PAGE PARTNERSHIP FOR ACTION ON GREEN ECONOMY

Exercise 1: Development of a qualitative system map

Course: Inclusive Green Economy (IGE) modelling

1 Overview and objective

The goal of this exercise is to create a qualitative system map to investigate the drivers of change in the system, based on the identification of key variables and how they interact with one another.

You will develop a qualitative system map, which could be a Causal Loop Diagram or a tree diagram, for a sector and specific geography, such as a country, a city or a landscape. Through the exercise, you will learn how to identify key variables of a system, determine the causality existing amongst them (all social, economic and environmental variables), and assess what drives change in the system. In fact, with the diagram, you will represent existing or emerging problems, as well as possible solutions, such as policy interventions.

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2 What needs to be done and how

2.1 Tasks

The following are the practical steps that you should follow for the creation of a Causal Loop Diagram (CLD) or Tree Diagram:

- Identify an issue and a target, representing an opportunity to solve the issue, and describe these with one sentence.
- Open Vensim (www.vensim.com), or draw the diagram in PowerPoint or manually on a flipchart.
- Identify the key indicator representing the problem and add it to your diagram, which is blank at this stage.
- Add the causes of the problem, one by one, linking them to the first variable considered, and determine the polarity of the causal relation. The polarity can be positive, for a direct relation, or negative, for an indirect relation.
- Continue identifying and adding the cause of the cause, and so forth.

2.2 Key concepts

The basic knowledge needed to build a CLD includes the polarity concept, which is the sign of the causal relation between two variables, whether positive or negative, and the feedback concept, which reinforces or balances. On the former (polarity concept), causal loop diagrams include variables and arrows, called causal links, with the latter linking the variables together with a sign, either + or −, on each link, indicating a positive or negative causal relation (see Table 1):

- A causal link from variable A to variable B is positive if a change in A produces a change in B in the same direction.
- A causal link from variable A to variable B is negative if a change in A produces a change in B in the opposite direction.

Variable A	Variable B	Sign
↑	↑	+
↓	↓	+
↑	↓	-
↓	↑	-

Table 1: Causal relations and polarity

With the latter, the feedback concept, as the diagram grows and new variables are added, circular relations are formed. These are feedback loops, representing closed loop thinking. There are a few methods to determine whether a feedback loop reinforces or balances. The two most commonly used are:

- Reading the CLD. Starting with the assumption that the first variable in the loop will increase when the loop is followed: 1) we end up with the same result as in the initial assumption, that is that the variable increases, and the feedback loop reinforces; 2) we end up contradicting the initial assumption, that is that the variable decreases, and the feedback loop is balanced or opposes change.
- Counting plus and minus signs: 1) reinforcing loops have an even number of negative links, where zero is also even; 2) balancing loops have an uneven number of negative links.

Once the diagram is complete, the analysis can begin. Normally the starting point is the first variable added to the diagram or the key problem to be solved. It is good practice to 'read' the diagram to understand the extent to which simultaneous factors influence the causes of the problem. Further, reading the diagram helps to check its consistency and validity, and also identifies the overall system pattern and the main feedback loops responsible for it.

2.3 Common challenges

A few common challenges emerge when creating a CLD or Tree Diagram (Sterman, 2000). Please make sure you read through the following recommendations before starting the exercise:

- Add variables one by one. Don't start with a long list of variables as this may constrain the boundaries of the analysis, leading to a tendency to focus only on this initial list of variables and not on an organic process where relevant variables emerge from the process.
- Use nouns or noun phrases to represent the elements rather than verbs. That is, the links (arrows) represent the actions in a causal loop diagram and not the elements. For example, use 'cost' and not 'increasing cost' as an element.
- Use an element (or variable) name in a positive sense. For example, use 'growth' rather than 'recession'.
- A difference between the actual and perceived states of a process can often be important to explain patterns of behaviour. In many cases, there is a lag (delay) before the actual state is perceived. For example, when there is a change in actual product quality, it usually takes a while before customers perceive this change.
- There are often differences between short-term and long-term consequences of actions and these may need to be distinguished with different loops.
- Keep the diagram as simple as possible, subject to the earlier points. The purpose of the diagram is not to describe every detail of the management

process, or the system, but to show those aspects of the feedback structure that lead to the observed problem. In other words, model the problem, not the system.

3 Example of results

The Causal Loop Diagram (CLD) presented in Figure 1 is an example provided for you to understand the level of complexity, i.e. the number of variables and interactions existing among them, expected from this exercise.

