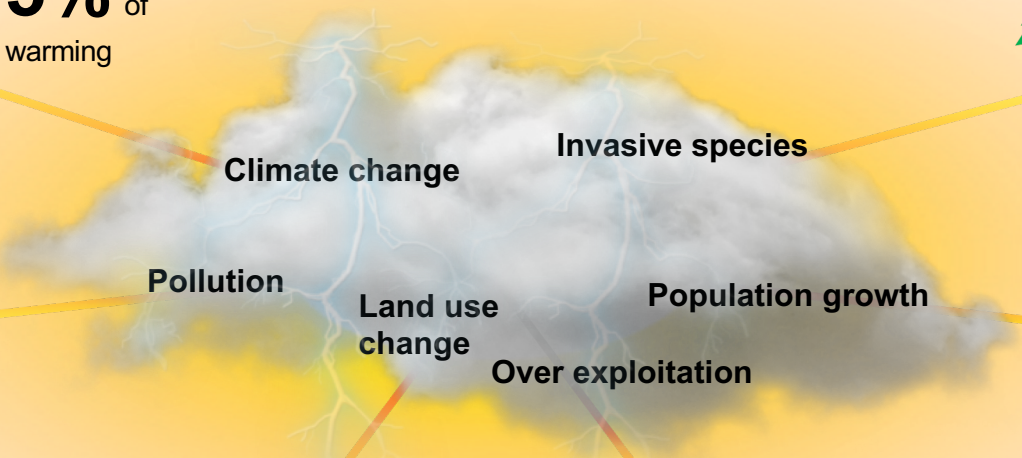
THE PERFECT STORM

A SIXTH MASS EXTINCTION
AND HOW TO AVOID IT

Annual investments of **2.5%** of world GDP could **stop** global warming

Norwegian **regulations** prevent Sitka spruce from invading heathlands



Push-pull pest management lead to **increased maize yields** in East-Africa

EU **ban** on disposable plastic articles

Wildlife corridors are enabling interactions crucial for **regeneration** and **preservation** of native habitats

National parks increased the "Svalbard reindeer" population by **13 times** from 1950 to 2019

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SCAN ME

The “perfect storm”: a sixth mass extinction and how to avoid it

Within the next few centuries, a sixth mass extinction could occur. Existing ecosystems will not withstand a potential strike of the “perfect storm” of ecological stress. If a synergy of parameters such as climate change, overexploitation, population growth, land-use change, pollution, and invasive species accumulates to a “perfect storm”, the biosphere would reach its utter limits until there is no longer a diverse life (Pievani, 2014). Luckily, the perfect storm has yet to arrive, but today’s trends are ever menacing (Barnosky et al., 2011), and change is necessary. This paper will further explain the challenges we face and provide some theoretical and empirical examples of possible solutions.

Overexploitation

Overexploitation caused by human activities is one of the biggest threats to biodiversity (Romero-Muñoz et al., 2021). Overexploitation is the action or fact of making excessive use of a resource. Excessive hunting, poaching, fishing and gathering can eventually eradicate species. When individuals of a species or number of species are greatly reduced in a short time, it affects the entire ecosystem. In general, the loss of biodiversity leads to a more unstable and less robust nature (“Overhøsting truer mangfoldet i norsk natur,” n.d.).

One of the core strategies to prevent overexploitation is the establishment of national parks and other protected areas (Cernea et al., 2006). Activities that lead to overexploitation are illegal in these areas, which will protect the species and the biodiverse ecosystem in the area. Other solutions to overexploitation are advertising campaigns for creating general awareness of the topic. Many people do not realise or care about the impact of overexploitation on the planet and its long-term effects. Policies and legislation will make it more challenging to utilise limiting natural resources. Community and government can also help to address the issue of overexploitation.

