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Controversies and Misconceptions related to Forest Carbon Storage and the Policy of Forest Bioenergy and Sustainability

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Abstract

The present commentary elaborates on the question whether the sequestration of carbon in forests can be interpreted as a renewable form of energy. Serious concerns have been raised regarding this classification of forest wood among the alternatives for fossil carbon reserves. The hypothesis of (Zhao et al. 2022), namely that taller forests (as a volumetric measure) procure a larger C-sequestration (storage) to the planet's biosphere, not only is extrapolated to all latitudes. Moreover, a number of 10 misconceptions is envisaged and critically answered, that are well-known from discourses of deforestation lobbyists. Finally, a case study is presented of the impact of deforestation and landscape reforms on bird biodiversity in the Netherlands, measured using a newly developed quick-scan for bird diversity in European temperate regions. It is observed that with broadening and increasing the impact of the political decision making process, the risk of generating bigger ecological mistakes may increase too.

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Introduction: the Heritage of the Paris Agreement (2015) and Europe's Renewable Energy Directives (REDs)

It was called the most important multilateral agreement on planet sustainability since the Kyoto Protocol (1997)[1], the Paris Agreement (2015), an agreement between 159 countries devoted to limit climate warming below 1.5°C [2]. The central aim of the *Paris Agreement*, convened at the International Climate Conference of Paris (2015), "included 'pursuing efforts' to limit global temperature rise to below 1.5 °C above pre-industrial levels and related global greenhouse gas emissions pathways" [3]. According to subsequent warnings issued by the *Intergovernmental Panel on Climate Change*, the rise of average surface temperatures are likely to exceed this 1.5 °C between 2030 and 2052, based on current trends (IPCC, 2019). It is obvious that the large scale deforestations seen since 2015, in Europe as well as in the world's greatest rain forests, were not intended specifically as measures to counter climate warming. However, after 10 years, from various sides an urgent need is expressed to evaluate the efficacy and effectiveness of this *Paris Agreement* for planet sustainability, and especially it is most needed to clarify the mismatches between forest carbon storage or sequestration and the policy of the use of forest wood as a source of sustainable bioenergy [4,5]. Partly these controversies resulted from previous classifications of forest wood as 'renewable energy' in Europe's 2009 *Renewable Energy Directive* (RED 2009) [6]. But also the revised RED of 2018 (RED II) (consolidated in 2023) [7] "continues to classify biomass in the same way as solar, wind and other categories of renewable energy" [4]. In the Netherlands between 2001 and 2020, for instance, Global Forest Watch estimated a deforestation of approximately 4.5 % of the national tree cover since 2000 [8]. One could sarcastically argue that the deforestation of pristine forests, as seen in many European regions including in parcels of the *Białowieza National Park* (Poland), are a form of collateral damage of the Paris Agreement, or the keen result of the vigorous wood industry lobbyist's finding of opportunities for deforestation at every corner, but there is also a serious scientific debate at the basis of this conflict. A number of the current misconceptions and arguments for deforestation, used to promote the interests of the wood industry, are summarized in **(Ten Misconceptions used by Deforestation Ambassadors).**

In the present commentary, we will first elaborate on the scientific question of the relationship between carbon storage (sequestration) and the forest characteristics, including geographical latitude, physical and soil characteristics (relating to soil chemistry, hydrology and ecology of the soil) **(see The Relation between Tree Size, Geographical Latitude and Carbon Sequestration in Forests).** This entails a twofold hypothesis testing. The first is the extension of an existing hypothesis, ascribed to Mefang Zhao *et al.* [9], namely: "taller forests have higher autotrophic C-consumption and sequestration rates in all ecosystems (irrespective of latitude)". The extension regards the extrapolation to all latitudes. Secondly, we envisage the hypothesis that the increasing size of geopolitical blocs not only increases their political weight but also increases the risk of reinforcing decisions that appear to become detrimental to the planet's sustainability and world climate system. Despite the impossibility of testing the latter hypothesis (without causing global conflicts), the reason for questioning this non-testable hypothesis is a call for counter-examples of 'smaller' geopolitical players (governmental or non-governmental organizations, NGOs) that might come up with better solutions than the 'big players' so far have procured.

In addition to the former hypothesis, questions regarding the long term effects of (large) forest zones for climate sustainability are also envisaged. The multi-functionality of taller and especially older forests, means that a sustainable forest biodiversity entails much more than the bioenergetic, biochemical and economical valorization protocols alone [10]. A well-known example is the important interaction of Lichens with other groups of epiphytic plants and fungi, in relation to the environmental conditions [11].

