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Comparative analysis of manure treatment scenarios on climate change and eutrophication in the Baltic Sea

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ABSTRACT

This study conducted a life cycle assessment (LCA) of manure management, identifying transportation as a major contributor to global warming and freshwater eutrophication impacts. Transporting substrates to the biogas plant was the main hotspot, highlighting a critical area for improvement. The findings emphasize the importance of method selection in geographically dependent assessments, especially in the Baltic Sea region. Characterization factors specific to Sweden revealed higher environmental impact values than those produced by the ReCiPe method, underscoring the need for regional differentiation in LCA. By optimizing manure management practices and enhancing nutrient distribution, impacts on both climate change and eutrophication can be significantly reduced, thereby lowering nutrient flow to the Baltic Sea. Combining these optimizations with transportation impact reductions further amplifies these environmental benefits, demonstrating that geographically tailored approaches in LCA offer essential insights for managing regional-scale effects.

1. Introduction

Greenhouse gas emissions (GHGs) from livestock manure are major contributors to environmental degradation. Manure releases potent GHGs like methane (CH_4) and nitrous oxide (N_2O), which trap heat in the atmosphere, intensifying global warming. From 1990 to 2020, global GHG emissions from manure increased significantly, underscoring the need for sustainable manure management to mitigate climate change (Mahal et al., 2024).

Additionally, manure runoff is a primary source of nutrients such as nitrogen (N) and phosphorus (P), which contribute to water body eutrophication. Excessive nutrients lead to algae blooms, depleting oxygen and creating hypoxic "dead zones" where aquatic life struggles to survive. This disruption affects biodiversity and water quality (EPA, 2024). Manure leaching also contaminates water sources, causing harmful algal blooms (HABs) that endanger wildlife and human health. Runoff from agricultural soil exacerbates contamination, posing widespread risks (Mahal et al., 2024).

Contaminated water affects public health, particularly when used for consumption or recreation. Toxins from algal blooms can harm people and animals, emphasizing the need for effective management to prevent manure-related pollution (Babuji et al., 2023). In large-scale dairy production, poor manure handling not only harms air, water, and soil quality, but also poses public health risks (Kovačić et al., 2022). Conventional practices – collecting, storing, transporting, and applying manure to land – are often inadequate, resulting in nutrient loss and GHG emissions (Hamelin et al., 2014).

Anaerobic digestion of manure and organic waste reduces climate impacts by capturing biomethane, which offsets fossil fuel GHG emissions. Manure's energy content is modest, but the large volumes produced in animal farming make it valuable for energy production. Including other organic waste in anaerobic digestion can further enhance biogas production (Malet et al., 2023; Billen et al., 2015). Digestate, the residue from anaerobic digestion, is rich in essential nutrients (N, P, K, and S), along with micronutrients and organic matter. In addition to this, digestion also converts some organic nitrogen into ammonium nitrogen, increasing its availability to plants (Chojnacka and Moustakas, 2024). Digestate can improve soil health, water retention, and microbial activity, through nutrient ratios may lead to P overapplication if rates are based on N needs (Kovačić et al., 2022).

Excessive P from manure leads to nutrient loss and eutrophication, especially in the Baltic Sea, where high livestock density contributes to P

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surpluses. Agriculture is the main source of eutrophication pressure in this region (Svanbäck et al., 2019a; HELCOM, 2018a). Improving manure nutrient use is an important management tool to reduce nutrient surplus (Oenema et al., 2007).

Unlike many N-limited marine environments, the Baltic Sea is constrained by both N and P, a unique challenge among its sub-basins (HELCOM, 2003). Improving P utilization efficiency can help maintain crop productivity while reducing P leaching. Redistribution of manure nutrients could meet up to 65 % of P reduction targets for the Baltic Sea by moving surplus P from high-density livestock areas to regions in deficit (McCrackin et al., 2018; Akram et al., 2019).

Life Cycle Assessment (LCA) studies show that anaerobic digestion (AD) reduces greenhouse gas (GHG) emissions by 82 % compared to conventional manure management, through digestate management still poses eutrophication risks. Integrated resource recovery offers a sustainable alternative by capturing nutrients and reducing on-farm GHG emissions (Glover et al., 2023; Dadrasnia et al., 2021). Digestate separation, which separates slurry into N-rich liquid and P-rich solid fractions, enables more precise nutrient application. The liquid can be applied nearby, while the solid can be transported to P-deficient fields, reducing nutrient loss and water contamination (Lyons et al., 2021; Metson et al., 2022).

The More Biogas AB cooperative biogas plant in southern Sweden converts organic waste into valuable energy and biofertilizers, supporting a circular economy. However, many fields receiving digestate have high soil P levels, prompting the adoption of separation techniques to optimize digestate use. Processing investments must consider potential environmental side effects, making environmental impact assessment essential. LCA is crucial for identifying resource-intensive stages like transport and ensuring sustainable choices (Björs, 2023).

