

OPEN LETTER TO:

The Estonian Presidency of the Council, the Environment Council, the Transport, Telecommunications and Energy Council  
CC: Miguel Arias Cañete, Commissioner Climate Action & Energy; Norbert Lins, Member of the European Parliament (Rapporteur LULUCF Regulation); José Blanco López, Member of European Parliament (Rapporteur, Renewable Energy Directive (recast) Energy Committee); Bas Eickhout, Member of the European Parliament (Rapporteur, Renewable Energy Directive (recast), Environment Committee)

## Scientific basis of EU climate policy on forests

We, the undersigned, would like to express our grave concern and dismay over the scientific basis of recent policy developments regarding EU climate legislation on forests: the LULUCF Regulation and sustainability criteria of biomass in the Renewable Energy Directive. We urge you to support the highest integrity of these two strongly interlinked EU climate laws in order to provide regulation that truly benefits the climate.

The promotion of an increase in active forest management encourages increased harvest levels in order to substitute fossil-derived fuels and products with wood and bioenergy without accounting for their full climate impacts. This approach risks having adverse effects on climate, biodiversity and resilient ecosystems by emitting more greenhouse gases, influencing biophysical processes and causing additional habitat loss - accumulating evidence suggests that the proposed strategy risks being counterproductive.

**Climate change and loss of biodiversity** (functional ecosystems) are critical global challenges, and vigorous measures are urgently needed if we are to meet these challenges. Early action will be crucial in combating these threats.

Climate change and forest management are major threats for conservation areas and biodiversity, and many plant and animal species are projected to decrease due to habitat loss and climate change.<sup>1,2,3,4</sup> Few old-growth forests remain in Europe and many of them are significantly fragmented.<sup>5</sup> Europe is the continent (sub-region) with proportionally least protected forests (including the Russian Federation) with less than 5% protected forest. Only 2,8 % of the boreal forests and 11 % of the temperate forests were protected on a global scale in 2015.<sup>6</sup> The EU, which harbours both forest biomes, has a legitimate responsibility to develop strategies that safeguard these forest ecosystems from exploitation.

From the **economic point of view**, the critical feature in LULUCF regulation is how the forest reference levels for Member States will be specified. If the reference levels and sinks are lower (in absolute terms) than actual 'business as usual' levels, countries have the possibility to increase emissions from managed forests by increasing bioenergy production and decreasing carbon sink. To avoid creating such perverse incentives, the forest reference levels should constrain the Member States' 'business as usual' utilization of forest resources. Without such regulation the emission levels of certain Member States will increase and may even be publically subsidized to unprofitable forest bioenergy production.<sup>7</sup> Also, reference levels based on future policies

as opposed to a historical reference period (or scenarios based on historical forest management intensity), give incentives to transfer emissions from the Effort Sharing sectors to the LULUCF sectors by increasing forest bioenergy production without being required to account for the effects on overall emission levels. The forest reference levels should therefore exclude all policies from 2009, since the introduction of the Renewable Energy Directive, to ensure all emissions from increase in bioenergy are accounted for.

**Honest accounting** of the climate impacts of forest use in the LULUCF Regulation would stimulate **wood** captured in long-term uses, such as construction, where the carbon is kept out of the atmosphere for longer periods and the demand for other carbon-intensive materials such as steel or concrete is reduced.<sup>7</sup> In 2010, about 60% of the European wood is used for (short-lived) energy and pulp, while only 40 % is represented by wood products.<sup>8</sup> Many of these products, such as disposable packages and direct advertising, do not even substitute fossil fuels. In general, reduced production and consumption patterns are necessary to mitigate climate change. Environmental impact assessments including life-cycle, cost and benefit analyses of forest management and forest products should determine how to utilize forest resources sustainably.

**Bioenergy** is not carbon-neutral and can have seriously negative climate impacts. The combustion of forest biomass generally releases more carbon dioxide to the atmosphere than fossil fuels, because of the lower energy density and conversion efficiency of biomass (more has to be burnt relative to fossil fuels).<sup>9,10,11,12</sup> The LULUCF Regulation need to account for the full climate impacts of biomass. To effectively reduce emissions from combustion of forest biomass,

use of feedstocks with long pay back periods (such as roundwood) should be restricted and for that more effective sustainability criteria are needed under the Renewable Energy Directive.

