Release notes – Overseer version 6.5.5

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1. Introduction

The OverseerFM model release 6.5.5 features significant enhancements to the modelling of nitrous oxide (N_2O) emissions and methane (CH_4) emissions from effluent management systems. These improvements are designed to enhance the accuracy and reliability of our greenhouse gas (GHG) emissions estimates from agricultural activities. The updates are informed by recent advances in scientific understanding and methodologies, particularly the Agricultural Inventory Model (AIM)[1] approach. This document outlines the main changes and their impact on the model results.

The N_2O enhancements provide more accurate and diverse modelling by:

- Incorporating the interaction between animal type and the slope of pasture blocks.
- Refining the treatment of organic fertilisers.
- Improving the way the model considers crop residues and root biomass.

The CH_4 enhancements provide more accurate and diverse modelling by:

- Aligning with the AIM methodology, including improvements for block emissions from updated assumptions about anaerobic conditions in effluent ponds, standardized holding pond conditions, and sludge spread.
- Correcting minor CH_4 modelling abnormalities.

The calculation of maintenance fertiliser for pastoral blocks has also been refined. Previously, only the weight gain of animals sold off-farm was considered, neglecting those still present on the farm. We now include the collective weight gain of all animals grazing on the block, providing a better representation of nutrient removal, and improving maintenance estimates.

[1] The Agricultural Inventory Model (AIM) developed by the Ministry of Primary Industries is a tool used for national GHG reporting. This model is designed to estimate GHG emissions, such as methane and nitrous oxide, from agricultural activities at the national level.

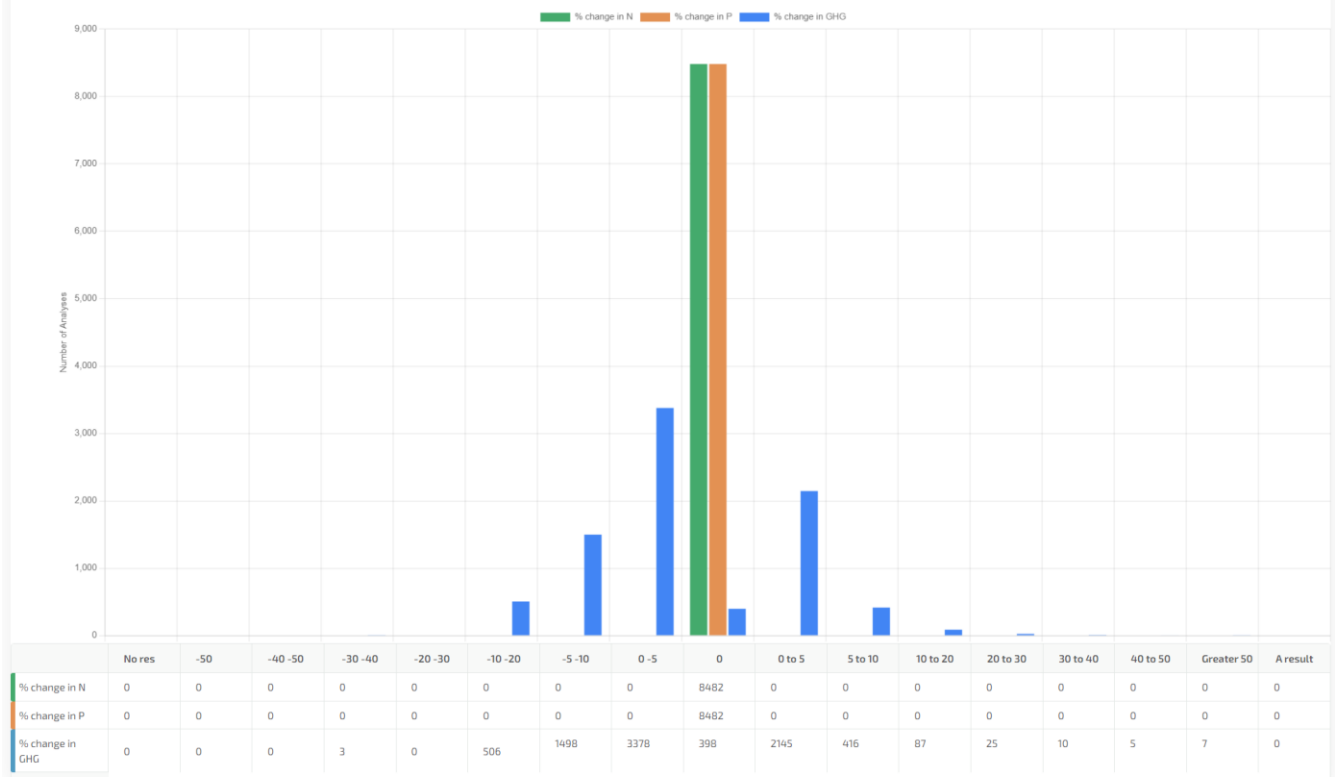
2. Overall impact on modelled results

The cumulative effect of these updates is a significant improvement in overall model performance providing a more representative and reliable tool. Overall, the changes moderately impact the results of OverseerFM.

