# Causal Loop Diagram (CLD)

## Transcript video 1

Video link: https://www.youtube.com/watch?v=INRwCMcPOPs

Full resource, see: https://www.ncrm.ac.uk/resources/online/all/?id=20845

Hi there. I’m Freya Palmer and this tutorial is about causal loop diagrams and the way for visualising connections between different parts of a system. So, first off, you may be thinking what are causal loop diagrams? Well, they’re a tool that often goes hand in hand with system thinking. This is where you consider the connections between things you may ordinarily assume are linear. By mapping the connections between variables, it gives you a greater understanding of the system in question and you can then infer how a system may react under different conditions. Through mapping the connections, you can also identify interdependencies, which also help deal with very complex systems.

So, now you may be wondering why do causal loop diagrams? Well, as mentioned in the previous slide, causal loop diagrams help gain a deeper understanding of your thing in question. So, as seen on the right, this is the causal loop diagram the UK government developed for electric vehicles and net zero. It may look complex, but later on we’ll go through how it can be simplified to just the nature of two feedback loops. You can also use causal loop diagrams for literature review purposes. This is by drawing them based on the existing literature to identify evidence and research gaps. Causal loop diagrams are also useful for identifying the root cause of a problem. This can be identified by identifying negative balancing loops, negative reinforcing loops, trade-offs and potential unintended consequences. Causal loop diagrams can also support policy changes and support theory of changes.

So, as I said earlier, the causal loop diagram on the right can be simplified to just the nature of each feedback loop. So, here you can see that there are two reinforcing loops. As the proportion of electric vehicles on the road increases, investment in manufacturing increases. This then increases the battery range and charging infrastructure, which increases the public confidence in electric vehicles, which then further increases the proportion of cars that are electric vehicles, so this is the first reinforcing loop. You can also see that as the proportion of electric vehicles increases, the investment increases, as earlier. As investment increases, the cost associated with electric vehicles decreases, and if the cost is lower, this means that the amount of electric vehicles on the road will increase, so that is why you have another reinforcing loop.

So, as you saw earlier, causal loop diagrams can be as simple or as complex as you wish. In this causal loop diagram you’re seeing how the population of X is dependent on birth rate and death rate by two different feedback loops. So, as population increase, death increases, and as death rate increases, the population decreases, so that gives rise to a balancing loop. But as birth rate increases, population increases, and as population increase, birth increase. The population should only stabilise when the birth rate and death rate are equal.

So, this slide is going through the causal loop diagram notation which is common practice within the field. So, when there is just text, this is your variable in question which when there is an arrow to or from it indicates a causal link to another variable. When that arrow has a positive sign next to it, that indicates a proportional relationship, so as variable X increases, variable Y also increases. When there is a negative sign next to the causal arrow, this indicates an indirectly proportional relationship, so as variable X increases, variable Y decreases. You can also find these things called feedback loops. You have the feedback loop with the R in the middle. This is the reinforcing feedback loop. And if you think of that about with a behaviour against time, this is an exponential growth. You also get balancing feedback loops, which is indicated by a B in the circular arrow. This, when you consider the behaviour over time, would be a growth which then plateaus. You can also have time delays and tipping points. These can be signified by a causal link with two lines through the centre.

So, now we’re going to go through the steps that you would take to build your own causal loop diagram. Step one is to mind dump any variables that you think are related to your question or research topic. So, in this particular example we’re going through the sustainability of cod fisheries, so here we have dumped any variables we think are relevant. Step two is to split these variables into key themes. When considering the cod fishery we could consider the three pillars of sustainability, which are environmental, economic and social, as well as the regulations that act upon these. So, in this step now you can see that we’ve split up each variable into its most relevant theme, but please note that some variables may also be within two themes or maybe even three, and that’s absolutely okay.

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So, the next step of building your causal loop diagram is to identify the research question and aims that you wish to address with your CLD. To do this you assess the context of your system and your relevant boundaries. If variables do not answer the research question then they aren’t in the boundary of your system and therefore should be removed. The research question we are asking in this tutorial are what impacts cod fish population focusing on a fishery perspective. Please note that this step in general is very iterative and you will add and remove different variables throughout the process, so it doesn’t need to be perfect first time.

So, now we’re going to do step four, which is start drawing our causal loop diagram, but please remember that this has been an iterative process, with variables, positions and feedback loops changed throughout. So, this particular one is the environmental pillar of sustainability, more specifically the flow of life, so I’ll get the laser pointer so we can follow. So, two factors that influence the juvenile cod population is birth rate and mortality rate. So, as birth rate increases, the code population increases, and as mortality rate increases, the cod population decreases. As the cod population increases, the recruitment rate also increases. This then means that the adult cod population also increases. Factors that impact the adult cod population are mortality rates. These can be predation mortality rates, fishing mortality rates or other mortality rates, which could be natural deaths.

This next stage of the environmental pillar of sustainability for the cod fish population is factors that influence spawning rates. So, this can be things such as temperature, salinity, habitat and season. As spawning increases, the birth rate increases, which increases the juvenile cod population. This then increases the recruitment rate, which increases the adult cod population, which then also increases the spawning rate. This gives rise to our first reinforcing loop, which is the exponential growth. So, this is because everything is positive and in a loop, so that’s how we can identify it’s reinforcing.

Other things that impact the populations and so juvenile cod growing into adult cod is food availability. Both juvenile cod and adult cod eat crustaceans, so they’re influenced by the crustacean population. Here you can see that adult cod population increases, the crustacean population would decrease. As the crustacean population changes, this has a directly proportional relationship to the recruitment rate, so if crustacean population was high, recruitment rate would be high. There’s also a positive influence between the recruitment rate and adult cod population, as mentioned earlier, but this forms a loop, and since there is one negative sign, this creates our first balancing loop. You can remember earlier that if you imagine the behaviour over time of a balancing loop, it would be growth followed by a plateau. You can also see, although not a loop, but as the juvenile cod population increases, the crustacean population decreases and then the direct relationship with the recruitment rate gain. But also note that adult cod do eat juvenile cod, which does give rise to another reinforcing loop.

This stage is adding factors that influence the predation rate, so these are populations of predators. So, things that eat cod fish and adult cod fish are marine mammals, such as seals, sharks and dogfish. So, here you can see that as the predation population increases, the predation mortality rate would increase, but as the predation mortality rate increases, the cod population decreases.

This is the final stage of our environmental sustainability pillar for our cod fish population, it’s simply just adding our other mortality rate factor which influences our other mortality rate and mortality rate. This will just be from natural deaths, such as old age for our cod fish.

So, that’s it for part one of our causal loop diagram - visualising connections between different parts of our system tutorial. We went through what are causal loop diagrams, why you would do causal loop diagrams, and the different steps you need to take to build a causal loop diagram. The key thing to remember when building a CLD is that it’s an iterative process and it will get better with time and practice. In the next part of the tutorial we’re going to go through the further development of our causal loop diagram and the connections between the other pillars of sustainability, as well as some considerations you need to make when building causal loop diagrams and also some further advancements you can make after you’ve built a causal loop diagram.

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