**Conserving** natural forests and old-growth forests is important for the protection of biodiversity and the mitigation of climate change. Old-growth forests function as carbon sinks for hundreds of years and store large amounts of carbon in the soil pool where it may remain stored in a stable condition for millennia.<sup>13,14</sup> Nevertheless, these old-growth forests are being cut down throughout the EU. Regeneration of an old-growth forest often takes centuries and, for some endangered species, the consequences of the destruction of old-growth forest may be irreversible.<sup>15</sup>

**Increasing harvest** levels have a negative impact on the climate because the standing forest **carbon** stock is immediately reduced when harvested. It may take decades to centuries until the former level of the carbon stock is restored by regrowth — especially if old-growth forests are clear-cut.<sup>16,17</sup>

Harvesting leads to emissions of other greenhouse gases such as methane and nitrous oxide. It also influences the climate via **biophysical processes**, such as albedo, evapotranspiration, forest structure and cloud-formation, which depend on the diversity of tree species, stand density, types of forest management and location.<sup>18,19,20</sup> These biophysical processes need to be taken into account in climate change mitigation actions, or there is a risk of costly and unfavorable climate effects.

In the face of climate change more **resilient** forests are needed. Forest management methods have led to an increase in a homogeneous and even-aged structure of single-species stands, making them more vulnerable to the effects of climate change. Natural forest ecosystems, with a diversity of species, show a greater resilience to environmental change and provide a greater number of **ecosystem services** — such as habitats for fauna and flora, recreation, harvest of berries, and protection from erosion, landslides, and flooding.<sup>21,22,23,24</sup>

**Management strategies**, such as continuous-cover silviculture, integrated with increased native tree species diversity and landscape heterogeneity, simultaneously contribute to the maintenance of forest cover, the conservation of carbon stocks, and the support of biodiversity and social and cultural values.<sup>25,26,27</sup> Mixed evergreen–deciduous stands (deciduous species have a more cooling effect than conifers) are expected to make a substantial contribution to climate-change mitigation than monocultures of conifers.<sup>28,29,30</sup>

**Conclusion:** The EU needs to set an evidence-based precedent on the implementation of Paris Agreement in relation to land and forests – the EU forest and climate legislation needs to serve climate mitigation, consider large-scale impacts on forests and to account for the multi-functionality of forests forcefully.

#### **In relation to LULUCF Regulation and the Renewable Energy Directive (REDII) we ask you to make sure that:**

- Policies from 2009 are not included in forest management reference levels.
- Deforestation is actively discouraged in EU.
- EU policies promote maintenance and increase in the EU forest sink and the EU makes an assessment on how forests can safely and sustainably contribute to increasing climate ambition.
- Climate impacts of forests are fully accounted for under LULUCF regulation to incentivize using wood in long-lived harvested wood products and standing forests.
- Policies are adopted to prevent the use of biomass feedstocks with long pay back times for energy, because these are unlikely to make an effective contribution to meeting the Paris Agreement target to limit global warming to well below 2 degrees and aspire to 1.5 degrees.

#### **We also ask you to take action on the following:**

- All remaining old-growth and high conservation value forests need to be protected to safeguard biodiversity and carbon stocks. Already degraded areas need to be restored through national measures and EU wide action plan. In implementing the EU climate regulations and national mitigation measures, the impacts on the achievement of EU biodiversity objectives, as specified in the EU biodiversity strategy and in the Birds and Habitats Directives need to be assessed.
- Forest management methods, such as continuous-cover silviculture, which minimize the release of greenhouse gases from soil should be promoted.
- Native mixed-deciduous forests should be favored because they generally store more carbon, have higher albedo and yield more ecosystem services. The biophysical processes should be taken into account.

Policies must provide an incentive to increase the resilience of forests, safeguard the carbon in the soil, and stimulate the production of long-lived wood products. We therefore accordingly ask you, as decision makers, to take a stand for both the climate and biodiversity – planet Earth does not need increased emissions. It needs resilience and cooling forests.

The views expressed in this open letter are those of the scientists whose signatures are given below, and do not necessarily reflect the opinion of EASAC, which has recently published a report for EU policy makers entitled “*Multi-functionality and sustainability in the European Union’s forests*” (2017):

<http://www.easac.eu/environment/reports-and-statements/detail-view/article/multi-fun.html>

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<sup>1</sup> Araújo M. et al. (2011). *Climate change threatens European conservation areas*. Ecology Letters 14, 484–492.

<sup>2</sup> Hanski I. (2011). *Habitat loss, the dynamics of biodiversity, and a perspective on conservation*. Ambio 40, 248–255.

<sup>3</sup> Hanski I. (2013). *Extinction debt at different spatial scales*. Animal Conservation 16, 12–13.

<sup>4</sup> EEA (2017). *Climate change, impacts and vulnerability in Europe 2016*. An indicator-based report. Report 1/2017.

