship between a process and another quantity is called an **influence** (I+ of I-). With this type of relation, **the value** of the process determines **the change** in the quantity on which the influence is exerted.

12. *Drainage* is a process (how much water is drained from the soil per unit of time). The connection between *Drainage* and *Water* is therefore of the type of **influence**. Make this connection (see). Pay attention to the direction of the arrow (cause → effect)!

13. You can keep the model organized and uncluttered by using several buttons at the bottom of the screen. Click to align everything neatly. Click to make your model fit the screen. Use these buttons regularly.

14. Read Box 6.

Box 6. What is an exogenous influence?

If you want a quantity to decrease, remain constant or increase throughout the simulation, then you must add an external influence (an exogenous influence) to the quantity.

15. Set as initial values (see):

   i. There is drainage of water: . This is the **value** of *Drainage*.

   ii. *Water* has the value *Current situation*: .

   iii. Create an exogenous influence (see) for *Drainage* of type constant . This indicates that the value of this quantity **does not change**.

16. Read Box 7.

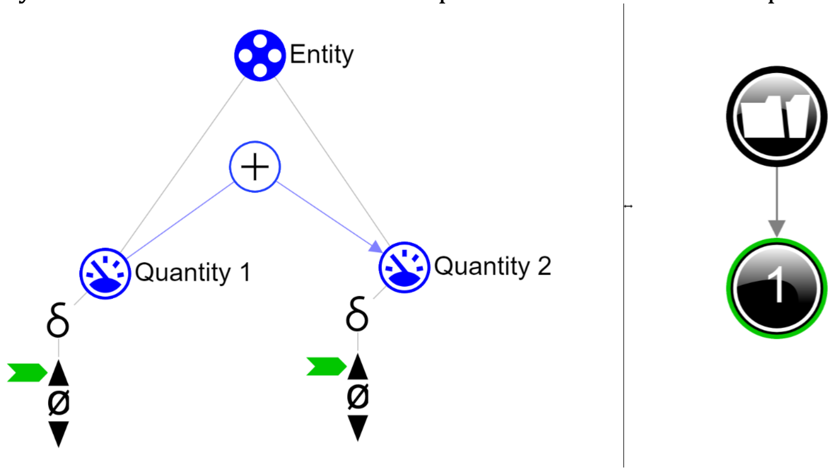
Box 7. Help function.

If the explanation mark appears (!), something is wrong during the simulation. Click on the explanation mark (!) for a hint. Then click on a number, for example (1), to see where the error is in your simulation.

17. Read Box 8.

Box 8. Read the outcome of a simulation.

After starting a simulation (with), a window appears on the right in which the possible states of the system are indicated. There is one possible state in this example (1).



You can click on the state to view the results. The state icon then gets a green circle. In the model, the change for this state is indicated by green arrows . Here, the model shows that in state (1) *Quantity 1* increases and that therefore *Quantity 2* also increases.

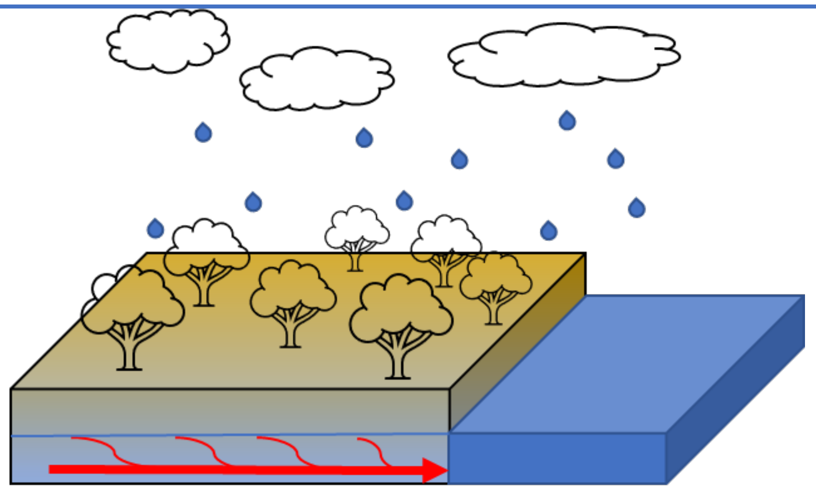
18. Start the simulation (Note: there are two buttons for running a simulation, use the right button for a full simulation).