Svalbard reindeer (R. t. platyrhynchus) was protected in 1925 after most subpopulations had been eradicated by harvest (Le Moullec et al., 2019). Over the last century, several deer species have increased in abundance through range expansion and density increase, following hunting restrictions, changes in land use, and translocations in Svalbard (Le Moullec et al., 2019). The abundance of the Svalbard reindeer subspecies is estimated to be approximately 22 000 individuals in 2019. It is estimated that the population was close to only 1000 animals when the sanctuary was introduced in 1925 (Governor of Svalbard, 2009). The total population size measured in 2019 gave estimates up to 13 times higher than the minimum estimates from the late 1950s (Le Moullec et al., 2019).

Population growth

The exponential population growth that we see today is by definition not sustainable because of its negative impact on earth’s natural resources. It is because human interactions with ecosystems will increase with population density, and thus the intensity of poor modification (Ellis and Ramankutty, 2008). The neo-Malthusian movement fostered by Garrett Hardin argues that an ever-increasing population is the most profound problem for the environment (Hardin, 1968). It is also argued that “freedom in a commons brings ruin to us all” due to overexploitation of shared resources, as famously stated in Hardin’s theory The Tragedy of the Commons (Hardin, 1968). Further, Hardin claims that population growth will weaken the production capacity of nature and deteriorate soil quality and biological production, and consequently act as a grand threat to biodiversity.

Many opponents to Hardin’s theory emphasise that many people have knowledge about ecology and that local management may regulate the pressure on natural resources. Elinor Ostrom raised a strong voice against Hardin’s arguments, claiming that free access to nature does not exist due to oral agreements, norms and internal regulations, in addition to sanctions against those who break the rules (Ostrom, 1990). She came up with eight principles for managing a common, which can be used to convey how humans, despite their multiplicity, can ensure their survival. One example can be the EU ban on disposable plastic articles, among many others.

Land-use changes

With an ever-growing population, the demand for new agricultural and grazing lands grows in tandem. From 2000-2010, agriculture was responsible for 80% of deforestations and forest degradation (Ramankutty et al.,

2018). The need for pasture and croplands is destroying the species richness. Conversion of forest for agricultural needs, use of manure, pesticides, synthetic fertilisers and crop choices has caused 20-30% of biodiversity losses across biomes and taxonomic groups (Ramankutty et al., 2018). Poor agricultural management has also impacted soil health. The replacement of forests and grasslands into farmlands with alternating annual crops and synthetic fertilisers influences erosion, organic matter inputs and infiltration (Ramankutty et al., 2018). Combination of these has increased soil-borne pathogens and crop susceptibility to droughts (Ramankutty et al., 2018). Ironically, agricultural lands are declining due to poorly planned urbanisation and industrialisation (Vlek et al., 2017). Compared to the deteriorating life in rural areas, employment security and livelihood in urban regions are attractive pull (Vlek et al., 2017). Poorly managed expansion of the cities costs agricultural land's productive capacity (Vlek et al., 2017). In turn, farms compensate by expanding to inferior land (Vlek et al., 2017).

In order to preserve biodiversity, we must implement changes when it comes to the use of our land. With better management and governance, we can minimise habitat loss and fragmentation. Land fragmentation deprives wildlife interactions necessary for the regeneration and preservation of native vegetation (Ramankutty et al., 2018). Therefore, we have to avoid it. The use of manure, synthetic fertilisers and nitrogen-fixing legumes needs to be significantly reduced to minimise the biodiversity loss on land and freshwater environments (Ramankutty et al., 2018). Most importantly, consumer demand has to elevate the pressure from agricultural lands.

Climate change

Climate change has not been the most important driver of biodiversity loss to date globally. However, it is projected to be among the most critical drivers in the coming decades. (Almond et al., 2020). This negative spiral is continuous and global emissions are projected to be about the same in 2030 as today (Almond et al., 2020). Without any additional actions to reduce greenhouse emissions, humans are on the pathway to a rise of 3-4°C, which could confound the signals that trigger seasonal events such as migration and reproduction vital to life, causing devastating effects on biodiversity (Almond et al., 2020). However, a loss in biodiversity could also have adverse effects on climate. For example, deforestation increases the atmospheric abundance of essential greenhouse gas (Almond et al., 2020).

