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Sustainability tomorrow: Identifying challenges, analysing approaches and assessing future strategies

Video Transcript

Sustainability Today 2: Resilience

[Prof. Dr. Patricia Holm] The term «resilience» has its roots in the Latin word «resilire», meaning to rebound or recoil. The concept of resilience was first studied in engineering. When engineers talk about resilience, they mean the resistance to disturbance, and they measure the speed of return to the equilibrium. In this context, the focus is on efficiency, consistency and predictability. The movement of the ball disturbs the stable system, so these spatial and temporal dynamics are seen as perturbations to an otherwise stable system.

In contrast, we can also see the ball as part of the system, and the movement of the ball as an inherent property of the system. In this case, we are talking about the ecosystem. This is the concept of resilience in ecology, as defined by C. S. Holling in 1973.

Here, the emphasis is on how large a disturbance has to be before a system flips to another stable equilibrium. This is illustrated by the two neighbouring valleys. It generally only takes a tiny but important nudge for the ball to move to one or the other valley. The ball can flip from one valley to the next – in other words, from one stable equilibrium to another one. In environmental sustainability, this is often called the «tipping point».

You might ask where we can find examples for such resilience in the environment and their relevance for sustainability. Let me give you an example.

Permafrost, or perennially frozen ground, covers one quarter of the earth's mass of the northern hemisphere and can be up to one kilometer in thickness. This frozen ground acts like a gigantic freezer of the earth and holds vast amounts of organic material. This material comes from plants and animals that have died and decomposed over thousands of years.

As a result of climate warming, permafrost begins to thaw. This causes the ground to release carbon dioxide and methane into the atmosphere. These gases are produced by microorganisms as they decompose biological material. Since carbon dioxide and methane are greenhouse gases, they act as a self-reinforcing feedback on the thawing of permafrost.

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Once set in motion, the thawing of permafrost can hardly, if at all, be stopped. At best, it can be slowed down by climate change mitigation measures. So why is this self-reinforcing feedback loop an indicator of a tipping point?

Because there is no turning back once the organic matter in permafrost decomposes and releases carbon dioxide and methane. The thawing of permafrost is therefore irreversible – one of the prerequisites for the «tipping point» concept. In this example, the original stable system is the Arctic permafrost, and the «new» stable equilibrium would be a swamp or bog ecosystem without permafrost.

As you can imagine, the processes set in motion by the thawing of permafrost are even more complex than just described. For more details, follow the link provided in this step.

In the context of sustainability, resilience is an important concept which describes how an ecological system reacts to disturbances. Depending on how large a given disturbance is, the system can either absorb this impact or flip into another stable equilibrium.