Also a case study is provided to evaluate the effects of deforestation and other landscape reforms on the local biodiversity in a number of regions **(see The Effects of Deforestation and other Landscape Reforms on Local Biodiversity)**. Finally, we search for answers regarding the question whether scaling-up against the threats of deforestation, dryness, bush fires, water flooding and biodiversity impairment, results in approaches that are also beneficial to mitigating the effects of climate change **(see Biodiversity, Proportionality and Planet Sustainability).**

The Relation between Tree Size, Geographical Latitude and Carbon Sequestration in Forests.

Several studies have addressed the question of the relation between tree size and carbon-storage or sequestration[9,12]. Mildrexler et al. [12] reported that 2.0 to 3.7 % of stems classified as 'large trees' (diameter > 53 cm) in Western USA (Oregon) accounted for 33 to 46 % of the 'overall aboveground carbon' (AGC) stored. Zhao *et al.*, [9] investigated several forest types in different geographical regions of continental China, and found a number of important relations, such as the relation between the asymptotic height (H_{max}) and the size-scaling exponent (β) of tree size. These are important architectural parameters of forests, based on the relationship between height and tree diameter, that are necessary to calculate the C-sequestration capacities of forests.

The mathematical formula used for the relation between H_{max} and β is:
$H = \alpha . D^{\beta}$ with *H, D* the height, resp. diameter of individual tree trunks, and α, β the allometric parameters (fitted to the population data), or

$$\log_{10} H = \log_{10} \alpha + \beta \log_{10} D.$$

First, Zhao *et al.* (2022) found a decreasing trend of H_{max} with increasing latitude (= angular distance from the Equator) and an increasing trend of β with latitude. The total vegetation C-stock (aboveground + belowground component) was significantly and positively correlated with H_{max}. For forests taller than 20 meter, however, the *Net Ecosystem Productivity* (NEP) showed a strong negative correlation with H_{max}. This means that an increase in H_{max}, for instance with 10 m, resulted in a decrease in mean ecosystem C-turnover time by 16.9 % (corresponding to 7.43 years) [9]. It is easy to understand that these findings have important implications for forest restoration, policy and management: "taller forests might indeed be expected to have higher autotrophic respiration consumption rates but lower mean ecosystem C-turnover time and NEP values than shorter forests" [9].

The influence of latitude is at least dual: on the one hand, trees grow taller (increasing H_{max}) near the Equator, but with a lower size-scaling exponent (β). On the other hand, it is also known, that trees grow bigger at much higher altitudes closer to the Equator (compare rain forests above 2500 mt in Taiwan and Himalayan Region with the alpine region in European mountains above 2500 mt) (Fig. 1. a,b). Moreover, the increased diameter points at an increased age of the trees, and, at higher temperatures and humidity, the growth is faster than in more temperate and subarctic climate zones. In the arctic zones, it is well-known that tree species like the Dwarf Birch (*Betula nana, Betulaceae*) grow not bigger than 0,20 – 0,30 mt, a size more similar to a shrub or grass in temperate zones. Zhao et al. also found important differences in forest growth and productivity measures depending on the soil and hydrology characteristics of the different regions (data obtained from the 'national forest database of China') [9].

Figure 1: a,b. Forest coverage dependent on latitude: (a) (left) in subtropical region (Taiwan, Alishan National Forest, latitude 23°30 N, altitude of 2500 mt); (b) (right) in temperate region (Swiss Alps, latitude 46°30 N, timber line around 2000 mt) (Photographs ©2016, Biological Publishing A&O).

Given the data available so far, no contradiction seems to exist refuting the first hypothesis, namely that taller forests (as a volumetric measure) procure a larger C-sequestration (storage) to the planet's biosphere. However, as discussed in the next section, several misconceptions appear to contrast with this general relationship, and are often misused to defend the interests of deforestation lobbyists and related stakeholders (like in the forest-dependent chemical industry).

Ten Misconceptions used by Deforestation Ambassadors

(Disclaimer) The misconceptions as formulated below (italic titles) are often used by local governments, lobbyists (not easily recognized as such) and (academic) scientists in public spaces, TV-programs like talk shows, and are therefore not always retrievable as scientifically validated publications, like science data are supposed to. Also, they do not always contain fake data or processes, but when the ecological and chemical processes are only regarded in an isolated, detached situation, the conclusions may as well become false. Because of the lack of opportunities to address the same audiences, we are inclined to present the refutations to these misconceptions in the present form, in a scientific journal. (End of disclaimer)