The impact of changes has been tested using the complete database of c.148,000 analyses (c. 129,000 analyses that have results). Results reported in these release notes are for a smaller subset of the latest year end analyses (c.10,100 analyses) since they are the most representative of current farm systems across New Zealand.

Only GHG emissions model results and pastoral block maintenance P values have been affected by this model update, therefore there is no impact on Nitrogen (N) and Phosphorus (P) loss results.

The following graph shows the total impact of model release 6.5.5 on N, P and GHG results for the latest year-end analyses.



	No res	-50	-40 -50	-30 -40	-20 -30	-10 -20	-5 -10	0 -5	0	0 to 5	5 to 10	10 to 20	20 to 30	30 to 40	40 to 50	Greater 50	A result
% change in N	0	0	0	0	0	0	0	0	8482	0	0	0	0	0	0	0	0
% change in P	0	0	0	0	0	0	0	0	8482	0	0	0	0	0	0	0	0
% change in GHG	0	0	0	3	0	506	1498	3378	398	2145	416	87	25	10	5	7	0

Note: The "No Res" column indicates the number of analyses that had a model result prior to the model upgrade but now get a model error because of the release. The "A result" column indicates the number of analyses that prior to the model upgrade did not have a valid result due to a model error but now have a valid result following this release.

3. Nitrous Oxide (N_2O) sub model updates and impact

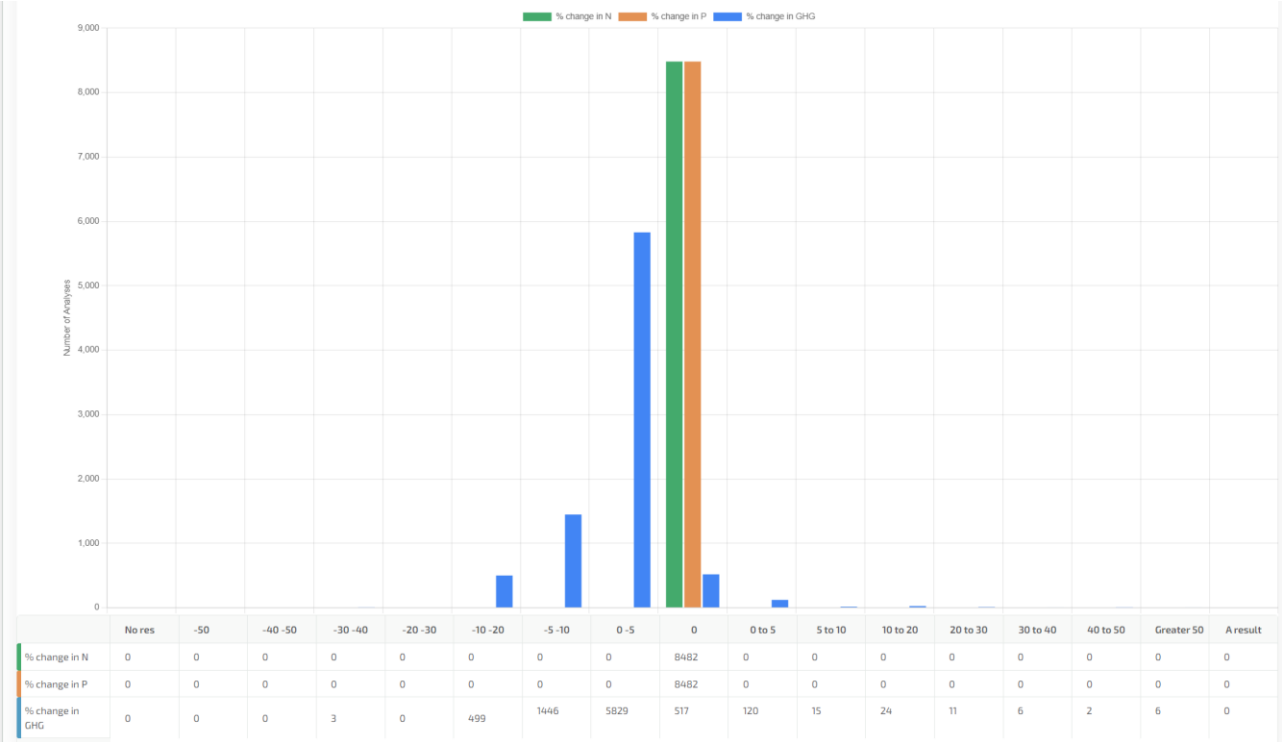
The OverseerFM model release 6.5.5 introduces significant improvements in N_2O emission modelling. These enhancements provide more accurate and diverse estimates by incorporating the interaction between animal type and pasture slope, refining the treatment of organic fertilisers, and improving the modelling of crop residues and root biomass. Key improvements included:

- **Dynamic urine emission factor:** A new dynamic urine emission factor has been introduced, considering the complex interaction between the characteristics of the urine (i.e. the type of animal) and one of the characteristics of the ground (i.e. the slope of the land). This allows a block-specific representation of N_2O emissions due to interactions between livestock urine and land slope. It also ensures alignment with AIM.

