

Handout 1: THE ADAPTIVE CYCLE

The **adaptive cycle** is a model for showing how complex **systems** undergo change. It is also a way to examine a system's **ecological resilience**, or ability to withstand big changes without losing its identity. The adaptive cycle depicts how these systems follow a continual pattern of growth, collapse, and reorganization through four distinct phases: 1) exploitation or growth (**r**), 2) conservation (**K**), 3) release or collapse (**Ω**), and 4) reorganization (**α**). Originally developed for the field of ecology, the adaptive cycle is now also applied to other complex systems like economies and societies.

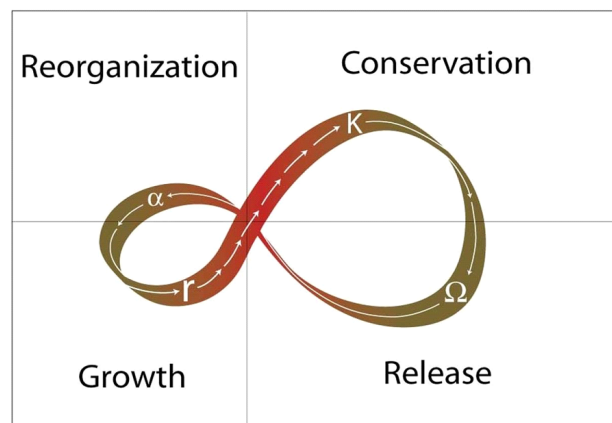


Fig. 1. The Adaptive Cycle. Courtesy A. Garmestani, US EPA.

“r” (exploitation or growth)

The **r** phase shows the initial growth of a system after reorganization (the “**α**” phase). Resources start out freely available and not tied up in the system. As components (parts of the system) gather up resources, the system becomes more stable and rigid, with resources tied up and not available for use. Picture a forest that has been destroyed by fire. Upon the seemingly barren landscape, new species have the opportunity to colonize and take advantage of the resources: open soil, sunlight, and rainfall. As more plants colonize the burned space, the less soil, sunlight, and rainfall is freely available for more plants, because the plants that were there first have already claimed those resources. When most or all of the resources are being exploited by plants or other system components, the system transitions into the **K** phase, or the conservation phase.

“K” (conservation)

Unlike the **r** phase, where there is a lot of growth and the system components are not tightly connected to each other, the **K** phase is characterized by slow growth, high connectivity, and relative stability. Though the system persists, the individuals within the system may change over time. In our example of a fire-disturbed forest, most or all of the available soil, sunlight, and

water has been claimed and little change to the system occurs. Individual plants may change, and whole species may be replaced by another plant species, but the way the resources are tied up, and the way the system is structured, does not change. In the **K** phase, resources are also stored for longer periods of time in the components of the system, whether it be organisms or economic entities like large corporations or banks, without transferring to other system components. As components become more interconnected, the system becomes more rigid and unable to adjust to change. This results in a less resilient system overall.

“Ω” (release or collapse)

When some kind of change inside or outside the system is too great for the tightly connected components to handle, the system collapses. This collapse can be swift - even small disturbances can be enough to bring down a very rigid, highly-connected system. Resources are released, connections are broken, and the structure of the system disintegrates. In a forest ecosystem, a disturbance can take many forms, such as an invasive insect, a plant disease, or another forest fire. As the particular disturbance sows destruction, the energy, biomass, and nutrients that were bound up in existing plants are made freely available to be exploited once again in the **α** phase.

“α” (reorganization)

The reorganization phase is an opportunity for innovation. Resources are once again freely available for the taking. The components of the system may be familiar, such as the same species of plants from before the collapse attempting to recolonize their previous domain, or new species may push into the system. Anything is possible. With the lack of rigidity that characterized the conservation phase, there are countless paths forward for the system. Over time, certain plants will prove to be the most effective colonizers of the collapsed area, and the system will return to the growth (**r**) phase.

Handout 2: CONCEPT MAPPING

As part of the case study, you will be making a series of mental models called “concept maps.” Concept maps are useful for understanding relationships among components of a system. You can use either a whiteboard, paper, Post-It notes, and an easel, or computer software to create a concept map. Once you have gathered the necessary materials, come up with a list of components present in your system. Draw lines with arrows to show which components are related to each other. Next to each line, place a “+” or “-” to show whether the first component has a positive or negative influence on the other component. Make the line thinner or thicker to denote the strength of the relationship. If there is a very strong relationship between two components, make the line thicker to reflect this fact. Similarly, if there is a weak relationship between the two components, make the line thinner. Each component can have multiple lines to or from other components since a component may influence many other components.