#1 Deforestation is needed to restore the pre-industrial rural landscape

One of the strangest arguments used to explain the large-scale deforestation efforts in the eastern provinces of the Netherlands (where the less densely populated regions are), was that deforestation was needed to restore the vast areas of heathland that dominated the rural landscape in the 19th century. It is well-known that large-scale deforestation was needed in the 17th century, in order to build the fleet of wooden ships that enabled the *United Dutch (Chartered) East India Company* (in Dutch called *VOC*, founded in 1602) to enter the intercontinental spice trade (and other trade activities we'd rather not mention) [13]. Not only hanging on to the fortune and glory of the past is a dangerously misleading goal, for the recent wood harvesting was used to produce woody biomass pellets [14], that eventually entered the global atmosphere… as CO_2 gas. Moreover, the argument that forests caused the gross reduction of heathland is deceptive, for the population growth obviously resulted in the enormous expansion of villages, urbanized areas and infrastructure, at the cost of both forests and heathland.

#2 Deforestation is needed to restore the biodiversity of heathland

Another argument related to the previous, is that deforestation is needed to restore certain rare reptile species like the Sand Lizard (*Lacerta agilis*), the Common European Viper (*Vipera berus*), the Common Slowworm (*Anguis fragilis*), and possibly others that are often found on sandy grounds or heathlands (see also #4). However, not only these species are rather common species in a broad region of Europe [15], we also observed that the highest density and biodiversity of these reptiles was observed in the border region between either forest and heathland, or between farmland and heathland [16].(Fig. 2.a). A similar observation holds for several large mammals, that prefer the border region for both shelter and foraging purposes [17] as well as for many bird species. Moreover, the abundance and breeding success of several heath bird populations appear to depend on the presence of structurally diverse grassland with sporadic trees, perches and brush wood, for the purpose of surveying the surrounding area [18].

Figure 2: a,b. Animal species typical for forest-heathland borders and open spaces in Europe: (a) (left) Sand Lizard (*Lacerta agilis*)(male); (b) (right) Crane (male), with 5 week offspring (*Grus grus*) (Photographs © 2024, Biological Publishing A&O).

Of course, also notable exceptions occur, especially with certain medium-size and large bird species, like the Black Grouse (*Tetrao tetrix*), that prefers vast heathland surfaces - however with sufficient numbers of tall trees – and the large Crane (*Grus grus*), that seems to have no other preferences than to stay away from human disturbances (Fig. 2.b). Unfortunately, the latter species are sometimes considered as flagship species for nature restoration projects, that often push aside many other species of lesser interest (Allaerts, 2014).

#3 Deforestation is needed to restore the quality of nature, in particular of heathland

In a close relationship with the former, it was reported that the quality of heathland and other natural reserves has been seriously diminished due to decennia of surplus nitrogen emissions, and that the saturation of ecosystems with nitrogen (N) has led to soil acidification and a diminished biodiversity [19]. It is known that plant communities and Lichens in particular are very sensitive to this increased N-deposition [20]. This argument was also used by defenders of deforestation to remove the N-saturated forests (coniferous forests in particular).

In this example, it is obvious that not the forests cause the problem, but the N-emission sources in industry and agriculture. The argument used by the nature management officials was based on the view that it was politically impossible to further reduce N-emission (from agricultural activities in particular) [19].

#4 Deforestation is needed to repopulate Sandy Biotopes with Insects

Sandy biotopes form a unique habitat for certain insect species, like several representatives of the parasitoidal and/or caterpillar-eating wasps (*Sphecidae,* Hymenoptera), e.g. *Ammophila (Podalonia) hirsuta*, and bee-killer wasps (*Philanthus sp., Crabronidae,* Hymenoptera), certain Skimmer dragonflies (*Sympetrum sp., Libellulidae,* Odonata), et cetera (Fig. 3.a,b). In order to make nature reserves more appealing to these sand-loving insects, deforestation is sometimes advised to enable the creation of sand-dunes and -plains.

Figure 3: a,b. Key insect species of sandy and open biotopes in temperate regions in Europe: (a)(left) Caterpillar-eating wasp (*Podalonia hirsuta*); (b)(right) Black Darter (*Sympetrum danae*)(female) (Photographs © 2023 Biological Publishing A&O).

However, not only the occurrence of these rather specialized insects in the first place depends on the occurrence in the eco-web of other, essential species (without bees, bee-killing wasps won't survive). Moreover, this argument is the result of economic considerations: to cut expensive labor costs ! Just like in heathland-management and in the management of other habitats, the common goal is to prevent the quick regrowth of tree seedlings. Therefore, it is suggested to keep these biotopes as far as possible away from the forest borders.

