NIBIO POP

NIBIO
NORSK INSTITUTT FOR
BIOØKONOMI

VOL. 6 - NO. 10 - 2020

Photo: Vibeke Lind

RUMINANTS AND METHANE 3:4

Global Warming Potential

GHG EMISSIONS FROM RUMINANTS

In recent years, greenhouse gas (GHG) emissions from ruminants have gained increased attention. Anthropogenic emissions of enteric methane (CH_4) are estimated to be responsible for about 18% of global GHG emissions (Gerber et al, 2013). The most important GHG are methane (CH_4) and nitrous oxide (N_2O). Enteric emission of CH_4 from domesticated ruminants, arising primarily from the fermentation of feed in the rumen, are considered as one of the three largest sources of GHG on a global scale. The emission of methane by cattle and sheep results in losses of carbon and energy (Johnson and Johnson, 1995). If the energy could be rechannelled into weight gain or milk production, it would increase production efficiency while reducing methane emission to the atmosphere. In pastoral ecosystem management, the challenge is to reach an equilibrium between pasture growth and animal intake. When proper grazing management practices are adopted, animal productivity is high while CH_4 emissions per kg of animal product is minimized (DeRamus et al, 2003). In Norway, GHG emission from ruminants are estimated to account for 4 % (SSB,

2018) of the total national emissions while at the same time, the production and use of fossil fuels account for 80% of the emissions.

GLOBAL WARMING POTENTIAL AND CO_2-EQUIVALENTS

The Global Warming Potential (GWP) is a measure of how much heat one ton of a gas will trap in the atmosphere over a given period relative to the emissions of one ton of carbon dioxide (CO_2). CO_2 is long-lived gas and will last in the atmosphere for hundreds of years. The larger the GWP for a given gas, the more that gas warms the Earth compared to CO_2 over a period which is usually defined over 100 years (GWP_{100}) (https://www.epa.gov/ghgemissions/understanding-global-warming-potentials). CO_2-equivalents is a metric for the GWP_{100} converting non-CO_2 emissions to CO_2 emissions over 100 years.

The short-lived climate gas, methane (CH_4) is estimated to have a GWP_{100} of 28. However, the half-life of methane is about a decade, so how can we compare short-lived gasses in terms of their contribution to global warming in a longer perspective?

Surface temperature responds differently to CO_2 and CH_4 emissions due to the rapid accumulation of the long-lived gas CO_2 in the climate system while the short-lived gas CH_4 is broken down by natural processes resulting in a slower accumulation (Allen et al, 2018). This means that the warming potential of CH_4 emissions are determined more by the current rate of emissions rather than on historical rates. GWP_{100} camouflage the strong warming potential of CH_4 on short term but over-aceturate the long-term warming effect (Haarsaker, 2019).

Figure 1 shows three scenarios of CO_2 and CH_4 emissions: both emissions rising steadily (upper left-hand panel), both emissions kept constant (upper central panel), and both emissions falling to zero (upper right-hand panel), in all cases over several decades. Lower panels show the warming caused by these emissions (Allen et al, 2017). We see from the figures that when the emissions are rising (left-hand panel), warming caused by CO_2 rises exponentially while CH_4 rises linearly. At constant emissions (central panel) the warming caused by CO_2 rises while CH_4 have no effect on global warming. The last scenario where both gasses have falling emissions over time, the warming potential of CO_2 over time gets stabile while that of CH_4 cause a cooling effect.