Practicing Concept Mapping

To practice concept mapping, create a concept map for “brushing your teeth.” Consider what components are in your mouth (the system), and show the positive and negative relationships between the act of brushing your teeth and the components of your mouth. Think about components of your mouth system we would consider “good” and “bad.”

Handout 3: GENERAL BACKGROUND

You will be exploring the concept of the adaptive cycle through the eyes of stakeholders from Sandville, a fictional small town in the Sandhills of Nebraska. Platted in the 1880s, the town has experienced a rich history full of ups and downs. Over time residents came to expect a certain lifestyle: friendly, familiar neighbors; a decent public education for their children; a way of life earned through hard work that provided for everyone's needs comfortably; and perhaps most importantly, a thriving community. Sandville was and still is economically driven by food production, as family farms and ranches make up the bulk of the local industry. Since the end of the second world war, however, the town has experienced the same trend as the rest of the country - younger residents have left to bigger towns for college, and the number coming back home steadily decreased. With fewer residents coming back to the town, businesses have been experiencing decreasing sales. Meanwhile, property taxes are high and the overall economic outlook is uncertain.

A new economic opportunity has been the talk of the town for the past few months. A wind energy developer has been looking at land on the outskirts of Sandville city limits as a potential site for a new wind energy farm. Resident opinions are split. Some of the farmers, the local environmental advocates, and the chamber of commerce all think the proposed wind farm would be a great way to revitalize Sandville. Other landowners and biologists from the local university have reservations about the consequences of reorganizing the town's social and environmental structure to incorporate this new element. The County Board has scheduled a town hall meeting to understand citizens' positions on the issue.

Each student (or student group) will be assigned a stakeholder with a specific stance on the wind energy development. You must defend your stance since the decision will radically impact both your stakeholder as well as the future of your town.

Handout 4A: FARMER (PRO-WIND DEVELOPMENT)

As a fourth-generation farmer who has grown corn and soybeans near Sandville for nearly your entire life, you have weathered the brain drain of the town and surrounding area, but have long felt the future of the area is pretty bleak. Three of your four kids have moved to bigger cities (and more opportunities) out of state. While the fourth has shown some interest in taking over the farm, you worry that volatile ag markets, changing consumer tastes, and other issues will make future farming difficult, if not impossible. The proposed wind development, however, has given you cause for hope. You have already had some informal talks with the wind developer, who has expressed interest in putting turbines on your property should the development be allowed to go forward. The turbines would provide a steady income source and provide you with the opportunity and funds to further diversify, providing some buffer from the rollercoaster effects of the market. While you aren't convinced being surrounded by a big wind farm would be a picturesque sight, it is a lot easier to swallow than losing the family farm. You plan to go to the town hall meeting to make sure the County Board understands just how important the economic benefits of the wind project are to farmers.

Stakeholder	Pros	Cons
Non-farming landowner		
University biologist		
Clean energy advocate		
Chamber of commerce		
Local rancher		
Mayor (optional)		

Handout 4B: NON-FARMING LANDOWNER (ANTI-WIND DEVELOPMENT)

You are a retired landowner who moved to this town six years ago. You decided to move here because you wanted to retire in a quiet place away from the city madness. Your land has an impressive amount of prairie diversity that you admire every day and is making retirement a lot more pleasant. As one of the largest landowners in Sandville, the wind turbine company may talk to you about possibly having wind turbines on your land. You know that wind turbines are not quiet and you will not believe anything the wind turbine company says. In addition, you think the turbines are ugly compared to the prairies you have on your land. You think the wind turbines will take away the beautiful aesthetics of the prairies that you observe every morning. You and your significant other are trying to have a peaceful and smooth retirement. You are also concerned about the health risk the wind turbines are going to impose if the company is given the thumbs up. You plan on attending town hall meeting to discuss your disapproval of the wind turbine development.

Stakeholder	Pros	Cons
Farmer		
University biologist		
Clean energy advocate		
Chamber of commerce		
Local rancher		
Mayor (optional)		

Handout 4C: UNIVERSITY BIOLOGIST (ANTI-WIND DEVELOPMENT)

You are a professor at the University of the Sandy Plains (USP) and oversee several research projects in the area around Sandville. As a born and bred Sandviller, you understand what energy development could mean for your hometown, but the construction of wind turbines gives you pause. You know from your research that the turbines are disruptive, and often lethal to bats and many of Sandville's migratory birds. These species play an important economic role in Sandville by eating hordes of agricultural pests, and bird migrations serve as a tourist attraction. You worry that increased disruption of these bats and birds could leave Sandville's agricultural-based economy vulnerable to infestation, alongside concerns of biodiversity, ecotourism, and other related concerns. Ultimately, you suspect the quick economic gain by wind energy development will sabotage the long-term success of Sandville's ecology and economy.