#5 Decay of dead trees and forest brush augments CO_2 emission

This is one of the most tricky arguments, because it involves a lot of chemical explanation and it is easy to misinterpret these chemical mechanisms when considered outside the ecological environment of an actual living forest. It is well known that plants produce carbohydrates (like glucose, $C_6H_{12}O_6$) out of water (H_2O) and carbon dioxide (CO_2) by a process called photosynthesis. Of course, plants also produce other carbohydrates and other substances (like lignin), a polymeric substance related to cellulose, and other macromolecules. Inversely, dissimilation of glucose (and other carbohydrates) in aerobic circumstances (i.e. in the presence of oxygen, O_2 , such as during respiration) results in the production of CO_2 and H_2O. But these products can be easily re-used by other plants in the ecosystem, like mosses, bracken, and also by lichens and fungi. In anaerobic conditions (without free oxygen), however, fermentation can take place, producing ethanol (C_2H_5OH) out of glucose. When the plants are submerged in water, like in marshes or compost heaps, fermentation is replaced by a process of putrefaction, yielding methane (CH_4) and CO_2 instead of alkanols.

The breakdown of forest wood into these greenhouse gases (CH_4 and CO_2) obviously does not spontaneously occur in nature (at normal speed), otherwise, the wood wouldn't be used as a sustainable building material. Lignin producing trees are normally well protected against the decomposing work of fungi and bacteria, procuring them considerably long decay times. During fermentation, in the food and other industries, aerobic acetic acid bacteria will decompose the short carbohydrates in wood pulp into CO_2, hydrogen (H_2) and acetic acid (CH_3COOH) [21]. Then methane bacteria will further transform these products into CH_4 and CO_2.

So, although the chemical constituents of wood can be all decomposed into hydrogen and greenhouse gases, it is a most misleading argument to state that forests in se contribute to the (enhanced) emission of greenhouse gases. On the contrary, they are the single most important habitat for C-sequestration (next to the world's oceans and ocean sediments) [22], when considered as a whole: the death of old trees giving way and a place in the sunlight for the young sprouts, as well as re-usable moieties for other species in the ecosystem, showcase the sustainability of the forest ecosystem as a whole (Fig. 4.a,b).

Figure 4: a,b. Examples of old trees structuring the surrounding landscape: (a)(left) Centennial Horse Chestnut (*Aesculus hippocastanum*) in Apennine Mountain forest (Italy); (b) (right) Swiss Stone Pine (*Pinus cembra*) leaving space to Edelweiss (*Leontopodium nivale*) in Swiss National Park
(Photographs © 2024, Biological Publishing A&O).

#6 Tree wood production is the only economic value of foresting

It is true that in common forestry business, wood is the far most product for calculating the forest's productivity (like the NEP, **see The Relation between Tree Size, Geographical Latitude and Carbon Sequestration in Forests**). Green Advertisement Companies (GAC) spend a lot of money for promoting a lot of other chemical products, used in paper, textile, pharmaceutical industries, that primarily are derived from cellulose, lignin and other substances derived from wood or bark [23]. A very extensive branch of chemical industries in fact is based on the grounding work of forest lobbyists, but chemical industries in the past haven't always established a reputation of responsibility and sustainability! Trees however are living organisms and even after dying, they literally sustain a lot of life forms, procure food and nesting for birds, vertebrate and invertebrate animals, such as beetles, and serve as decay material for fungi [10]. Moreover, either dead or alive, trees are the most important structuring factor in full-grown forests, especially in the tropic regions, where from the canopy to the forest floor multiple stages with varying degrees of sunlight, wind and rainfall build a multi-stratified ecosystem.

Of course, the huge economic value of forests has been well recognized and valorized in the tourism industry too, yielding billions of GDP to several developed countries and probably much less to developing countries. But the damage of the touristic industry to nature and natural biodiversity is very heterogenous and also not easily calculated. Therefore, we prefer to leave it out of the present commentary.

Still, another very important economic value of forests, and of the tropical rain forests in particular, are the multitude of ecological, medical and other characteristics that aren't known yet, and may as well escape human exploitation or get lost in a near future. For, in general, humans are too impatient or too insecure to experience Nature without trying to exploit or harvest it, and eventually destroy the potential benefits.

#7 Chased species will re-appear after large-scale management interventions

This argument is often used by project managers to indicate that large-scale interventions may temporarily chase a number of species, especially the shy and vulnerable species, but that these will come back after the intervention is completed. We know that this isn't the case at least with the large anthropoid apes and several groups of rare mammals and birds in several tropical forest regions. As regards the vulnerability to habitat degradation and re-migration we previously discussed the *Louette hypothesis* [18]. According to the latter hypothesis, in particular non-migrating tropical forest birds may be very sensitive to extinction following large-scale interventions, but this may also hold for other, so-far unknown animal groups.