Allen et al (2017) suggest revising the usage of GWP_{100}, to GWP*. GWP* uses the same metric

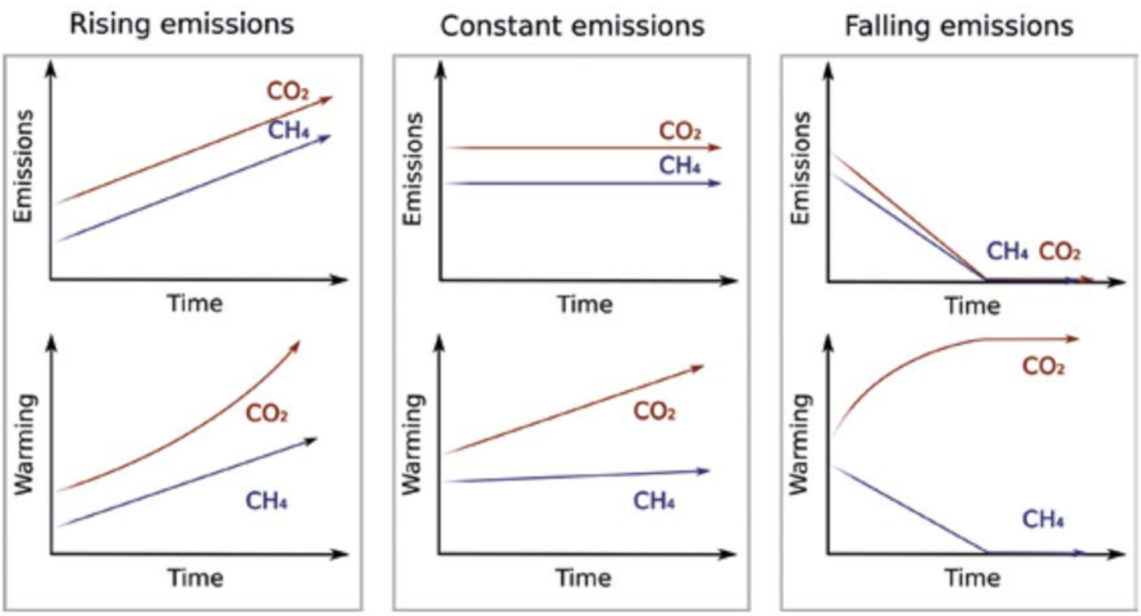


Figure 1. Global warming potential related to emission rates of CO_2 and CH_4 (Allen et al, 2017)

