Consequences of Sitka spruce afforestation in Norway

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Introduction

On a global scale, forests play a substantial role in diminishing climate change through carbon sequestration. Additionally, forests constitute the most biodiverse of all the terrestrial ecosystems, as they are home to more than 80% of the terrestrial animals, plants and insects (UN, no year). The sub-target 15.2 of the 2030 agenda is devoted to "*promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally".* However, this rises an important question on how afforestation can be increased in a sustainable manner. Naturally, planting trees contribute positively to keeping levels of CO2 down by absorbing it from the atmosphere. On the other hand, planting trees in places they weren't before can be problematic for other plants, animals and fungi, as their habitats change to a landscape more resembling a forest. (Øyen & Nygaard, 2020) In this paper we aim to discuss the possibilities of sustainable practices for afforestation, including its possible negative impact on biodiversity, using the introduction of the Sitka spruce in Norway as an example.

What is afforestation?

Afforestation is one of the methods of forest management that could be put into action to tackle the issue of deforestation and unsustainable land use. It is important to firstly understand the differences between afforestation and other forest management practices. The term *reforestation* is used to describe the re-establishment of forests and woodlands that have been destroyed, doing so in the exact same site. The term *afforestation* on the other hand, describes forests that are established in areas where there was no previous tree cover. They both differ from the practice of *forest restoration*, which aims to restore a degraded forest to its original state and to re-establish a presumed original structure, productivity and biodiversity of the forest (Lee, 2021). Reforestation and afforestation usually resolve in the intense plantation of few or single species, with potential negative effects on the surrounding vegetation and local biodiversity (Duan & Dilnur, 2021).

The practice of afforestation provides different environmental benefits, reflecting the ecosystem services produced by forests. So, the plantation of trees in the form of a forest increases the rainfall regulation of the specific area, the removal of CO2 from the atmosphere and its conversion in biomass, the soil quality, creates natural resources such as timber, improves local living conditions and, if done in urban areas, it could also reduce air pollution (Bernard et all, 2007).

Tree plantation in itself could also have negative effects. Afforestation in grasslands, heathlands, or areas where forests would not naturally occur needs to be attentively managed. Since, the life cycle of forests is very long, it is difficult to change them once afforested (Lee, 2021). Therefore, the forest site and the selected species must be analysed in depth before afforestation to maintain the success of afforestation and the healthy growth of forests later. Invasive tree species could dangerously alter and change the original landscape and species diversity count (Duan & Dilnur, 2021).

Is afforestation always net positive for the environment?

When looking at the effects of afforestation on biodiversity, in many cases where afforestation happens there is timber production in plantations involved, meaning few species planted. Many are intensively managed in around 30 years cycles with agricultural practices such as ploughing, fertilizing, harrowing and use of herbicides, in addition to invasive harvesting with a clear-cut practice. This gives little room for biodiversity to flourish. However, some planted stands can become more diverse naturally after centuries out of use. (Brockerhoff et al, 2008) The phase the forest is in is also important for the biodiversity in the area, for example more mature forests will give less light to lower living plants. Afforestation in general leads to a reduced number of open habitat species and increases forest bird species: predatory and seed eaters. Other bird species and insects do in general decrease in direct connection to the vascular plants decreasing. Structural heterogeneity can be achieved by using several species of trees for the afforestation, which can increase diversity of several groups of species in the area. Other forest management strategies can also be applied to help increase diversity. (Øyen & Nygaard, 2020)

The latitude where the forest will be is another important element to take into consideration. Tree planting practices in high latitudes could have reverse effects in the climate mitigation strategy compared to tropical latitudes. In fact, it could affect the surface albedo of the area with a warming effect, because snow falls through the forest canopy, keeping the surface darker compared to snow covered grasslands. Even without snow, forest canopy in high latitudes is much darker than grasslands (Lee, 2021).

Case study: Sitka spruce afforestation in Norway

After the Second World War, a lot of the Canadian spruce “Sitka” was planted in Norway; most heavily along the at the time mostly barren coast. This was done to prepare for the future in terms of economic growth and gathering building materials for societal expansion. Yet, the first planting of the Sitka spruce happened in the 1880’s, just on a much smaller scale. The Sitka spruce was chosen because of its better resilience against colder climates, such as the climate along Vestlandet, and further north.