Spatialized characterization factors (CFs) for eutrophication help prioritize nutrient reduction strategies based on geographic variations (Henryson et al., 2018). Such CFs differentiate between freshwater and marine eutrophication, supporting more tailored assessments (Henderson et al., 2021). By evaluating the impacts of mitigation measures on the Baltic Sea, this study provides a foundation for informed decision-making to combat eutrophication and enhance the region's sustainability.

Therefore, the objectives are: a) to assess the environmental impacts of current management practices at More Biogas compared to systems with further digestate separation; b) to analyze nutrient allocation scenarios to improve P use efficiency and reduce Baltic Sea pollution; c) to use Henryson et al.'s (2018) spatialized eutrophication CFs to conduct a geographically sensitive analysis of improved P allocation across regions.

2. Material and methods

2.1. Case study

The More Biogas AB plant, a farmer-owned facility in Kalmar, southeast Sweden, processes biomass into compressed biogas for local use (Figure S1). Situated on the Baltic Sea, the plant utilizes raw materials such as manure from nearby livestock farms, food industry byproducts, and household food waste (Biogas, 2023). Emphasizing a sustainable loop, More Biogas processes around 100,000 tons of substrate annually, with 80 % consisting of animal manure. This process yields nearly equivalent amounts of digestate, which is returned to farmers for crop production across over 3500 hectares of arable land. The digestate contains up to 20 % more plant-available N than raw manure, enhancing its fertilization value. Besides manure, the plant also digests external substrates, including food and slaughterhouse waste, allowing it to supply digestate to external customers as well (Biogas, 2023).

In summary, three categories of partners supply and receive digestate: farms that supply manure and receive digestate, companies that send only waste, and farms that only receive digestate for fertilization. For this study, we selected one representative farm from each category—referred to as the Cow farm, Pig farm, Chicken farm, and Other farm—based on local production types. Nutrient flows and fertilizer plans for typical farms in each category were assessed to reflect their operations in this study.

According to plant specifications, the facility setup includes a substrate reception tank, a buffer tank holding four days' worth of substrate, substrate sanitization at 70 °C for one hour, and a 6000 m^3 anaerobic digester operating under thermophilic conditions. Digestate is stored onsite for up to four days. The plant's heating is powered by a 0.8 MW wood-chip boiler. After anaerobic digestion, the biogas produced contains approximately one-third carbon dioxide and is purified to over 99 % methane in the upgrading unit. The gas is then compressed and stored in tanks for local distribution.

2.2. Scenarios

Beyond the current practices at More Biogas, we explored scenarios to improve nutrient allocation, particularly focusing on phosphorus (P). This is a significant issue in the region, where high livestock density and a long-term manure application have led to elevated P levels in the soil. To mitigate the risk of P leaching into the Baltic Sea, P application through fertilizers should be reduced (Hassby, 2016). Therefore, our scenarios considered transporting P to other regions after separating into a solid phase with reduced water content, making transport more feasible.

The study defined six manure management scenarios for environmental assessment. These included the Baseline (current) scenario, where slurry digestate is applied locally in the Kalmar region (Fig. 1) and a Separation scenario, where the phase separated liquid and solid phases are also applied locally. Additionally, three alternative scenarios involved transporting the solid phase to other regions. For one of these (the longest-distance scenario), a drying process reduced the solid phase's water content to 10 % for easier transport.

The separation method in our study was based on ongoing tests at More biogas plant, using preliminary results for separation efficiencies achieved through screw press and decanter centrifuge treatments.

For scenarios involving the transport of the solid phase to other regions, we adopted the categorization of Swedish catchment areas from Henryson et al. (2018). These are named after the nearest town to which the fertilizer would be transported: Lund (Öresund), Lidköping (Kattegat) and Eskilstuna (Baltic Proper). These are referred to as "alternative separation scenarios" and are further detailed in Table S1. Supplementary Material (SM) provides additional information on the data and results used in this study. The map in the SM (Figure S2) illustrates the P balance across Sweden, representing the average P need per hectare as the difference between manure P and the crops' estimated requirement. Recommended crop fertilizer levels were adjusted based on yield and soil P content across all separation scenarios.

In the inventory, the varying values among scenarios are listed in Table S3, with a summary of all scenarios presented in Table S1.

2.3. Life cycle assessment

The environmental impact assessment was conducted according to ISO standards (ISO, 2006a, 2006b) for LCA, using the Easetech® software for modelling (Clavreul et al., 2014). Developed in Denmark, Easetech® has a database largely compatible with Swedish characteristics and data. Where available, processes specific to Sweden - such as the electricity mix - were sourced from Ecoinvent (Wernet, 2016).