Therefore, issues of biodiversity loss and climate change must be addressed together. More specifically, following sustainable development goals, such as that made by the UN, are vital to take urgent action to combat climate change and its impact on biodiversity (DESA, 2021). Targets need to be focused on integrating climate change and measured into national policies, improving education, awareness-raising, and institutional capacity on climate change mitigation, adaptation, impact reduction, and early warnings (DESA, 2021). Moreover, our economies are embedded within nature, and it is only by recognising and acting on this reality that we can protect and enhance biodiversity (Almond et al., 2020). In addition, the UN's Intergovernmental Panel on Climate Change estimates that stabilising levels of greenhouse emissions would require annual average investments of around $2.4 trillion between 2016 and 2035, representing about 2.5% of the world GDP (Gasser et al., 2018).

Pollution

When considering biodiversity, the biggest threat from pollution comes from nitrogen deposition. Human interference with the nitrogen cycle has exceeded the planetary boundaries (Cox, Ladle and Moore, 2020), primarily due to nitrogen application in soil from artificial fertilisers and inefficiencies, meaning over-application or poor synchronising with crop demand timings (IPCC, 2019). The IPCC report (2019) further found that agriculture, forestry and other land use are the main sources of nitrous emissions globally during 2007-2016 (82%) due to the increased manure deposition from managed pastures. This imposes several challenges for biodiversity, especially in aquatic ecosystems, where high abundance of these nutrients cause toxic algal blooms, loss of oxygen, fish kills, loss of aquatic plants and coral reefs etc. (Cox, Ladle and Moore, 2020). Moreover, nitrous oxide is a greenhouse gas that will contribute to global warming and consequently poor conditions for several species.

But there are ways to reduce nitrogen deposition. One approach can be to implement agroecological principles in farming. This is a method where life itself is the crucial measure for fertility. It acknowledges that agricultural land is part of an interactive ecosystem and takes advantage of the natural processes that are already happening there. One example is the push-pull agricultural pest management: to seed something that

attracts the pests (pull), in addition to something that displaces them (push) in order to preserve the initial crops (Pretty et al., 2012). This has been successfully done in East Africa, for example, where the maize yields are increasing without the use of expensive and polluting assets (Pretty et al., 2012).

Invasive species

Invasive species are established in areas outside their natural range and are causing harm in ecosystems they are not native to (NWF, 2020). This is one of the biggest threats to biodiversity today because they can outcompete native species by occupying their space and resources. They can also take the role as a predator or bring new diseases with them that have not been present in the ecosystem before (Almond et al., 2020). The rate of new introductions of invasive species has increased steeply since 1950, probably due to increased globalisation and population growth (Almond et al., 2020).

An example of an invasive species is the Sitka spruce (*Picea Sitchensis*) in Norway. It originates from the west coast of North America and was imported to Norway at the end of the 19th century in connection to forestry (Artsdatabanken, 2018). Today the Sitka spruce spread into heathlands, an endangered habitat in Norway. Here the trees displace the light-demanding heather species and gets in the way of livestock grazing, which maintains this landscape form (Artsdatabanken, 2018). To stop the further spreading of the Sitka spruce, we must cut down trees in areas where it becomes invasive, like in the heathlands. It can also be a good idea to remove nearby trees to prevent the spread of seeds with the wind, considering that spreads up to 2 kilometres away from the nearest tree field have been registered (Artsdatabanken, 2018). We can also stop planting new trees, especially in areas where it could become invasive and threaten native species.

Invasive species is a worldwide problem today, and a general approach to reducing the threat of these species is more strict border controls. People and resources can carry uninvited species with them. For instance, insects can hide in wood or plants. It is also a good idea to regularly clean your shoes, and the tires on your car, etc. when you travel from one place to another. Another measure is to learn to identify invasive species, so that we can report them and do something about it (NWF, 2020).