- **Organic fertilisers:** The modelling of N_2O emissions from organic manure and compost has been improved. Users will benefit from more accurate estimates from organic fertiliser applications, ensuring consistency with AIM.

- **Crop residues and roots:** The treatment of N_2O emissions from crop residues and root biomass has been refined. This enhancement results in improved estimates of N_2O emissions from soil-incorporated biomass, contributing to more precise and reliable results for users.

The following graph shows the impact of improved modelling of N_2O emissions provided by version 6.5.5 on N, P and GHG results for the latest year-end analyses.



	No res	-50	-40 -50	-30 -40	-20 -30	-10 -20	-5 -10	0 -5	0	0 to 5	5 to 10	10 to 20	20 to 30	30 to 40	40 to 50	Greater 50	A result
% change in N	0	0	0	0	0	0	0	0	8482	0	0	0	0	0	0	0	0
% change in P	0	0	0	0	0	0	0	0	8482	0	0	0	0	0	0	0	0
% change in GHG	0	0	0	3	0	499	1446	5829	517	120	15	24	11	6	2	6	0

4. Methane (CH_4) sub model updates and impact

The CH_4 sub model has been updated to address concerns regarding the accuracy of CH_4 emissions estimates from modelled effluent systems. The key improvements are:

- **Total anaerobic conditions:** The model now assumes that 100% of the liquid components of effluent in holding ponds experience anaerobic conditions, which aligns with the AIM approach. Overseer Ltd is also collaborating with researchers to further refine the estimate of the proportion of aerobic vs anaerobic volumes. The model will be updated with these refinements once suitable peer-reviewed publications are available.

- **Standardised holding pond conditions:** All holding ponds are modelled as uncovered lagoons with a national average annual temperature of 15°C following the AIM approach. Although it may not fully capture the diversity of agricultural conditions in New Zealand, the national average approach provides a well-supported estimate that represents the best understanding currently available.

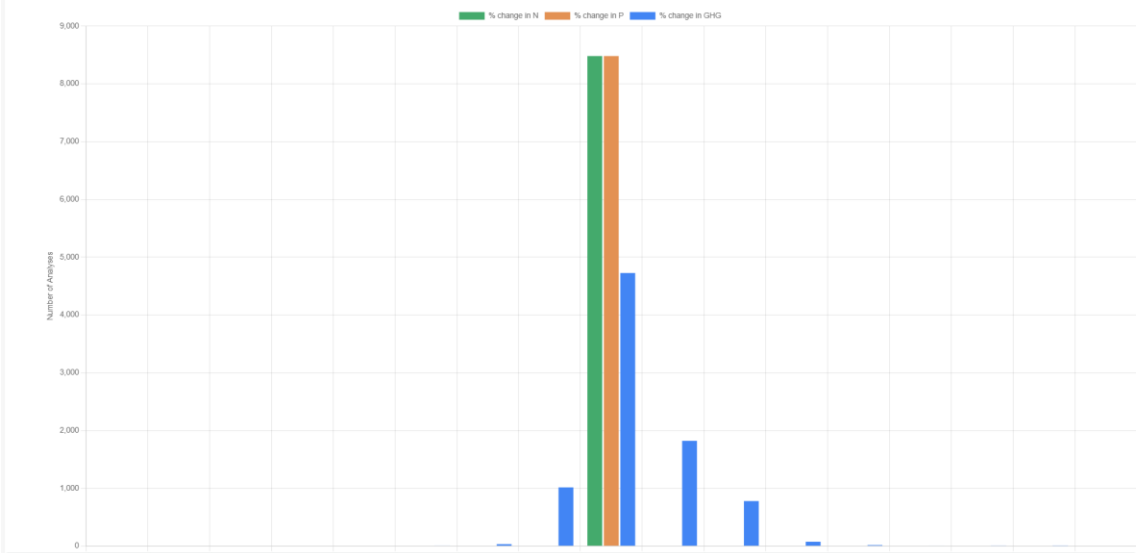
- **Negligible sludge emissions:** Emissions from applied sludge are considered negligible due to aerobic storage conditions, following the AIM approach.

