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The XXIV International Grassland Congress / XI International Rangeland Congress (Sustainable Use of Grassland and Rangeland Resources for Improved Livelihoods) takes place virtually from October 25 through October 29, 2021.

Proceedings edited by the National Organizing Committee of 2021 IGC/IRC Congress
Published by the Kenya Agricultural and Livestock Research Organization

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Considering natural baselines when calculating livestock impacts point to a negligible role of grass-fed livestock systems in climate change

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Key words: pastoralism; global change; international development; transdisciplinarity

Abstract

The use of baselines is common in a variety of academic disciplines, including environmental science, but they are subjected to relativity depending on the geographical or historical reference considered. Such considerations are illustrated by how invasive species are evaluated or what reference baselines are considered in biodiversity assessments.

The measurement of livestock effects on climate change has, however, disregarded the use of baselines. Current methodology is based exclusively on greenhouse gas emissions by individual animals, without putting them in their ecological context. As a consequence, current analyses of livestock impacts put grass-fed ruminant systems in the spotlight, because of their high methane emissions. Conversion into intensive, grain-fed chicken and pork systems is recommended to cope with increased meat demand, an approach that is being echoed by media.

In this study we reviewed existing literature on baseline greenhouse gas emissions by wild ruminants, with models available for North America and northern Russia. We also considered the potential of termites in filling herbivore niches in an ungulate-free scenario and reviewed the literature for possible consequences of ensuing wildfires. We found consistent evidence for natural baseline scenarios to be of the same order of magnitude as current livestock scenarios. This implies that the current policy recommendations for tackling climate change through the livestock sector are likely to be much less effective than currently thought.

Other studies on livestock environmental impacts, such as for water or biodiversity, have also not taken into account natural baseline levels from wild herbivores, hence depicting an exaggerated negative image on grass-fed livestock. Policy recommendations should take baseline levels into account, concentrate on reducing intensive use of fossil fuel and focus on double-win strategies for methane emission reduction, such as the use of manure-fed biogas cooking stoves.

This paper uses concepts originally developed at Manzano & White (2019).

Introduction: need and use of environmental baselines

The use of baselines is common in a wide variety of scientific disciplines. The intelligence quotient, for example, defines the baseline (with a value of 100) as the average quotient of the population, although it varies significantly between generations – the so-called Flynn effect (Baker et al. 2015). Important variables of international cooperation, such as well-being (Minkov 2009) or the quality of governance (Kekic 2007) are also subject to subjective criteria requiring commonly shared baselines.

Establishment of baselines is essential to measure environmental impacts, but there is great variability depending on the geographic areas studied. In biodiversity loss, for example, it is common to take as a baseline the level of biodiversity when European colonizers arrive in countries such as the United States or New Zealand. This approach is justified by two major reasons: this is the period of the first historical records and it is difficult to know what exactly was there before. However, the adoption of such baselines introduces an important relativism, because it is known that the Amerindians 13,000 years ago (Stuart, 2015) or the Polynesians 1,000 years ago (Wilmhurst, 2014) caused extinctions and very significant changes in biodiversity well before European arrival. For the Mediterranean basin, the modification of biodiversity is so important and so old that it is very difficult to tell apart native from allochthonous species, i.e. those introduced by humans (Thompson 2013). Africa is even more challenging, for it is home to the bestpreserved megaherbivores guilds worldwide (Stuart 2015), but they have co-evolved with humans. Human impacts are oldest here but, paradoxically, human impact on ecosystems has been moderate over history. African ecosystems offer some important keys to the establishment of reference levels thanks to the presence of megafauna. It is here that the paradigm of the forest as an ecological climax, unchanged since Humboldt and continued by Darwin or Clements, collapses when both savanna fire and elephants are identified as drivers of tree clearing (Pausas & Bond 2019). Savannas are no doubt a natural landscape in Africa, and its current fauna is a key piece for what we review below.