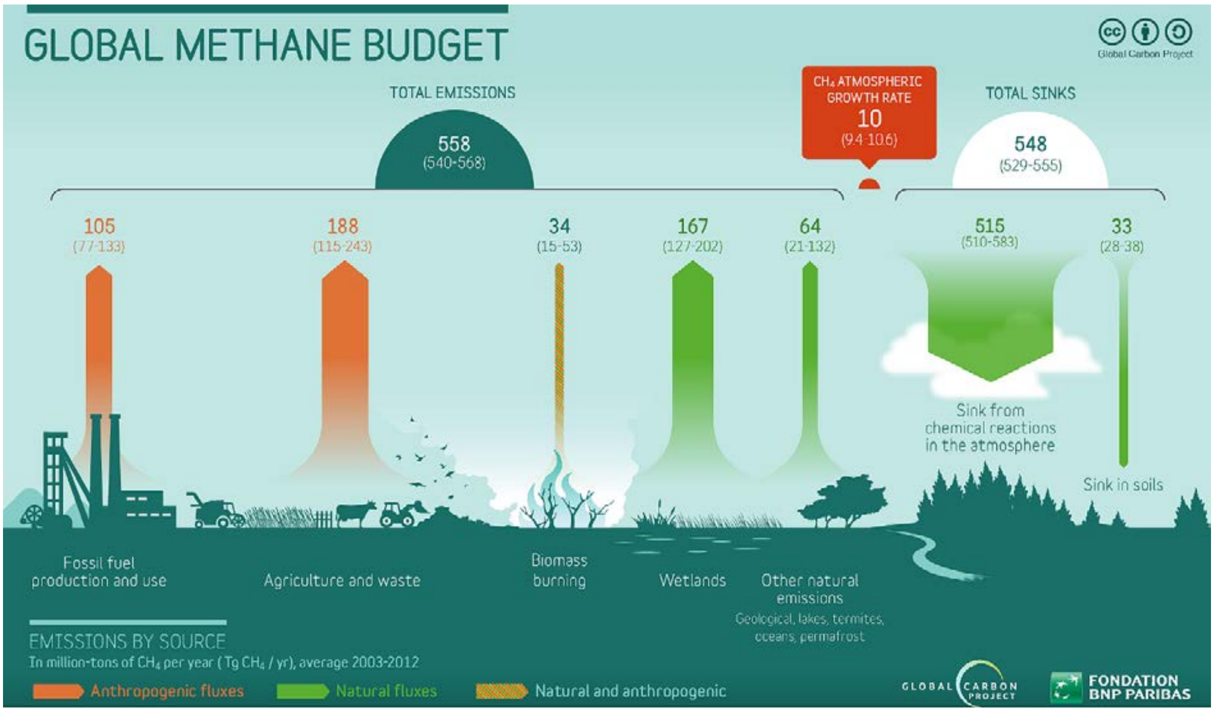


Figure 2. Global methane budget (million tons CH_4 per year) (http://www.globalcarbonatlas.org/en/CH_4-emissions)

values as GWP_{100} but interpret the warming potential in a new way considering the longevity of the gases and thus provide more accurate indications of the net impact of all pollutants on global temperature over a longer timescale. The method has not yet been implemented as a tool to calculate the climate effect of different gasses. Haarsaker (2019) suggest that emissions of climate gasses should be reported individually and not as CO_2-equivalents.

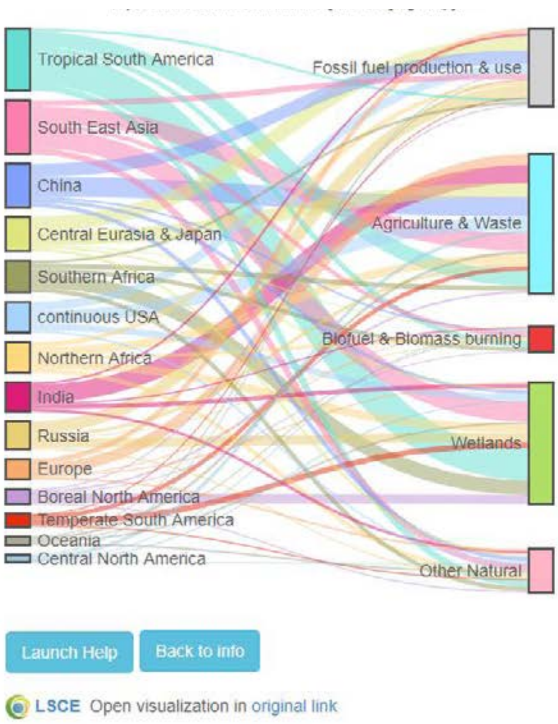
GLOBAL METHANE BUDGET

The Global Carbon Atlas is a platform to explore and visualize the most up-to-date on carbon fluxes resulting from human activities and natural processes (http://www.globalcarbonatlas.org/en/content/welcome-carbon-atlas). A new assessment of the global methane budget is presented showing how CH_4 is arising from both natural and human-induced emissions and how it is destroyed in the atmosphere by chemical reactions and soil uptake (http://www.globalcarbonatlas.org/en/CH4-emissions).

The emissions coming from human activities include "Agriculture and waste" (e.g. livestock, rice paddies) and "Fossil fuel production and use" (e.g. coal, gas, oil). "Wetlands" are the largest natural CH_4 source due to decomposition of organic matter. "Biofuel and Biomass burning" are both related to human and natural activities. "Other natural sources" include e.g. geological processes, lakes, rivers, and activities by termites which are also important even they are not yet very well understood. The largest sink of CH_4 comes from "Natural chemical reactions in the atmosphere" while a smaller part is sequestrated in "Soil".