The study employed the Recipe (ReCiPe) method, a widely recognized Life Cycle Impact Assessment (LCIA) methodology that quantifies environmental impacts across a system's life cycle.

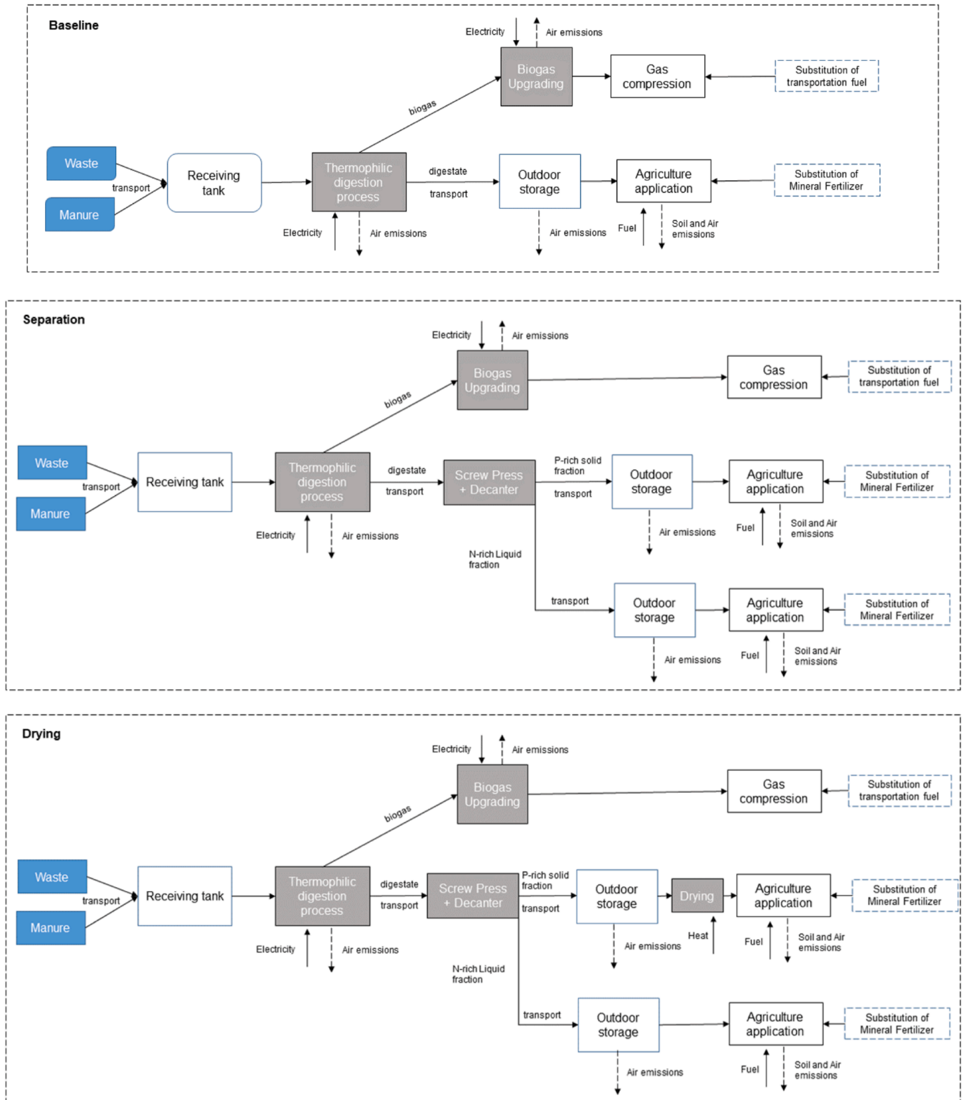

Fig. 1. Baseline, Separation (base for Lund, Lidköping and Eskilstuna scenarios) and drying scenarios and its boundaries.

2.3.1. *Scope and system boundaries*

The study scope covers the entire life cycle, encompassing substrate (manure and waste) collection, treatment, storage, transport, and field application on farms. Systems boundaries are illustrated in Fig. 1.

The assessment uses the Functional Unit (FU) defined as the management of 1 ton of substrate to the More Biogas plant. This substrate comprises a mix of waste and manure, with logistics following the processes outlined in 2.1.

2.3.2. *Inventory*

Life Cycle Inventory (LCI) data for manure and waste management practices at More Biogas were collected and compiled for each life cycle stage, using both primary and secondary sources. These data, detailed in the SM, include information on substrate composition, treatment technologies, energy consumption, transportation, and waste management, all quantified in accordance with ISO 14,040 and ISO 14,044 standards.