19. Read the simulation result. Describe below what the cause-effect relationships are that take place (cross out wrong answers):

- In state 1 there is no/is *drainage* of water. As a result, the amount of water in the soil will *decrease/remain the same/increase*.
- In state 2 there is *no/is* *drainage* of water. The soil is now *wet/dry.*

3. Supply of rain

1. Read Source 2.



Source 2. In the Amazon, the supply of rain provides a supply of water in the soil.

2. Create the quantity *Rain* of the entity *Atmosphere* of the Amazon.

3. Create a quantity space (see →) for the quantity *Rain* with a point zero (Ø). Above zero there is a positive interval *(+)*.

4. *Rain* is a process (how much water **is supplied from the atmosphere** per unit of time). The relationship between *Rain* and *Water* is therefore of type influence. Create this relationship (see →). Pay attention to the direction of the arrow (cause → effect)!

5. Click to align everything. Click to make your model fit on the screen.

6. Set as initial values:
   i. There is a supply of rain: Ø
   ii. Create an exogenous influence (see →) for *Rain* of type **constant**. This indicates that the value of this quantity **does not change**.
   iii. Leave all other initial values as in the previous simulation.

7. Start the simulation . Read the simulation result. Describe below what the cause-effect relationships are that take place (cross out wrong answers):

There are now 3 paths with 3 end states. Different end states arise because we *have not yet defined* the extent of the Drainage *and* Rain processes in the model. The simulation then displays all the possibilities. *Path: State 1 → State 5* The amount of water decreases. Thus, the amount of drainage is less than/equal to/greater than the amount of rainfall. *Path: State 2* The amount of water remains the same. Thus, the amount of drainage is less than/equal to/greater than the amount of rainfall. *Path: State 3 → State 4* The amount of water increases. Thus, the amount of drainage is less than/equal to/greater than the amount of rainfall.

8. Read Box 8.

Box 8. An (in)equality

An inequality (<, ≤, ≥, >) can indicate which values of two quantities is initially the largest (e.g. A < B). You can also specify that both values are initially equal (=) with an equality. Please note! This concerns the **initial** (in)equality, i.e. at the beginning of the simulation. This may change during the the process.

9. Set as initial values:

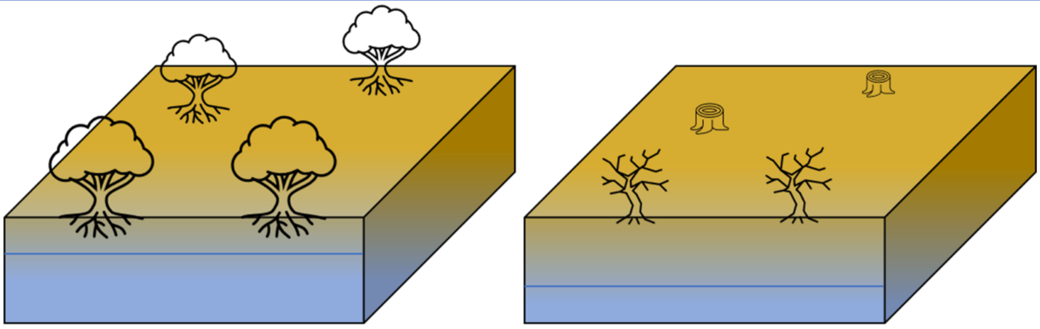
   i. Create an (in)equality (see → (=)): *Drainage* = *Rain*
   ii. Leave all other initial values as in the previous simulation.

10. Start the simulation. How many states are there?

Number of states:

4. Protecting the rainforest

1. Read Source 3.



Source 3. The size of the forest has an effect on the water capacity of the soil. Trees retain water in the soil and thus increase the water capacity. When trees are cut down, the water capacity of the soil decreases. This will increase the drainage of water.

2. Create the *entity People* (see →).

3. Describe how people can protect the rainforest.

4. Create the Quantity *Protect* the *Entity People*.

5. Create the quantity *Size* of the entity *Amazon Forest*.

6. Create the quantity *Water capacity* of the entity *Soil* of the Amazon.

7. Read Box 7.

Box 7. A proportional relationship

With a proportional relationship, **a change** in the quantity that is the **cause, causes a change** in the quantity that is **affected**. In DynaLearn, **positive** and **negative proportional** relationships between quantities can be defined, respectively by (P+) and (P–).

8. Create the relationships between *Protect, Size, Water capacity,* and *Drainage.* The relationships are proportional. Think carefully about the direction of the relationships.