<sup>5</sup> EEA (2016). *European forest ecosystems. State and trends*. EEA Report No 5/2016. European Environment Agency. DOI:10.2800/964893.

<sup>6</sup> Morales-Hidalgo, D., Oswalt, S. N. & Somanathan, E. (2015). *Status and trends in global primary forest, protected areas, and areas designated for conservation of biodiversity from the Global Forest Resources Assessment 2015*. Forest Ecology and Management 352, 68–77.

<sup>7</sup> EASAC (2017). *Multi-functionality and sustainability in the European Union's forests*. EASAC policy report 32.

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- <sup>8</sup> Mantau U. (2012). *Wood flows in Europe (EU27)*. Project report. Commissioned by Confederation of European Paper Industries (CEPI) and European Confederation of Woodworking Industries (CEI-Bois).
- <sup>9</sup> Ståhls M. et al. (2011). *Impacts of international trade on carbon flows of forest industry in Finland*. Journal of Cleaner Production 19, 1842–1848
- <sup>10</sup> JRC (2013). *Carbon accounting of forest bioenergy*. European Commission, Joint Research Centre – Institute for Energy and Transport.
- <sup>11</sup> Smyth C. et al. (2016). *Climate change mitigation potential of local use of harvest residues for bioenergy in Canada*. GCB Bioenergy.
- <sup>12</sup> Soimakallio S. et al. (2016). *On the validity of natural regeneration in determination of land-use baseline*. International Journal of Life Cycle Assessment 21, 448–450.
- <sup>13</sup> Jonsson, M. och Wardle, D. (2009). *Structural equation modelling reveals plant-community drivers of carbon storage in boreal forest ecosystems*. Biology Letters 6 (1):116–9.
- <sup>14</sup> Luysaert S. et al. (2008). *Old-growth forests as global carbon sinks*. Nature 455, 213–215.
- <sup>15</sup> EASAC (2017). *Multi-functionality and sustainability in the European Union's forests*. EASAC policy report 32.
- <sup>16</sup> Bellassen V. and Luysaert S. (2014). *Managing forests in uncertain times*. Nature 506, 153–155.
- <sup>17</sup> Sievänen R. et al. (2014). *Carbon stock changes of forest land in Finland under different levels of wood use and climate change*. Annals of Forest Science 71, 255–265.
- <sup>18</sup> Ellison D. et al. (2017). *Trees, forests and water: cool insights for a hot world*. Global Environmental Change 43, 51–61.
- <sup>19</sup> Jackson R. et al. (2008). *Protecting climate with forests*. Environmental Research Letters 3, 44006.
- <sup>20</sup> Pielke R. et al. (2002). *The influence of land-use change and landscape dynamics on the climate system: relevance to climate-change policy beyond the radiative effect of greenhouse gases*. Philosophical Transactions of the Royal Society of London A 360, 1705–1719.
- <sup>21</sup> Balvanera P. et al. (2013). *Linking biodiversity and ecosystem services: current uncertainties and the necessary next steps*. BioScience 64, 49–57.
- <sup>22</sup> Gamfeldt L. et al. (2013). *Higher levels of multiple ecosystem services are found in forests with more tree species*. Nature Communications 4, 1340.
- <sup>23</sup> Tilman D. et al. (2014). *Biodiversity and ecosystem functioning*. Annual Review of Ecology, Evolution and Systematics 45, 471–93.
- <sup>24</sup> Holm, S-O. (2015). *A Management Strategy for Multiple Ecosystem Services in Boreal Forests*. Journal of Sustainable Forestry 34 (4): 358–379.
- <sup>25</sup> Balvanera P. et al. (2013). *Linking biodiversity and ecosystem services: current uncertainties and the necessary next steps*. BioScience 64, 49–57.
- <sup>26</sup> Gamfeldt L. et al. (2013). *Higher levels of multiple ecosystem services are found in forests with more tree species*. Nature Communications 4, 1340.
- <sup>27</sup> Tilman D. et al. (2014). *Biodiversity and ecosystem functioning*. Annual Review of Ecology, Evolution and Systematics 45, 471–93
- <sup>28</sup> Zhao K. and Jackson R. (2014). *Biophysical forcings of land-use changes from potential forestry activities in North America*. Ecological Monographs 84, 329–353.
- <sup>29</sup> Matthies B. and Valsta L. (2016). *Optimal forest species mixture with carbon storage and albedo effect for climate change mitigation*. Ecological Economics 123, 95–105.
- <sup>30</sup> Naudts K. et al. (2016). *Europe's forest management did not mitigate climate warming*. Science 351, 597–600.