The Norwegian government of the 1950’s even subsidized the planting of the spruce for private landowners (Fylkesmannen, no year).

The result of this mass-scale planting can be seen today, where earlier barren pastures are now

covered with Sitka spruce, and both smaller and bigger islands previously barren are now covered to the brim with spruce. This was, however, the previous generation's plan all along. Vestlandet is now covered with strong, durable, fast-growing and dense trees that can be, and is being used for timber production. The Sitka spruce contributes positively to carbon sequestration, as it binds large amounts of Co2 (Fylkesmannen, no year).

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However, the rapid expanse of the Sitka spruce also brings issues. Because of the Sitkas ability to spread early and rapid, it endangers vulnerable areas of biological diversity. Sitka spruce is a non-native species in Norway and will quickly grow in nutrient rich areas close the coast and nothing is going to stop this growth because the trees do not have any natural enemies (Penniston & Lundberg, 2014). Because the Sitka spruce grows tightly together and tall, there is little sunlight and nutrients on the forest floor. This often results in a barren forest floor covered in spruce needles (Fylkesmannen, no year). The trees will shade for the smaller native vascular plants which will lead to less diverse number of vascular plants in the areas (Øyen & Nygaard, 2020). This has not only consequences for the biodiversity of plants in the areas, but also minimize the biodiversity for the birds, insects etc. that relay on these plants in the ecosystem. Studies have found that afforestation of invasive species such as Sitka spruce give only negative effects for vascular plants and epiphytic lichens, when observed over a short period of time in Norwegian conditions. This is also a trend in other European research. However, few of them have researched mature forests. (Øyen & Nygaard, 2020)

Afforestation in Norway with Sitka spruce of previous agricultural land is attempted to store carbon above the ground instead of in the ground. The reason for this, is that agricultural soil has a different distribution of organic matter compared to the soil before land-use. This is a problem for native plants and the ecosystem around these plants, which require a specific distribution of organic matter. The intention of the afforestation is also to achieve a distribution of organic matter in the soil equivalent to distribution before land use. However, a recent study from 2021 (Strand et al., 2021) shows that Sitka spruce plantations in Norway do not significantly change the distribution of organic matter in the soil, even though the plantation has been there for approximately 50 years. This is one of the reasons why afforestation with Sitka spruce in Norway does not have the desired benefits. Now, Sitka spruce is mostly widespread near the Norwegian coast. However, seeds are getting spread as more trees in Norway are getting mature, the distribution of Stika spruce will also occupy areas in national parks (Øyen & Nygaard, 2020). This will even have bigger consequences for vulnerable wildlife in Norway, as Sitka spruce will eventually shade for vascular plants in these parks.

Conclusion

On paper, afforestation using Sitka spruce is an easy and efficient way of securing increased CO2 sequestration, while simultaneously providing material for timber production. Unfortunately, the

afforestation of Norway has had unforeseen negative consequences for the local ecosystems and has severely decreased biodiversity in the affected areas. Since Sitkas have no natural enemies and spread uncontrollably, it seems that the problem will only grow bigger in the future. To both deliver on subtarget 15.2 to increase afforestation and simultaneously lower the negative impact on biodiversity, it should be considered to use only species that are native to the area, to prevent uncontrolled spreading. It should also be considered to plant more than one species, to ensure structural heterogeneity, and thereby biodiversity.

An emerging issue of SDGs is that the practices proposed cannot be put into action in a universal way. It is needed to localize and consider every action in its own context. In our example, the practices of afforestation could be either positive or totally endangering for the environment. It is essential to formulate "educated guesses" to clearly evaluate the feasibility of such practice in different areas and its changes at different latitudes. The efforts of the SDGs cannot be generalized and may not be always adequate for different landscapes. The addition of traditional local knowledge should also be included to create a sense of involvement in the decision-making process for the inhabitants of the land, who are those mostly affected by land use changes.

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