Livestock environmental impacts

Growing concerns about methane emissions from ruminants that contribute to climate change are being reflected in diverse media, leading to recommendations that vegan choices reduce the environmental impact of our food (Sanz-Cobeña et al 2020), or claims that 'lab meat' is a less polluting alternative (Chriki and Hocquette 2020). Criticism is targeted toward livestock in general, and not just factory farming. In spite of its well-known environmental benefits (Manzano & Salguero 2018), pastoralism is also targeted by climate critics. Firstly, methane emissions increase with diets rich in cellulose, i.e. grass, because the digestion of fodder by herbivores is necessarily accompanied by the production of methane by micro- rumen organisms. Secondly, the lower production of meat or milk per animal in extensive farming results in a higher ratio of methane per kg of product. This thinking has led on to active recommendation to replace ruminants with monogastrics (pigs and chickens) or to increase the protein intake of ruminants through fodder (Garnett et al 2017). Increasing grain inputs for livestock is seen as a necessary climate strategy in a world with an increasing demand for meat and dairy products, especially in emerging economies (Gerber et al 2013).

It is questionable whether such claims make sense. Anthropogenic climate change is ca. 200 years old, while herders have been part of human culture for 10,000 years and the magnitude of their impact 6,000 years ago was enough to delay the desertification of the Sahara by half a millennium through the application of sustainable rangeland management systems (Brierley et al 2018). The accounting method must be wrong if an ancient practice is being blamed for a new problem. The first attempts to solve such a riddle was centred on the capacity of global rangelands to offset livestock emissions. Some in-depth analyses have rejected such approaches, mainly due to soils reaching a saturation point in carbon storage (Garnett et al 2017, Chang et al 2021). Factoring non-climatic environmental benefits with climate impacts into more holistic environmental impact metrics (Ripoll-Bosch et al 2013) still does not explain why grazing did not change past climate.

Baseline levels of greenhouse gas emissions

Baselines have not yet been applied in analysing climatic impacts of livestock but are routinely used by climatologists. Water vapor is known to be a powerful greenhouse gas, yet thanks to its action Earth is habitable by humans. When considering what baseline options are available, current African ecosystems show a model of natural landscape once widespread, with North American landscapes dominated by herbivores such as bison and deer before the arrival of Europeans (Hristov 2012) or megaherbivores some millennia earlier (Smith et al 2010); similarly in Siberia (Zimov & Zimov 2014). Greenhouse gas emissions would in these examples equal the same order of magnitude as those produced today by all the extensive and industrial livestock: 84% in pre-Columbus USA (Hristov 2012) and even more when megafauna roamed in Siberia (Zimov & Zimov 2014). If there were no mammal herbivores, plant cellulose would be consumed by other organisms, or by fire (which also emits methane; Archibald and Hempson 2016). In African savannas, termites are the main animal candidate. They are the source of 4% of current methane emissions (Spahni et al 2011) and, without the herbivorous mammals that compete with them for cellulose, they would multiply their numbers, increasing their greenhouse gas emissions.

Garnett et al. (2017) claim that grass-fed livestock are anyway not very relevant for the global livestock system. However, 46% of livestock feed on leaves and grass (Mottet et al 2017). Since leaves and grass aren't edible for pigs or for chickens, they are very relevant for ruminants – in France, grass is 80% of the ration for beef systems (Dollé et al 2015). Globally, 90% of the beef ration is made up of grass, leaves, silage and crop residues (Mottet et al 2017). Savanna-like ecosystems are not only tropical but they expand into temperate countries, according to Vera (2000) or Bond (2019). Many landscapes perceived as climactic forests were open landscapes during the megaherbivore era and, once the megaherbivores were gone, these areas continued to be lightly-wooded grasslands, maintained by fire. Areas usually perceived as potential forests fall into this category: they include most of Europe, the Eastern United States, India or China. According to IPCC (2000), such grazed landscapes can fix as much carbon as forests, even if most biomass is invisible because of being underground; Holdo et al (2009) and Dass et al (2018) showed root carbon is more stable than the carbon stored in aerial parts of the vegetation.