Large-scale heathland restoration in the Netherlands and other European regions, indeed may reveal that certain (heath-related) species are recovered at pre-intervention abundancies, but this doesn't apply to all of them [18].

Following the prediction of MacArthur and Wilson's *Island Hypothesis* [24], with the island metaphor here representing an emptied biotope, it is known that some bird species expand at the cost of others. But this is also true for certain unwanted (or even so-called exotic) tree species that are known to easily colonize open logging areas in the forest, like Birch (*Betula* sp.) and especially the North-American Black Cherry (*Prunus serotina*) (Fig. 5.a,b), which is considered an exotic species in Europe. Obviously, the colonization with opportunistic and exotic species may also affect the other species in the ecosystem. This is not only the case with wild plants and birds, also opportunistic and exotic animal species distort the ecosystem, all the more so because exotic species lack the natural predators to limit their abundance numbers. In addition, they may also introduce exotic pathogens that might affect the health of endogenous species [25].

Figure 5: a,b. Logging areas are quickly colonized, often by opportunistic and exotic plant species: (a) (left) Black Cherry (*Prunus serotina*); (b) (right) newly logged area in protected natural reserve. (Photographs © 2019, Biological Publishing A&O).

#8. Red List species can be protected regardless of their environment

Following the goals of the *Natura 2000* program, supporting the European implementation of the Birds and Habitats directives [26], a multi-national, European program was set up to protect Red List species (of birds and other species) and specific habitats. In these habitats, specific plant species were also considered as practically 'untouchable' species, meaning that they had to be spared during extensive vegetation logging and landscape reforms. This holds for instance for the Bog Myrtle (*Myrica gale*) and the Common Juniper (*Juniperus communis*) [18].

These Red List species, however, also are a constituent part of an ecosystem, implicating they interact with other species, animals, as well as plants and fungi. One example of these interspecies interactions is the occurrence of Pear Rust (*Gymnosporangium sabinae*), a fungus species (*Gymnosporangiaceae, Pucciniomycetes*) (Fig. 6.a) that has two host plant species (a so-called heteroecious species), namely Juniperus and the Pear tree (*Pyrus sp., Rosaceae*). This is only one example of the many interspecies interactions that occur in natural ecosystems, or, in this particular case, of the interactions between farmland and nature.

Figure 6: a,b. (a) (Left) Example of species interaction: Horn-like growth of Peer Rust (*Gymnosporangium sabinae*), a heteroecious fungus, here growing on Juniperus stem; (b) (right) large-scale landscape reform with Bog Myrtle (*Myrica gale*) in a Natura2000 special protected area.
(Photographs ©2020, Biological Publishing A&O).

#9 The soil-inhabiting species are not affected by large-scale interventions

This argument is similar to the argument presented above (#7), but here also other factors play a role. In large-scale interventions often soil vegetation and upper soil-layers are equally removed. For the organic soil components, both living and dead, not only the chemical composition matters, but also the structuring impact (especially of tree roots) on the soil, which often is the result of a long term accumulative process. All the more so, it is regrettable to say that the practice of burning tropical (forest) areas for agriculture, so-called 'slash and burn' agriculture [27], has proven to have only a very short-time benefit for culturing crops. But, on the other hand, it may have very dramatic consequences for the water circulation, not only locally but for the whole planet[17,28].

Figure 6 c: Example of a common but very vulnerable soil-inhabiting plant species, the fly-catching Roundleaf Sundew (*Drosera rotundifolia*), often disappearing after the use of heavy equipment.
(Photograph © 2017, Biological Publishing A&O).

In addition, when regarded at a very local scale, certain soil-inhabiting species are especially vulnerable to the use of heavy equipment for extensive landscape reforms, causing compression of the soil structure. For example, we have noticed at several locations that the carnivorous, fly-catching Sundew (e.g. *Drosera rotundifolia, Droseraceae,* Caryophyllales) (Fig. 6.b,c) disappeared after interventions with heavy equipment, and also didn't regrow after surface recovering with new vegetation.

#10 Why do large-scale deforestations form a global threat to biosphere sustainability?

Finally, the biggest misconception used by wood lobbyists and deforestation ambassadors is that the true reason for deforestation is **not** to restore a rural landscape, heathland or the biodiversity of a certain ecosystem, but the earning of bioenergy. We didn't list the argument of preventing wood fires, not only because of our sincere respect for all the victims of woodfires worldwide, but also because removing forests and burning the forest bioenergy is not an answer to the raising temperatures and already high CO_2 levels in the atmosphere. Reducing monotonous plants of highly inflammable tree species (such as *Eucalyptus* sp.), or reducing woodfire risks by all kind of measures, is another topic that deserves attention in a distinct paper.