2.3.3. *Life cycle impact assessment*

The ReCiPe method includes three main elements: characterization, normalization, and weighting. In LCIA, weighting requires assigning relative importance to impact categories, which introduces subjectivity and uncertainty, so it was not applied in this study. During the characterization phase, LCI results are converted into environmental impact scores for each impact category using ReCiPe's characterization factors. Normalization factors then standardize results to a common reference unit (e.g., global warming potential per unit of CO_2 emissions). The ten impact categories used in this study, along with their abbreviations and units, are presented in Table S6.

Additionally, given the study's focus on eutrophication, we also applied the characterization factors developed by Henryson et al. (2018). These factors account for N and P emissions in terms of N eq. for Marine eutrophication across Swedish geographic locations, considering factors such as distance to the Baltic Sea, catchment area conditions, and nutrient transport. Hence, the factors shown in Table 1 were applied across all scenarios, with specific values for Lund, Lidköping and Eskilstuna.

Table 1
Characterization factors used for the different catchment areas.

Scenario	To Catchment area number	MEP (N)	MEP (P)
Baseline and Separation	076079–001	0.792	7.2188
Lund	91–002	0.414	0
Lidköping	108–083	0.532	0
Eskilstuna and Drying	65–009	0.174	0.3179

Note: MEP (N) refers to Marine eutrophication from N release [kg Neq./kg N], MEP (P) refers to Marine eutrophication from P release [kg Neq./kg P].

2.3.4. Sensitivity analysis

Parameter sensitivity analysis is a systematic method for assessing the influence of individual input parameters on model outputs. This approach identifies which parameters significantly impact results, offering valuable insights into model behavior and robustness.

Since the alternative scenarios inherently function as sensitivity analysis, we also varied a few additional parameters across scenarios to examine their system-wide impacts. The adjusted input parameters are listed in Table 2.

3. Results and discussion

3.1. Life cycle impact assessments results

3.1.1. Full results

LCIA results for all impact categories, as calculated using the ReCiPe method, are presented in Table S7 with their respective units. In consequential LCA, negative values indicate environmental savings within an impact category, while positive values represent environmental impacts (burdens). The net results reflect the balance between these positive and negative impacts. In Table S7, the best-performing results for each category are highlighted in blue, showing that the Separation scenario outperformed all others, whereas the Eskilstuna scenario had the highest impacts, highlighted in orange.

As for the normalized impacts, which provide an overview of the relationships among different impact categories, are plotted in Fig. 2. This figure illustrates the net results for each impact category and their relative significance based on the normalization factors used in the ReCiPe method.

The upper and lower graphs show a similar order of magnitude and comparable values. The most significant impacts appear in climate change (GWP), human toxicity: non-cancer (HTnc), and photochemical oxidant formation: ecosystem quality (POFeq). Photochemical oxidant formation is largely influenced by transportation-related emissions, particularly nitrous oxides and NMVOCs, while human toxicity: non-cancer impacts mainly arise from fuel combustion emissions during transportation and soil application.

Overall, results showed minimal changes, even with the reductions observed in the Separation scenario, suggesting that further impact reduction efforts may be more effective if directed at other parts of the system rather than focusing solely on phase separation – an area discussed further in subsequent sections.

Although HTnc and POFeq did not have high values in the characterized results (as detailed in the Supplementary Material), the ReCiPe method assigns high importance to these categories due to their potential adverse effects on air quality from pollutants like ozone. In this study, climate change (GWP), freshwater eutrophication (FEP), and marine eutrophication (MEP) are particularly critical impact categories, given the Baltic Sea's proximity and the transportation changes evaluated in the scenarios.

Table 2
Parameters and description of the sensitivity analysis performed.

	Sensitivity (parameter)	Variation description	Scenario applied
S1	80 % Substitution	The 1:1 substitution ratio of nutrients and mineral fertilizers was change to 1:0.8	Baseline
S2	70 % Phosphorus	Increased efficiency of phosphorus separation	Separation
S3	Electricity	Swedish electricity mix instead of heat for drying	Drying
	Heat from Natural Gas	"Heat, district or industrial, natural gas, Europe without Switzerland"	

3.1.2. Process contribution analysis

Fig. 3 presents the specific process contributions for climate change (GWP), freshwater eutrophication (FEP), and marine eutrophication (MEP) in a characterized format. The visualization displays the emissions for each impact category in their standard units.

In Fig. 3, the "sum" represents net emissions, calculated by subtracting emission savings from total emissions. This reveals a net reduction of 26.4 % and 21.5 % in GWP for the Separation and Drying scenarios, respectively. Similarly, FEP shows a reduction of 39.0 % and 21.5 % in FEP for these scenarios. However, net results for MEP show minimal variation between scenarios.