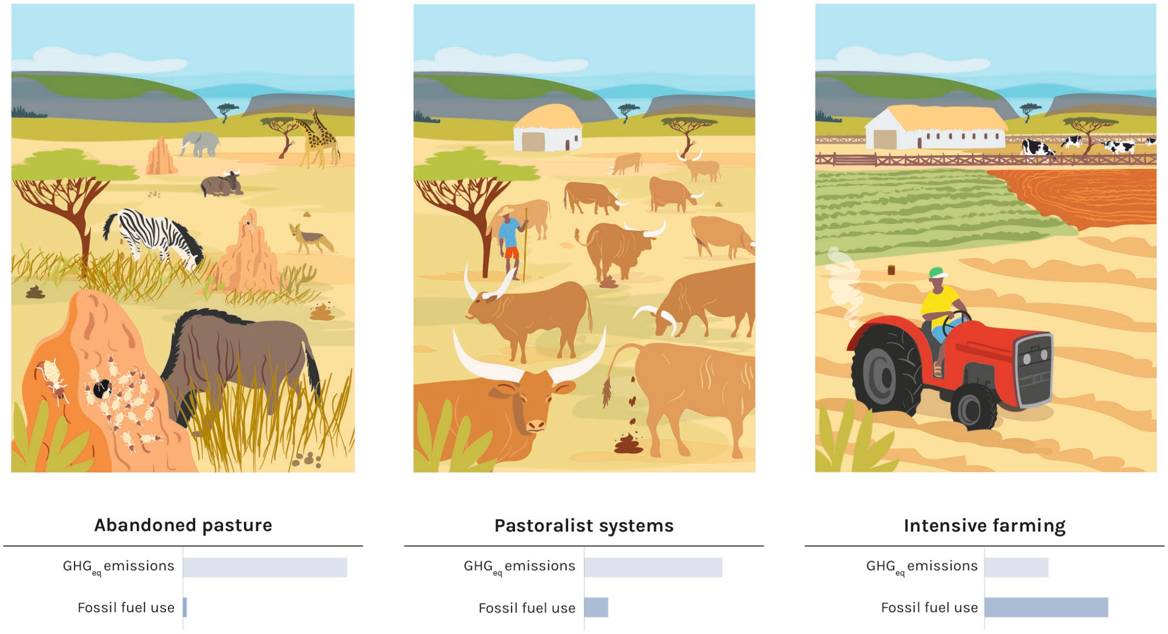

Fig. 1. Conceptual approach for comparisons between different scenarios: abandoned pastures, extensive livestock, and intensive agriculture. Scales are arbitrary – values for GHG_{eq} emissions and for fossil fuel use are not equivalent.
Source: Manzano and White 2019. Reproduced with permission from the publisher. © InterResearch

Application of livestock baselines to other fields of sustainability

Perhaps the most interesting aspect to consider about baselines is their applicability to other areas. Regarding water impacts, it is common to hear that a hamburger needs thousands of liters to be produced. In media narratives, the difference between "green", "blue" and "gray" waters are rarely mentioned, even if they are fundamental concepts for Life Cycle Analysis of water use. "Green water" is rainwater that will always fall on pastures, whether used by livestock or not. However, ·blue water· is the water of rivers, ponds or lakes that we need to channel and that is essential for irrigated agriculture or human consumption uses – with a big impact on aquatic ecosystems that it is taken from. A liter of accounted blue water will therefore have a considerably higher ecological impact than a liter of green water. Gray water is polluted water that is discharged after use on farms, and it is exclusively an industrial livestock problem. Manure from grazing cattle is spread at a low density, fertilizing instead of polluting. Such necessary elements have been considered in recent consensus-building around different water impact measurement methods in livestock systems (Boulay et al 2021).

The same reasoning can be held regarding biodiversity. In the first life cycle analyses, all the effects of breeding were assessed as negative. Fortunately, after incorporating rangeland ecologists into the discussions, the FAO landmark publication incorporated both negative and positive impacts, which also go hand-in-hand (Teillard et al 2013).

Conclusions

Applying baseline scenarios at estimating livestock impacts shows that (i) the semi-natural processes are integrated into the ecosystem as a whole (also when positive), (ii) mankind's real climatic problem are fossil fuels and (iii) some pastoralist livestock emissions can be mitigated, for example in win-win situations, such as the use of manure-fed bio-gas in cooking stoves that improve air quality in kitchens of low-income countries (van de Ven 2019). But the whole political implications should be envisioned when actions on the food system are proposed, and scenarios should also be analyzed to forecast consequences. A scenario cannot be relevant if baselines are not previously chosen, defined and/or negotiated so that fair comparisons (Fig.1) are possible.

Acknowledgements

This research was possible through support of FAO's LEAP Partnership. P.M.'s attendance to the Joint XXIV IGC and XI IRC Congress is supported by HELSUS & the Internat. Union for Biol. Sciences (IUBS).

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