9. Describe how humans degrade the rainforest?

10. Create the Quantity *Degrade* for entity *People*.

11. Create the relationships between *Degrade* and *Size* of the entity *Forest.*

12. Click to align everything neatly. Click to make your model fit on the screen.

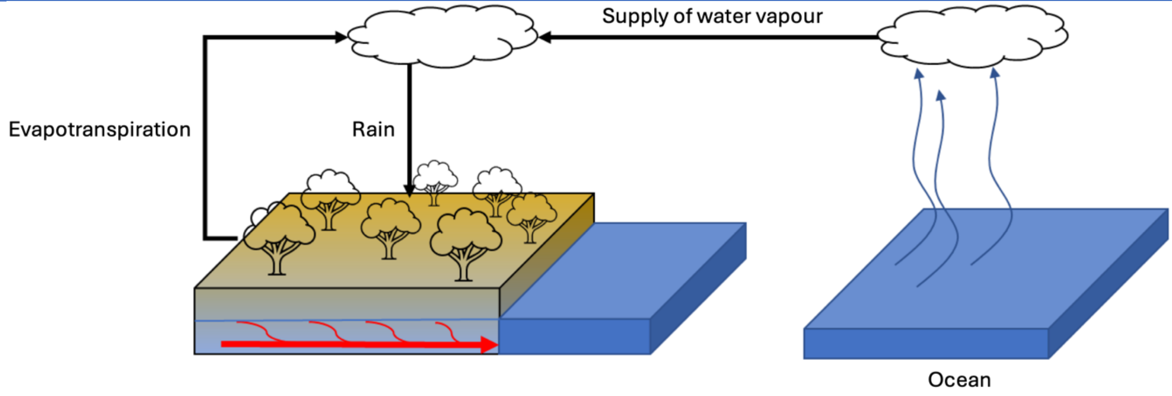
13. Set as initial values:
    i. Create an exogenous influence for *Degrade* of type **increase**
    ii. Create an exogenous influence for *Protect* of type **constant**.
    iii. Remove the exogenous influence on *Drainage.*
    iv. Leave all other initial values as in the previous simulation,

14. Start the simulation.

15. Using the results of the simulation, describe the effects of a decrease in protection on the amount of water in the soil.

5. Expending the Supply of rain

1. Read Source 4.



Source 4. Supply of rain from the ocean and local evaporation. The rain that falls in a certain part of the rainforest is the sum of the amount of water vapour that is supplied from the ocean and the amount of water vapour that the forest discharges through the leaves (evapotranspiration).

2. Create the *entity Ocean*.

3. Create the *entity Atmosphere.*

4. Create a configuration between the entity *Ocean* and the entity *Atmosphere*. You can do this by first clicking on entity *Ocean*. A menu will then appear. Select ⚙⚙. And then click *on Atmosphere*. You have now linked the entities to each other. You can now indicate what the relationship is. Select *has*.

5. Create the quantity *Water vapour* of the entity *Atmosphere* of the Ocean.

6. Create the quantity *Water vapour* of the entity *Amazon* of the Atmosphere.

7. Create the relationships between *Water vapour* (2x) and *Rain.* The relationships are proportional. Think carefully about the direction of the relationships.

8. Click to [icon] align everything neatly. Click [icon] to make your model fit on the screen.

9. Set as initial values:
   i. Create an exogenous influence for *Water vapour* of the ocean's atmosphere of type **constant**
   ii. Remove the exogenous influence on *Rain.*
   iii. Leave all other initial values as in the previous simulation.

10. Start the simulation.

11. Read the simulation result. Describe below what the cause-effect relationships are that take place (cross out wrong answers):

The supply of water vapour from the atmosphere above the ocean to the atmosphere above the rainforest *decreases/remains the same/increases*. As a result, the amount of rain will *decrease / stay the same / increase.*

12. Create the quantity *Evapotranspiration* of the entity *Forest* of the Amazon.

13. Create two relationships between *Evapotranspiration* (2x) and other variables from the model. The relationships are proportional. Think careful about the direction of the relationships.

14. Click to align everything neatly. Click to make your model fit the screen.

15. Start the simulation. Read the simulation result. Describe below what the cause-effect relationships are that take place (cross out wrong answers):

The supply of water vapour from the atmosphere above the ocean to the atmosphere above the rainforest remains the same. However, the supply of water vapour through evapotranspiration of the forest *decreases/remains the same/increases*. As a result, the amount of rain will *decrease/remain the same/increase.* This makes the soil *wet/dry.*

16. A decrease in the forest has a twofold effect on the dehydration of the soil. Describe this twofold effect.