Stakeholder	Pros	Cons
Farmer		
Non-farming landowner		
Clean energy advocate		
Chamber of commerce		
Local rancher		
Mayor (optional)		

Handout 4D: CLEAN ENERGY ADVOCATE (PRO-WIND DEVELOPMENT)

You are the founding member of the Sandville Wind Energy Association (SWEA), a group that holds weekly meetings advocating for the benefits of wind power. You know that wind energy is a cleaner, more sustainable source of energy than traditional fossil fuels because it is renewable and no pollution is produced during energy creation. Your group is quick to point out to skeptics that burning fossil fuels (i.e. coal or gas) contributes to greenhouse gas emissions, and current U.S. wind energy production reduces the amount of CO₂ released into the atmosphere by 200 million metric tons annually. Also, manufacturing, installing, and maintaining wind turbines creates jobs and supports numerous workers. You also care a great deal about Sandville and believe the project could pump a great deal of money into the area and revitalize the town.

Stakeholder	Pros	Cons
Farmer		
Non-farming landowner		
University biologist		
Chamber of commerce		
Local rancher		
Mayor (optional)		

Handout 4E: CHAMBER OF COMMERCE, SANDVILLE (PRO-WIND DEVELOPMENT)

You are the representative of the Sandville Chamber of Commerce (SCoC). The primary goal of the SCoC is the economic growth and prosperity of the Sandville community, both as a whole and as individuals. As the representative of a diverse set of business owners, you want to unite the businesses of Sandville behind an economic-based course of action that will benefit the residents and stop the economic decline of the town. You see the proposed project as an opportunity to develop the community, provide new jobs to residents, attract new businesses, and maybe even lead to a new housing development. Overall, you think this project has the potential to enrich the town of Sandville.

Stakeholder	Pros	Cons
Farmer		
Non-farming landowner		
University biologist		
Clean energy advocate		
Local rancher		
Mayor (optional)		

Handout 4F: LOCAL RANCHER (ANTI-WIND DEVELOPMENT)

You and your family have been ranching on 10,000 acres of land outside Sandville for five generations. You feel responsible not only for the well-being of your livestock, but also that of the land. Most importantly, it is up to you to provide for your family. The proposed wind development project makes you uneasy. It is adjacent to a portion of your land and you are concerned about possible health impacts to your cattle. Also, you regularly hunt on your land and have an agreement with the state's Game and Recreation office to allow public hunting on some sections of your land during the hunting season. With the addition of wind turbines to the landscape, you are uncertain if wildlife will still visit your land or if the development will drive them away. You also have a sense of business, having helped run the family's ranch since you were young. You want the company to run a cost-benefit analysis of the proposed project that includes costs of manufacturing, shipping, and building additional infrastructure to see how long until the project breaks even. That way you can assess the long-term viability of the project. Lastly, you are concerned about whether the wind company respects the town and its residents. They may not appreciate the community's way of life and may transform the town into something unrecognizable.

Stakeholder	Pros	Cons
Farmer		
Non-farming landowner		
University biologist		
Clean energy advocate		
Chamber of commerce		
Mayor (optional)		

Handout 4G: MAYOR (OPTIONAL)

You are the mayor of Sandville. Throughout the past eleven years, you've guided your town through times both good and bad. Recently, Sandville has taken a hit economically - over the past decade, your town has experienced nearly a 10% population decrease as younger residents leave for larger cities. Your residents are taking it in stride, but you can tell a sense of unrest is spreading. The new wind developers have sparked a strong debate in the community, and both sides are passionate in their positions. Many farmers believe having wind turbines on their property will provide a steady flow of income to supplement the unstable agriculture markets. Other landowners worry that the noise and unpleasant aesthetics from wind farms near their properties will lead to values plummeting. Many, including yourself, are wary of letting a group of outsiders create such a significant change to Sandville. This tension could not have arrived at a worse time for you - you're in the home stretch of a bid for reelection! While you've been popular enough to be voted in as mayor for three consecutive terms, this upcoming election will be your toughest challenge yet. The outcome of your choice will essentially decide your fate, as your opponent will be sure to capitalize on your failure. How can you balance managing Sandville's economy with the conflicting interests of your citizens?

Stakeholder	Pros	Cons
Farmer		
Non-farming landowner		
University biologist		
Clean energy advocate		
Local rancher		
Chamber of commerce		