The global impact of deforestation for reasons of procuring wood pellets as an alternative energy form to fossil fuels, is huge [4,14]. According to Hawkins Wright [29], in 2019 global industrial pellet production amounted to 24 million metric tons (Mt) (equivalent to a feedstock of ~ 50 million m^3 of wood). In 2022, this enormous amount has almost been doubled since 2019, to 47 million m^3 of pellet, or almost 0,1 billion m^3 of wood [29]. The yearly international trade of wood pellet has been estimated at some 4,8 billion euro. Not only these are gigantic numbers, the negative impact of these forms of biomass on climate change moreover is simply stunning. Scientific reports, e.g. by Europe's Academies of Scienc [4,14], have revealed that these activities will increase atmospheric levels of CO_2 for substantial periods of time, ranging from decades to hundreds of years. This effect is explained as the equivalent of taking out a 'carbon loan'[14]. It is a chemical fact that forest regrowth will re-capture carbon from the atmosphere. However, this is a slow process of decades and, meanwhile, until the 'payback of the carbon loan' is achieved, the effects on the climate are negative [14]. 'Negative' here means a further rise of global temperatures, with all of its accumulating and accelerating effects on climate change, like permafrost meltdown and release of huge methane stores from the arctic and subarctic regions.

The Effects of Deforestation and other Landscape Reforms on Local Biodiversity (case study)

In the following paragraph, we present a short case study of the effects of deforestation and/or landscape reforms on biodiversity in a number of Dutch landscapes and nature reserves. The counting of abundancies of the forest and heathland bird species, was performed according to the same procedure (timing, route and observation method) before and after the intervention. The biodiversity index is calculated as described below (adapted and slightly modified from previous study) [18] (Fig. 7)(Legends to 5 [or 10]-point-scale in Table 1).

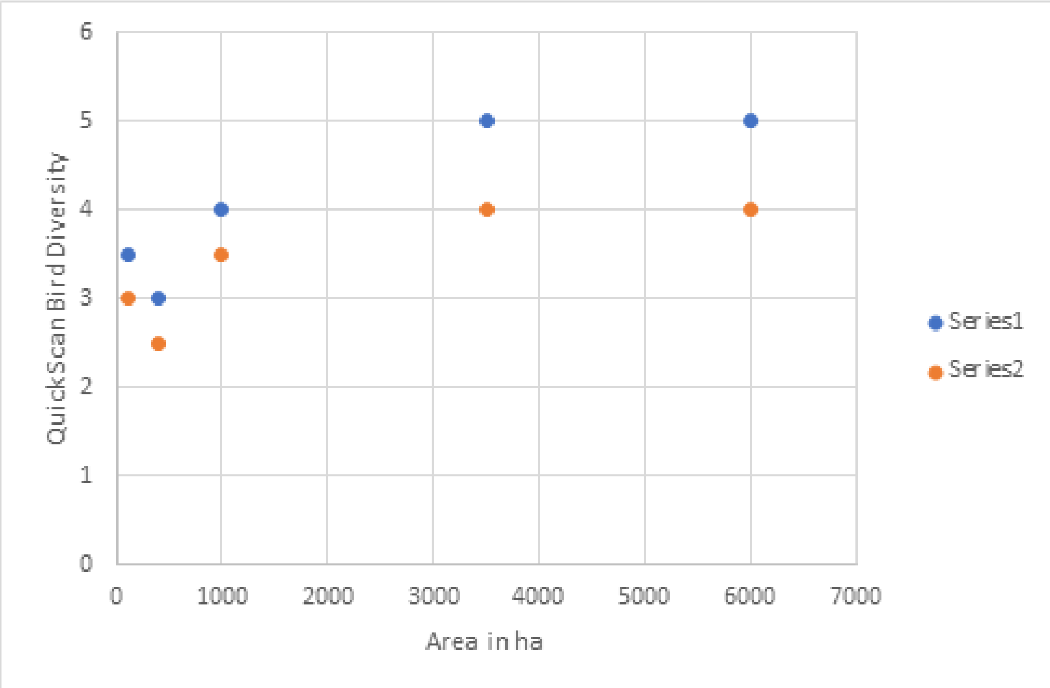

Figure 7: Quick Bird Diversity Scan (see Table 1 for scaling) as a function of (approximated) surface area (in ha) in a number of Natura2000 protected areas (4x) and a protected natural reserve in the Netherlands, before (series 1) and after (series 2) large-scale interventions (performed after 2015)
(© 2024, Biological Publishing A&O, own data).