For both GWP and FEP, transportation was the primary contributor, accounting for approximately 97 % of GWP and 62–83 % of FEP, including transport to and from the plant. This trend aligns with findings from other LCA studies (De Vries et al., 2012; Lima et al., 2022). Globally, the transportation sector contributes around 24 % of direct energy-related CO_2 emissions, with road transportation, especially freight trucks, being one of the largest contributors (Sims et al., 2014). The significant role of manure transport – due to its high-water content – marks it as a system hotspot and a key improvement target. Transitioning to renewable fuel or changing to pumped transport could enhance system benefits and reduce overall impacts.

The contribution from returning digestate to farms was slightly less (Transportation from More, Fig. 3), particularly for the Separation and Drying scenarios, which showed lower CO_2 eq. emissions than the Baseline and alternative scenarios. Drying the solid fraction reduced emissions by 390 kg CO_2 eq. and eliminated GHG emissions from storage for the stabilized fraction, through the high-water content of the input substrate limited additional for GWP benefits.

Angouria-Tsorochidou et al. (2022) assumed a transport distance of 10 km, resulting in net emissions of −0.36 kg CO_2 eq./kg of dry digestate for their Baseline scenario equivalent and −0.47 kg CO_2 eq./kg for their Separation scenario equivalent. This further emphasizes the critical impact of transportation in manure management, especially when transporting large liquid volumes.

Similarly, Glover et al. (2023) found that conventional manure management practices, such as applying raw manure on soil, generated a GWP of 361 ± 18.0 kg CO_2-eq. per 1000 kg of manure, while anaerobic digestion scenario reduced impacts to 73.4 ± 5.7 kg CO_2-eq. In their study, transportation was not considered, yet it was the major factor in our analysis. Excluding transportation from the Baseline and Separation scenarios in our case reduced the GWP impacts to 49 kg CO_2-eq. and 29.5 kg CO_2-eq., aligning more closely with their findings.

The Separation scenario reduced environmental burdens by 25.7 % compared to the Baseline due to improved nutrient distribution and lower product weight. In contrast, scenarios with transport to Lund, Lidköping and Eskilstuna showed higher CO_2 emissions than the Separation scenario, as expected with increased transport distances. However, overall environmental burdens only slightly increased across these scenarios. The Drying scenario exhibited the smallest increase due to its reduced water content.

Environmental savings in GWP derived from avoided biogas and fertilizer production, were similar across scenarios, with Separation showing slightly higher savings.

For FEP, transportation indirectly contributes through nitrogen oxide (NOx) emissions from fossil fuel combustion, which are deposited in freshwater systems through precipitation (Bobbink et al., 2012). Since FEP is presented in kg P eq, the ReCiPe method's equivalence factors may over- or underestimate certain emissions.

FEP followed a similar pattern to GWP, with transportation as the main burden. However, fertilizer avoidance yielded higher environmental savings due to avoided P fertilizer impacts, which affect FEP more than GWP. In contrast, anaerobic digestion and biogas production did not directly impact this category.

Further, the lowest net impacts were achieved in the Separation scenario, largely due to reduced transportation. In line with findings