The methane budget is estimated in 14 regions for 5 source categories. As the number of studies in general are small and uneven the uncertainties (in brackets, Figure 2) are large and typically around 30%. The sources categories, as shown in Figure 3 uses both "top down" and "bottom up" methods.

Figure 3 shows that Europe in the Top Down approach have methane emissions of 28 (21-34) million tons (Tg) CH_4 per year of which the Agricultural and Waste source account for 15 (9-19) Tg CH_4 per year. Similarly, via the interactive figure (http://www.globalcarbonatlas.org/en/CH4-emissions) the Bottom Up approach



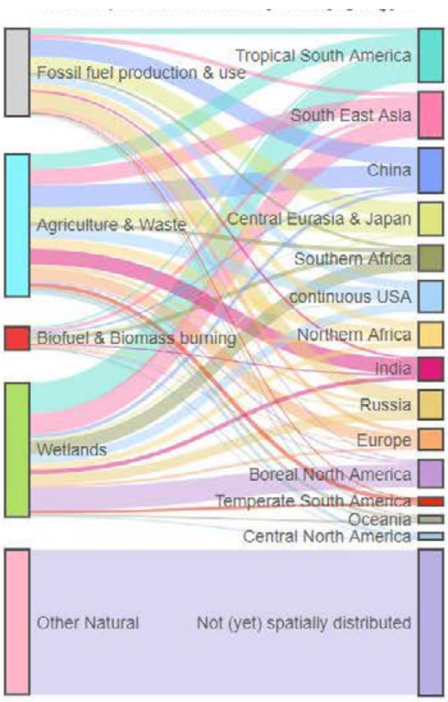


Figure 3. Methane source estimates (2003-2012) from top down (left) and bottom up (right).

shows that China has the largest contribution from the Agricultural and Waste source with 15% of the emissions (30 Tg of global emissions of 195 Tg CH_4 per year).

The new way of calculating short-lived GHG (GWP*) such as methane in combination with the methane budget should be implemented when discussing enteric methane emissions from ruminants. Their impacts on GHG emissions are significant, directly and indirectly, yet, ruminants consist many other qualities which also should be accounted for in the discussions.

LITERATURE

Allen, M.R. et al. 2017. Climate metrics under ambitious mitigation. (https://www.oxfordmartin.ox.ac.uk/downloads/academic/Climate_Metrics_%20Under_%20Ambitious%20_Mitigation.pdf).

Allen, M.R. et al. 2018. A solution to the misrepresentations of CO_2-equivalent emission of short-lived climate pollutants under ambitious mitigation. *Climate and Atmospheric Science*, 1, 16. Doi:10.1038/s41612-018-0026-8

DeRamus, H.A. et al. 2003. Methane emissions of beef cattle on forages: Efficiency of grazing management systems. *Journal of Environmental Quality*, 32, 269-277. DOI: 10.2134/jeq2003.2690

Gerber, P.J. et al. 2013. Tackling climate change through livestock: a global assessment of emissions and mitigation opportunities. Rome:FAO. http://www.fao.org/3/a-i3437e.pdf

Haarsaker, V. 2019. Metan – ny metodikk for en kortlevd klimagass. AgriAnalyse, Rapport 13. p. 63. ISSN 1894-1192. https://www.agrianalyse.no/getfile.php/135272-1578911791/Dokumenter/Dokumenter%202019/Rapport%2013%20metanrapport%2007012020%20%28web%29.pdf

Johnson, K. A, and Johnson, D.E. 1995. Methane emissions from cattle. *Journal of Animal Science*, 73, 2483-2492. https://doi.org/10.2527/1995.7382483x

SSB. 2018. https://www.ssb.no/natur-og-miljo/statistikker/klimagassn/aar-endelige/2018-12-11

AUTHOR:

Vibeke Lind

NIBIO-**POP** 6(10)2020
ISBN 978-82-17-02511-5
ISSN 2464-1170

Fagredaktør: Mats Höglind
Ansvarlig redaktør: Per Stålnacke, Forskningsdirektør

nibio.no