The data in Fig. 7 not only show the higher biodiversity index in the larger protected areas (for the Netherlands large is relative, namely 1000 ha or more). But in both larger and smaller areas, the result of large-scale interventions doesn't show a restoration of the pre-intervention biodiversity index. A widely heard explanation is that the impoverished results are the result of a biodiversity decline following the agricultural activities in the surrounding areas (and accompanying N-deposition). However, also examples are found of areas where the landscape management practices directly affect the bird diversity [18]. Another criticism is that the presence or absence of several flagship species has a strong impact on the diversity index (scaling impact from 4 to 5)(see Table 1). However, one flagship species can be replaced by another, so rendering the index independent of the presence of a single species. A similar biodiversity index can be established for water– and land insects (e.g. lists of species of Odonata, Hymenoptera, Lepidoptera), although the public awareness of (and fondness about) these invertebrate animal groups is probably much less.

Table 1: Five (ten*)-point scale for Quick-scan of Bird Biodiversity in Temperate European Forests (#):

Scale	Description	Examples of species	Type of Biotope
0	No Birds species are present	-	-
1	Only very common species are present	Common *Corvidae* like Crow, Magpie, Jay, Starling, Wood Pigeon, Common Finch, Robin, Blackbird, Blue – and Great Tit, Heron, White Stork, Buzzard, Kestrel, etc.	Mixed wood- and farmland
2	In addition to the above, two to three of following indicator species	Any of the Warblers (*Sylviidae*), Wagtails and Pipits (*Motacillidae*), Wren, Nuthatch, Long-tailed Tit, Tree Creeper, Song Thrush, Stonechat, Redstart, Goldcrest, Cuckoo, Spotted and Green Woodpeckers, Linnet, Reed Bunting, Sparrow Hawk, Goshawk, Little &Tawny Owl	Mixed forests and heathland
3	More than 3 species of indicator species listed above as well as two so-called key species	Key-species: Wheatear, Nightingale, Golden Oriole, Bluethroat, Whinchat, Flycatcher, Nightjar, Crested -, Marsh- & Willow Tit, Wood- & Sky Lark, Grey- & Red-backed Shrike, Mistle Thrush, Yellowhammer & other Buntings, Raven, Black Woodpecker, Wryneck, Crane	Mixed temperate forests, with open spots of heathland and/or wet forests
4	Three or more key-species (listed above) as well as (at least) two so-called key predator species	Key predator species: any of the Owls (*Strigidae*) and Birds of Prey (*Falconidae*) not mentioned above/below	Protected natural forest reserves
5	In addition to the above, one or more of the so-called 'flagship' species	Flagship species: Golden Eagle, White-tailed & Short-toed Eagle, Osprey, Black-, Griffon- & Bearded Vulture, Eagle Owl, Black Grouse, Ptarmigan and other *Tetraonidae*, Night- & Purple Heron, (Little) Bittern, Black Stork	Top natural forest reserves (& Special protected areas)
(ten*)	When only half of the condition is met, then also a half point is added to the scale (equivalent to a 10-point-scale)		

(#) Typical so-called water-bound birds (like *Anseriformes and Charadriidae*) are not listed here, although they may also be found in mixed marsh-forest biotopes.

Biodiversity, Proportionality and Planet Sustainability

In contrast to the (moderate) effects seen at a local scale in the case study presented (see **The Effects of Deforestation and other Landscape Reforms on Local Biodiversity**), there is a tendency in Europe to implement landscape reforms at a higher level. E.g. in France, a very controversial example is found the 'Large basin' (mega-basin) discussion. Defenders of the mega-basin measure claim that water collection in huge aboveground reservoirs will be necessary to enable agriculture in a changing climate (give the extremely dry summers of 2016, 2019, and especially 2023) [30]. Modern history has revealed many examples of such massive water works, as seen in the damming of the Suriname river (Afobaka Dam, Brokopondo Lake, 1964), the Nile (Aswan High Dam, Egypt, 1970), and the divertion for irrigation in the 1960s of the water from the Aral Sea (Kazachstan), of which the Southern part had mostly dried up in the 2000s. The many environmental catastrophes and failures resulting from these large-scale human interferences have been textbook material for decades now. Or, more recently, similar signals are heard after the building of the Itaipu Dam on the Paraná river (at the border between Brazil and Paraguay, 1982) and the Three Gorges Dam on the Yangtze river (PR China, 2012). Even the building of the Afsluitdijk in the Netherlands (damming of the former Zuiderzee in 1932), apart from countering the flooding risks by the North Sea, has created also economic and environmental problems, mostly related to the local fishing industry. For the same reason, a fish migration river has been planned by the Dutch Rijkswaterstaat, that e.g. will enable Common Eel (*Anguilla anguilla*) and other migratory fish to reach their foraging grounds [31].