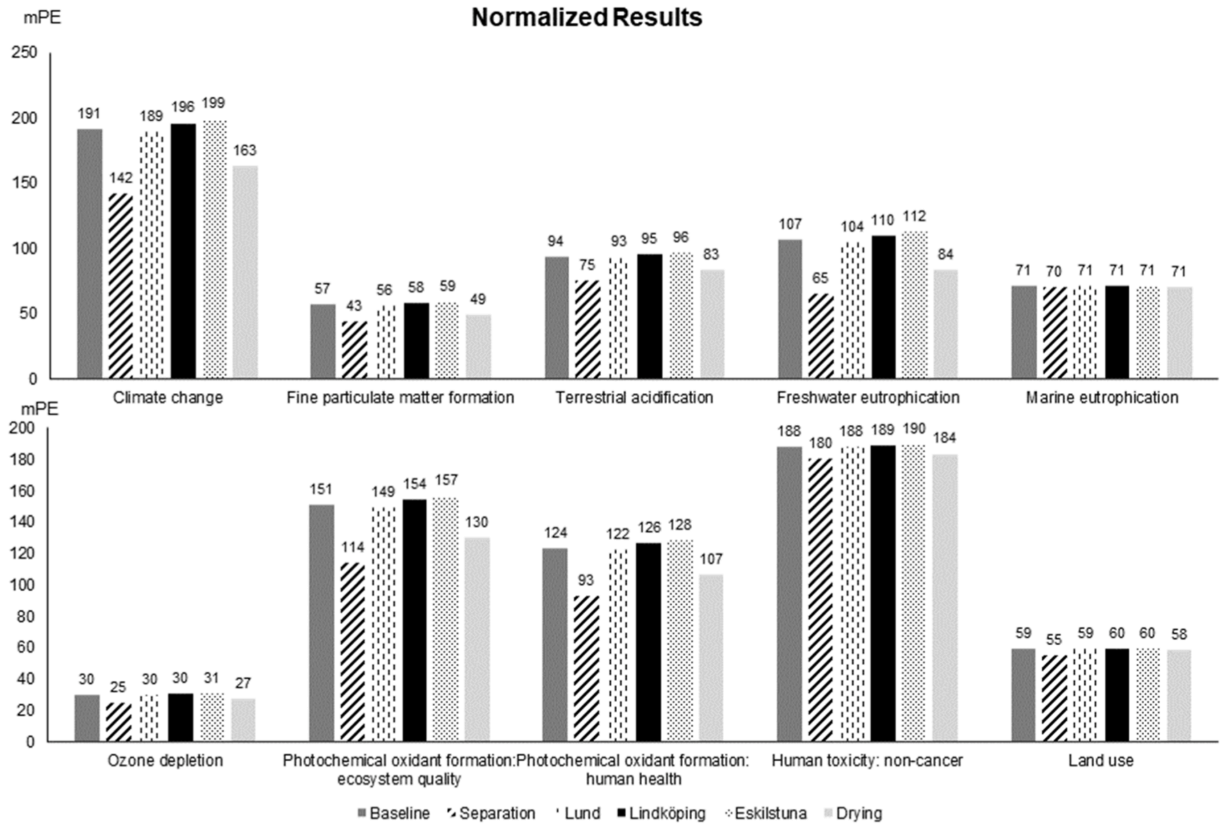

Fig. 2. Complete net normalized results for the four scenarios in mili Person Equivalent (mPE).

from Baltic Manure (2013), separating pig slurry digestate with a decanter centrifuge also showed potential to lower P-eutrophication compared to unseparated digestate. However, limitations in the ReCiPe model prevent estimating further benefits from reduced phosphorus leaching, potentially underestimating the comparative scenarios' advantages.

For MEP, mineral fertilizer application is the main emissions contributor due to N runoff to the Baltic Sea. While avoided fertilizer application yielded savings, there were insufficient to offset net impacts. In a French study by Angouria-Tsorochidou et al. (2022), 99 % of MEP emissions came from spreading operations due to low transportation distances, and they achieved high fertilizer savings without additional N supplements. In our study, N is supplemented to comply with Swedish organic fertilizer regulations and ensure soil fertility, influenced by local soil conditions and digestate quality.

Less impactful contributions, such as ammonia and methane emissions from open digestate storage, were found by Esteves et al. (2019). Emissions reduce significantly in tightly covered storage, which limits ammonia and CO_2 losses (Baltic Manure, 2013). Although these impacts were small in our analysis, they mainly influenced GWP, and closed storage could further reduce emissions.

Additionally, the ReCiPe method only considers waterborne N emissions in MEP, whereas Henryson et al. (2018) include both N and P, as will be shown later.

3.1.3. *Eutrophication potential*

The Baltic Sea, with its semi-enclosed nature, shallow depth, and limited water exchange, is highly sensitive to nutrient inputs, leading to elevated eutrophication risks. Consequently, the characterization factors from Henryson et al. (2018) were essential for a detailed assessment of potential eutrophication impacts on the Baltic Sea. The analysis results are shown in Fig. 4, displaying N and P contributions combined in kg Neq..

It's important to note that the results in Fig. 4 represent net outcomes for each scenario, including both emissions from mineral fertilizers and avoided burdens from organic fertilizers. While these results are not entirely comparable due to the ReCiPe method not expressing P in kg N eq., Henryson's method provides a much clearer distinction of environmental burdens across scenarios. For N, for example, both the quantity and scenario patterns varied significantly. Reactive N emissions cause diverse environmental impacts, which are difficult to measure accurately due to their site-specific nature (Henryson et al., 2020).

In the ReCiPe assessment, scenario variations were minimal, and contributions were approximately three times lower than those indicated by Henryson et al. (2018). Additionally, the Drying scenario, rather than the Separation scenario, performed best for N. These differences arise because the ReCiPe method uses a European-wide average for calculations, which may not fully reflect local conditions. Henryson et al. (2020) observed significant model-based variation between in N emissions and marine eutrophication impacts in crops-related LCAs, underscoring the importance of model selection for assessing both N and P.

For MEP, the Henryson et al. (2018) method considers a broader range of parameters than ReCiPe and, crucially, incorporates Sweden's specific geography, including nutrient transport to the Baltic Sea.

Despite nutrient reduction efforts under the Baltic Sea Action Plan, the Baltic Sea remains heavily impacted by eutrophication, with 97 % of the region still classified as eutrophic in the latest Helsinki Commission report (HELCOM, 2018b). Although nutrient loads have decreased, their effects are yet to manifest in the marine environment. Accurate and current nutrient monitoring is therefore essential, as this study seeks to address. Our exploration of different assessment models for Baltic Sea nutrient impacts highlights how the choice of method can significantly influence burden estimations.

