**Flexible options for carbon taxes to achieve Paris Agreement targets: implications for land systems change, water use and nitrogen leaching**

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Virtually all of the countries in the world signed the 2016 Paris Agreement whose objective is to “hold the increase in the global average temperature to well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels…” (UNFCCC, 2020). As such, 195 parties, including the European Union, have submitted their individual commitment, also called the Nationally Determined Contribution (NDC), and action plans to achieve their commitments through 2030.[[1]](#footnote-1) The economic modeling community has developed various interpretations of the commitments, largely translating these into required emission reductions by 2030 relative to baseline emissions, and assessing the carbon tax that would lead to the desired emission pathway—albeit recognizing that countries will be implementing a wide variety of instruments to meet their goals, for example subsidizing investments in clean energy, investing in energy efficiency, reforming fossil fuel subsidies, imposing technical regulations, etc. (Chepeliev and van der Mensbrugghe, 2020; Gallaher et al., 2019; Michaelowa et al., 2018; Vogt-Schilb and Hallegatte, 2017).

NDC interpretations also differ in terms of gas coverage. While some submissions include commitments for CO2 emissions reduction from fossil fuels combustion only (in the limited set of sectors), other parties committed to act on both CO2 and non-CO2 greenhouse gas emissions (UNFCCC, 2020).

In this study, we will take as a starting point the commitments and the required tax on fossil fuel combustion that achieves the goal, as well as add more stringent mitigation efforts consistent with limiting global warming below 2°C relative to the pre-industrial level.[[2]](#footnote-2) We will expand the set of instruments to assess the impacts of reducing greenhouse gas emissions from sources other than fossil fuel combustion, notably methane emissions—largely derived from rice production, livestock, extractive industries and municipal waste—nitrous oxide emissions that are largely agriculture-related, and carbon emissions linked to forestry. Studies have shown that these alternative policies can come at a lower overall economic cost than taxing fossil fuels, albeit may be more difficult to implement (van Vuuren et al., 2006).

These alternative sets of policies, while enhancing flexibility to achieve the Paris Agreement targets, are likely to have a greater impact on land-use and food availability than the more focused tax on fossil fuels. Reaching the climate change mitigation targets would also interact with other regional and global environmental constraints (planetary boundaries), such as land system change, freshwater use, biochemical flows and genetic diversity (Steffen et al., 2015). In some cases, climate change adaptation and mitigation policies could help to reduce the pressure on the environmental constraints (e.g. biodiversity), while other planetary boundaries could face regressive impacts (e.g. biochemical flows). We will explore such interactions by first assessing the impacts on the food systems and land use activities using the multi-region computable general equilibrium framework. Impacts on land-use will then be fed into downstream models to assess the implications on water use and nitrogen leaching.

**References**

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1. Though the United States has formally announced its intent to leave the Paris agreement, we will be assuming that it will eventually aim to achieve its originally announced emission target. [↑](#footnote-ref-1)
2. Currently submitted NDC commitments are not consistent with target of temperature increase well below 2oC (Rogelj et al., 2016). [↑](#footnote-ref-2)