The starting point for this exercise depends on the perception of the problem. Some students may consider that poverty (or income gap) is the issue to start from, while others may consider deforestation, such as illegal forest encroachment, to be the primary problem. Nevertheless, once the CLD is built, it is possible to see that these two variables are connected to one another, in a circular fashion, and are both important and responsible for the behaviour of the system.

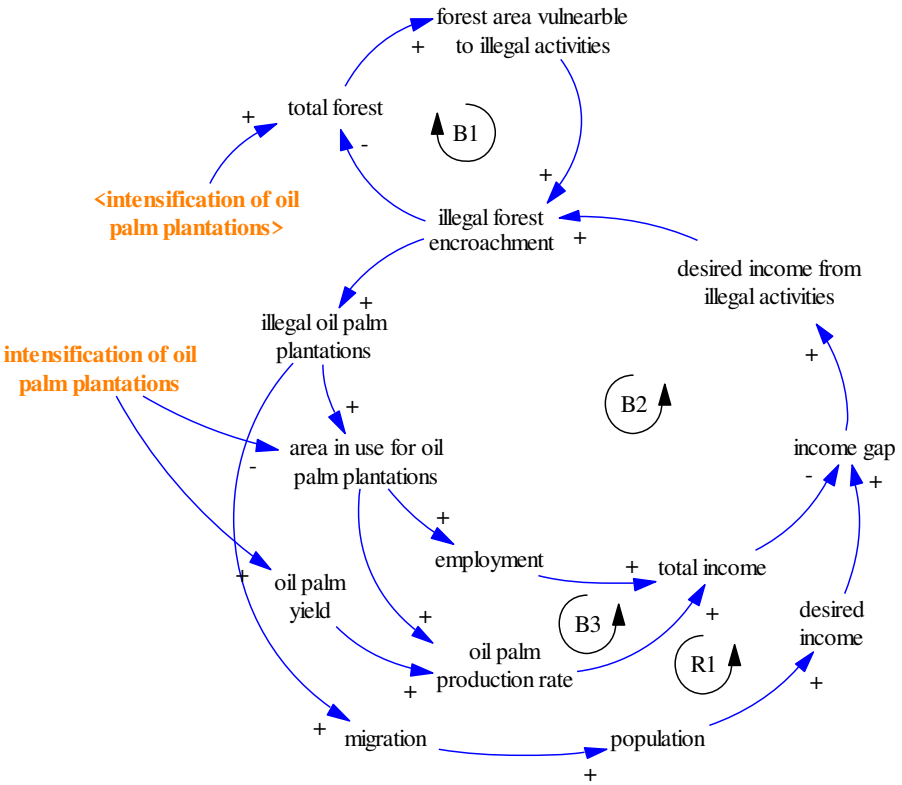

Figure 1: Causal Loop Diagram representing the dynamics of oil palm production at local level. Legend: system variables are in black; intervention options are orange and bold.

The causal loop diagram shows that if there is an income gap at the local level, there will be an incentive to engage with illegal activities. This will lead to the encroachment of forests, the growth of oil palm plantations, employment creation

and growing economic activity. This leads to income creation, which reduces the income gap, creating a balancing loop (B2) through employment and (B3) through oil palm production.

On the other hand, when new plantations are established, migration to the area may increase, leading to more population and more desired income, which increases the income gap and further leads to illegal activities and forest encroachment, creating a reinforcing loop (R1).

Finally, any activity that increases the forest area, such as intensification of oil palm plantations, in the absence of monitoring and enforcement, is likely to be ineffective in the long-term (B1) and lead to more deforestation.

It is important therefore to understand the underlying drivers of change of the system, and to be able to identify desirable and undesirable developments originating from policy implementation.

4 Evaluation criteria

The diagram will be evaluated based on its completeness, in the following order:

- Is the problem correctly represented by the diagram?
- Does the diagram include causal relations (i.e. blue arrows)?
- Does the diagram include polarity (i.e. plus and minus signs next to the arrowhead)?
- Does the diagram include feedback loops (i.e. circular relations) and feedback notations, such as the R and B signs shown in Figure 1?
- Does the diagram include policy interventions, such as the orange variables included in Figure 1?
- Are you able to create a narrative with the CLD or Tree Diagram that explains what the problem is and whether the interventions identified would solve the problem?

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The Partnership for Action on Green Economy (PAGE) is a joint programme between UN Environment Programme (UNEP), the International Labour Organization (ILO), the United Nations Development Programme (UNDP), the United Nations Industrial Development Organization (UNIDO), and the United Nations Institute for Training and Research (UNITAR).

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