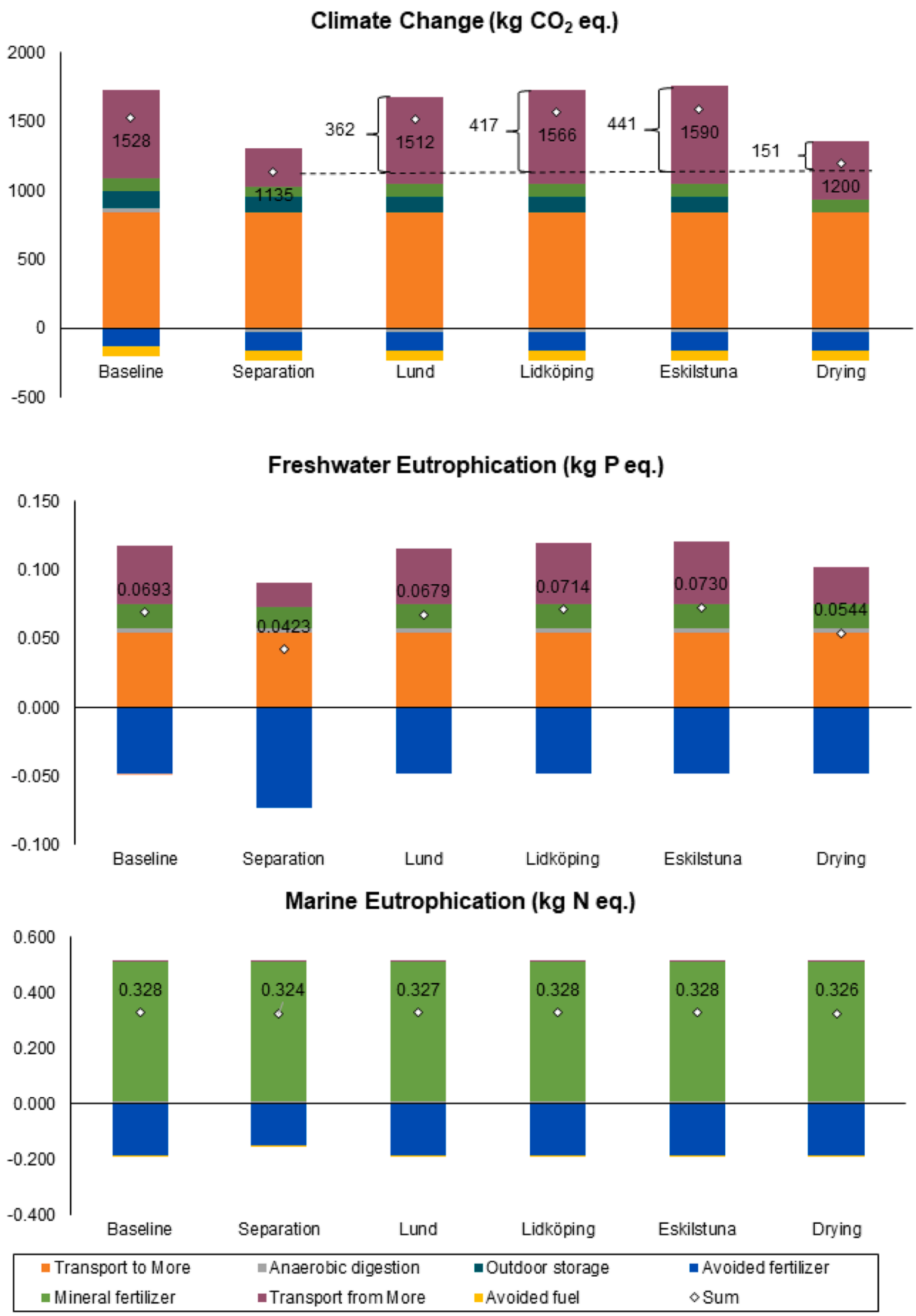

Fig. 3. Specific process contributions to climate change (GWP), freshwater (FEP) and marine (MEP) eutrophication.

3.2. Sensitivity analysis

This analysis provides insights into how changes in certain parameters impact the model's predictions and how sensitive the model is to variations in specific input values.

Transport distance significantly affects the energy efficiency and environmental performance of biogas plants, especially those using raw materials with low biogas yield, such as animal manure (Bacenetti et al., 2013; Esteves et al., 2019; Hamelin et al., 2014).

As shown in Table S8, sensitivity results indicate that parameter variations had minimal impact on overall results. The most notable difference was a 1.13 % increase in GWP emissions with 80 % fertilizer substitution.

Changing the type of drying showed substantial differences on a smaller scale. In the original Drying scenario, the drying process contributed 0.538 kg CO_2 eq., while the sensitivity analysis with electricity increased emissions to 0.857 kg CO_2 eq. (a 59.3 % increase) and to 12.4 kg CO_2 eq. when using natural gas for heat (2205 % increase). While both alternatives raised emissions, the overall scenario impact remained minimal.