Also at present in France, many nature organizations and sympathizers are adverse to the large basin initiative, because taking water out of the river drainage would lower the ground water levels and worsen the drought problems in the future. For instance, large coastal wetlands like the Poitevin marshes (Parque naturel regional du Marais Poitevin) in the Loire basin, risk to dry out and bring the critical coastal ecosystems at risk [32]. Another point of criticism is that the choice for the large water reservoirs is only favorizing a single, peculiar type of non-sustainable, intensively water consuming type of agriculture (like maize, used for dairy fodder). This type of agriculture has a negative image, and also a negative impact on all others. For it accounts for only 7 % of farmland area in France, but uses more than half of the water consumed in French agriculture [32]. The choices made by the local co-operations and supported by the national government, providing up to 70 % of the total costs in this *Coop de l'eau project* [33] (estimated at some 76 million euros) [32], is totally not in line with an 'ecofriendly' designed agriculture, envisaged for a future, sustainable Europe, critics report. Attempts to solve the dispute at the European Parliament, stumble at the interests of the agroindustry, that uses food sovereignty and safety as their main argument [32]. The European lobby that so far has the ear of the Agriculture Committee is known as COPA-COGECA [34]. According to a 2018 document, COPA-COGECA states that "water storage is the most important means of water security" and calls for "increased fiscal and financial support" and "a reduction in the administrative burden" to achieve this [32]. This brings us to the second (designated as non-testable) hypothesis, namely that increasing the size of the (geo)political blocs increases the risk of taking the wrong decisions and measures (see also Table 2). The example in the case presented above [32] suggests that when the matter isn't solved in the French democratic institutes, but forwarded at an European control level instead, the risk of the European institutes lending their ears to the strongest lobbyist group, is very probable. As a result, the political decisions might not be based on the soundest, most environmentally underpinned and climate-sustainable ideas, and consequently another ecological or climate disaster could be in the making. This finding is not dissimilar to the described mismatches generated by certain aspects of the Paris agreement, namely related to the decision to classify forests (as a whole) as 'renewable energy'(see **Introduction: the heritage of the Paris Agreement** (…)).

Table 2: Characteristic numbers of the Netherlands, France and Europe a/o European Union, comparing population size, surface area, agriculture budget and spending on environmental & climate objectives (data from Eurostat, European Commission, IMF, Dutch Rijkswaterstaat and others).

Country or political entity	Netherlands	France	Europe a/o European Union
Population size (2024)	17,7 million	64,9 million	448 million (EU)
Surface area of country	41,850 10^3 km^2	549,087 10^3 km^2	10,5 10^6 km^2 (Europe)
Budget agriculture	2 to 4 billion €	72,9 billion €	215,5 billion € (EU)
Budget environmental & climate objectives	1,4 billion € (2024)	53 billion € (2024)	578 billion € (2021-2027 period) (EU)
Examples of large protected areas (surface)	Oostvaardersplassen (6000 ha), Wadden Zee (35 10^3 ha)	Poitevin marshes (1,120 10^3 km^2)	Bialowieża National Park (Poland, 105,2 km^2)
Relevant landscape (reform) projects	Maintenance of Wadden Zee navigation (yearly 7,5 million €)	*Coop de l'eau project* (76 million €)	Yearly international wood pellet trade (estimated 4,8 billion €)

This assumption of a scale-dependent growth of the risk of failure, although not well-fit for experimental research, however, is far from unreasonable. Apparently, there seems to exist a proportionality relation (with a certain bandwidth) between the sizes of populations, geographical area, economic and agricultural budget spending (see Table 2) and some relation with political power too, well known from ages of political history in Europe. This is partly the result of equal population densities and rather homogenous demographic and economic characteristics throughout Europe, given a larger sector of agriculture in France compared to the Netherlands. But what misses in these official data is the unbalanced pressure exerted by certain lobbyist groups, giving leverage to certain minority interests and thus disproportionally influencing the political decision-making.

Meanwhile, the local impacts of global climate warming are becoming ever more obvious in nearly all regions of the world. With respect to global biodiversity, the repeated alarms of the *World Wildlife Fund (WWF)* have specially stressed the devastating impact of rain forest degradation on the biodiversity in tropical rain forests [35]. In contrast to the large-scale initiatives, often also supported by large international non-governmental organizations (NGOs), fortunately also small-scale initiatives and enterprises are popping up, offering solutions for ecologically responsible and sustainable forms of agriculture, e.g. reducing the use of N-fertilizers, reducing methane emission (especially from live stock) and aiming at zero carbon-emission goals [36]. For the well-being of our planet, it is found a hopeful wish and wishful thought, that many more of such initiatives are coming about.

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