Conclusion

In this paper, we have emphasised the main challenges for life on land and the future of biodiversity. Even though they act as significant threats alone, the most profound threat is a potential accumulation of these parameters into the perfect storm of ecological stress. Such an incident would lead us into a sixth, human-induced, mass extinction unless the trend of accelerating rates reverses. In order for that to happen, societies need to implement more sustainable approaches in environmentally-friendly policy-making, whereas green financing, land protection (national parks, management and governance) and agroecology constitute sensible strategies.

References

Almond, R.E.A., Grooten M. and Petersen, T. (Eds). (2020) *Living planet Report 2020. Bending the curve of biodiversity loss, WWF*.

Artsdatabanken. (2018) *Sitkagran Picea sitchensis.* Available at: https://artsdatabanken.no/fremmedarter/2018/N/537 (Accessed: 8 May 2021)

Barnosky, A. D. *et al.* (2011) 'Has the Earth's sixth mass extinction already arrived?', *Nature*, pp. 51–57. doi: 10.1038/nature09678.
Cernea, Michael M & Schmidt-Soltau, Kai. (2006). Poverty Risks and National Parks: Policy Issues in Conservation and Resettlement. World development, 34(10), pp.1808–1830.

Climate change | Department of Economic and Social Affairs (no date). Available at: https://sdgs.un.org/topics/climate-change (Accessed: 7 May 2021).

Cox, C.B, Ladle, R.J. and Moore, P.D. (2020) *Biogeography: An ecological and evolutionary approach*. Oxford: Wiley.

Gasser ; Nathan Gillett, T. and Luderer, G. (2018) 'Edgar Hertwich (USA/Austria), Lena Höglund-Isaksson', *Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change*.

Governor of Svalbard. (2009). Plan for forvaltning av svalbardrein. Volume 1/2009. Sysselmannen på Svalbard, Longyearbyen, Norway.

IPCC (2019) 'Summary for Policymakers. In: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems [P.R. Shukla, J. Skea, E. C', in *International Encyclopedia of Geography: People, the Earth, Environment and Technology*, pp. 1–15. Available at: https://www.ipcc.ch/site/assets/uploads/2018/07/sr2_background_report_final.pdf (Accessed: 11 May 2021).

Le Moullec, M. et al. (2019). A century of conservation: The ongoing recovery of svalbard reindeer. The Journal of wildlife management, 83(8), pp.1676–1686.

Ramankutty, N. et al. (2018). Trends in Global Agricultural Land Use: Implications for Environmental Health and Food Security. *Annual review of plant biology*, 69(1), pp.789–815.

Overhøsting truer mangfoldet i norsk natur [WWW Document], n.d. . Sabima. URL https://www.sabima.no/hva-truer-naturen/overhosting/ (accessed 5.10.21).

Pievani, T. (2014) 'The sixth mass extinction: Anthropocene and the human impact on biodiversity', in *Rendiconti Lincei*, pp. 85–93. doi: 10.1007/s12210-013-0258-9.

Pretty, J, Toulmin, C, Stella, W. (2011). Sustainable intensification in African agriculture, *International Journal of Agricultural Sustainability*, pp. 5-25

Romero-Muñoz, A., et al. (2021). Habitat destruction and overexploitation drive widespread declines in all facets of mammalian diversity in the Gran Chaco. Global change biology, 27(4), pp.755–767.

NWF (2020) *Invasive Species | National Wildlife Federation, The National Wildlife Federation*. Available at: https://www.nwf.org/Educational-Resources/Wildlife-Guide/Threats-to-Wildlife/Invasive-Species?fbclid=IwAR3IFbumQc_HDWrdpnCujoW8LAEB_e0PVbJ9gJx4KWBrVtlto3JQR2BloSE (Accessed: 11 May 2021).

Vlek, P.L.G. et al. (eds.). (2017). "Land degradation and the Sustainable Development Goals: Threats and potential remedies". CIAT Publication No. 440. International Center for Tropical Agriculture (CIAT), Nairobi, Kenya. 67 p. Available at: http://hdl.handle.net/10568/81313