The More Biogas plant has a heat exchanger for digestate that could potentially be used for drying, effectively eliminating drying-related emissions.

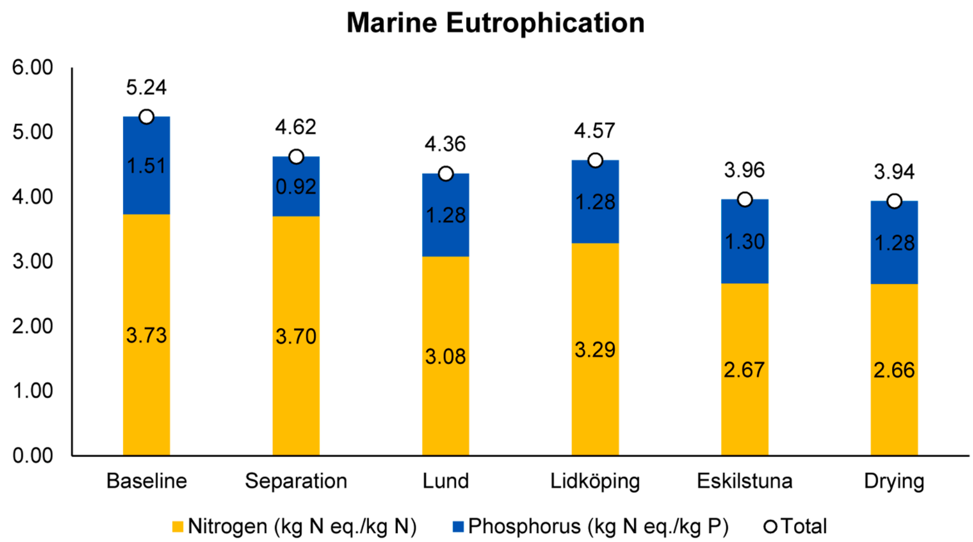

Fig. 4. Marine eutrophication in terms of Nitrogen and Phosphorus according to the characterization factors of Henryson et al. (2018).

3.3. Spatial differentiation of characterization modelling

Henryson et al. (2018) emphasized the importance of site-specific factors in determining the true impact of emissions. Site-dependent impact assessments can therefore provide valuable insights in life cycle assessments (LCAs), enhancing the relevance of LCA as a robust tool for evaluating product-related eutrophication impacts. This need is underscored by the substantial underestimation of impacts observed with the ReCiPe method.

In LCIA, the relationship between an emission and its indicator value is defined by a characterization factor (CF) specific to each substance. For site-dependent LCIA, the location of emissions further influences CFs, as the calculated midpoint CFs capture the impact of waterborne nutrient transport from the emission source to the coast, as well as their role as limiting nutrients in the recipient ecosystem (Henryson et al., 2018).

In Sweden, climate change and lifestyle changes are expected to increase nutrient loads into the Baltic Sea (Hägg et al., 2014). Accurate, current data on nutrient leaching to the Baltic Sea is essential for managing future emissions and impacts.

Spatial differentiation in LCA enables more accurate and realistic evaluations of environmental impacts, particularly in cases with localized or regionally concentrated effects (Owsianiak et al., 2018). Therefore, practitioners should consider the advantages of implementing spatially differentiated LCA.

4. Conclusions

This study conducted a comprehensive life cycle assessment (LCA) of manure management, revealed the significant role of transportation in contributing to global warming and freshwater eutrophication impacts. Transporting substrates to the plant for digestion emerged as the primary hotspot with the greatest potential of improvement.

The findings underscore the importance of method selection for geographically dependent assessments, particularly in the Baltic Sea region, as Sweden-specific characterization factors produced higher impact values compared to the ReCiPe method. Implementing geographical differentiation in LCA enables a more precise evaluation of environmental impacts, especially for regional-scale effects.

Overall, the results highlight that optimizing manure management practices and improving nutrient distribution are essential not only for reducing climate change impacts but also for mitigating eutrophication and nutrient flow to the Baltic Sea. These benefits are further amplified when combined with efforts to reduce transportation impacts.

Content of the publication

During the preparation of this work the author(s) used ChatGPT in order to improve language and readability. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

CRediT authorship contribution statement

P.D.M. Lima: Writing – review & editing, Writing – original draft, Methodology, Formal analysis. **M. Edström:** Data curation. **H. Aronsson:** Writing – review & editing, Validation, Formal analysis, Conceptualization. **Å. Nordberg:** Writing – review & editing, Supervision, Methodology, Conceptualization. **E. Sindhøj:** Writing – review & editing, Validation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.resconrec.2024.108017.

Data availability

Data will be made available on request.

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