- **Emissions correction:** A minor error in the CH_4 emissions calculation for farm dairy effluent systems has been corrected. The impact was very small.

- **Wintering pad management**: Improvements have been made to manage solid effluent components in wintering pads based on user-defined inputs, correcting previous inaccuracies.

- **Double counting of CH_4 emissions:** The model now correctly accounts for CH_4 emissions from the storage of solid components and their subsequent land spreading, preventing double counting.

The following graph shows the impact of the improved modelling of CH_4 emissions provided by version 6.5.5 on N, P and GHG results for the latest year-end analyses.



	No res	-50	-40 -50	-30 -40	-20 -30	-10 -20	-5 -10	0 -5	0	0 to 5	5 to 10	10 to 20	20 to 30	30 to 40	40 to 50	Greater 50	A result
% change in N	0	0	0	0	0	0	0	0	8482	0	0	0	0	0	0	0	0
% change in P	0	0	0	0	0	0	0	0	8482	0	0	0	0	0	0	0	0
% change in GHG	0	0	0	0	0	7	32	1015	4726	1821	778	74	16	5	3	1	0

5. Explanations for GHG number changes

If you notice an increase in your GHG numbers from version 6.5.4 to 6.5.5, this change may be attributed to increases in one or more of the three modelled sources of GHG emissions:

- **Methane (CH_4) emissions from 'Effluent'** – The increase is attributed to the change in modelling of the holding pond as an uncovered lagoon, which results in increased CH_4 production. This impact is particularly visible on farms that intensively use wintering pads. On these farms, most excreta are managed by the effluent system, thus amplifying the increase in CH_4 emissions from the uncovered lagoon modelling. Therefore, farms that house animals in a wintering pad for long periods of time throughout the year and store their effluent in a holding pond may see an increase in reported effluent methane GHG emissions.
- **N_2O emissions from 'N fertiliser'** – Farm systems that utilise organic fertilisers experience an increase in N_2O emissions from 'N fertiliser'. Historically, N_2O emissions were considered negligible and thus not accounted for. However, the new methodology incorporates organic fertilisers with an emission factor of 0.25%, in line with the AIM approach. This adjustment results in a higher calculated emission rate for farms extensively using organic fertilisers.
- **N_2O emissions from 'Crops'** – Farm systems showing an increase in N_2O emissions from 'Crops' will be those that modelling crop blocks that have events of 'cultivation' or 'end crop' on a block during the reporting year. The observed increase is due to the inclusion of N_2O emissions from root residues during these two events.

If you notice a decrease in your GHG numbers from model version 6.5.4 to 6.5.5, this change may be attributed to increases in one or more of the three modelled areas of GHG emissions:

- **CH_4 emission from 'Effluent'** – The decreases mainly come from correcting double counting issues and a new assumption that CH_4 emissions from applied sludge are negligible. This change aligns with the AIM approach, which recognizes that land-applied sludge has minimal impact on methane emissions. Conversely, emissions from anaerobic conditions have been adjusted upward. On some farms, effluent management practices shift the balance between emissions from land-applied sludge and those from anaerobic processes, ultimately leading to a reduction in overall methane emissions.

- **N_2O emissions from 'Excreta in paddocks'** – Observed decreases are due to the introduction of dynamic urine emission factors, which replace the generic urine emission factor of 1%. These dynamic factors, which

vary based on animal type and pasture slope, tend to be less than 1%, leading to more precise and often lower estimates of N_2O emissions.

- **N_2O emissions from 'Crops'** – Decreases are attributed to methodological changes. Previously, crop residues (retained residues) were included in the N_2O emissions calculation even if they were deposited before the reporting year. The revised methodology ensures that only current year management practices are considered, providing a more accurate assessment of mitigation strategies and their effectiveness.

Users can find these values in the Reports > GHG section of an OverseerFM analysis, as shown below:

6. Conclusion

Overall, the impact of changes on total GHG emissions are relatively small. These adjustments to the Overseer model provide improvements in N_2O modelling and a more agreeable representation of CH_4 emissions from effluent systems, particularly holding ponds. Future improvements, based on emerging scientific research, will be crucial to further improve the accuracy and reliability of the model.

These latest updates to the Overseer model mark a significant advancement in our ability to accurately simulate GHG emissions from agricultural activities. By incorporating the latest scientific methodologies and addressing previous inaccuracies, the model now offers improved reliability and precision. We are committed to continuous development and refinement of the model, informed by ongoing scientific research and expert inputs, to ensure Overseer remains a valuable tool for sustainable agricultural management.

Acknowledgement

The development of the Overseer scientific model was made possible through the support, active solution development, and valuable feedback from scientists at New Zealand's Crown Research Institutes. For all the improvements in Overseer version 6.5.5, we extend special thanks to the AgResearch and Lincoln University scientists involved in the project for their significant contributions and support.