
# Why study Nitrous Oxide and What does it mean for your organisation?

Nitrous Oxide ($N_2O$) accounts for around 10% of all greenhouse gases, however it is 300 times more potent than Carbon Dioxide ($CO_2$), and is consequently potentially more damaging than $CO_2$. The production of $N_2O$ by bacteria dwelling in the soil is the major source of this potent green house gas. Research to understand when and why these bacteria produce $N_2O$ will lead to methods to mitigate it. This issue and research is therefore of importance to a range of industries from the agricultural sector working with the land directly through to the end users of biofuels produced on this land. Even sectors that do not use biofuels directly (yet) but are attempting to reduce their $N_2O$ emissions, such as the transport sector will be affected positively by an ability to reduce $N_2O$ elsewhere.

### Nitrous Oxide, Food and Farming

$N_2O$ is produced naturally in soils through the microbial processes of denitrification. These natural emissions of $N_2O$ can be increased by a variety of agricultural practices and activities, including the use of synthetic and organic fertilisers, production of nitrogen-fixing crops, cultivation of high organic content soils, and the application of livestock manure to croplands and pasture. All of these practices directly add additional nitrogen to soils, which can then be converted to $N_2O$. Indirect additions of nitrogen to soils can also result in $N_2O$ emissions. Surface run-off and leaching of applied nitrogen into ground water and surface waters can also result in indirect additions of nitrogen to the soil. Nitrous oxide is also produced through the denitrification of the organic nitrogen in livestock manure and urine. The production of $N_2O$ from livestock manure is likely to depend on the composition of the manure and urine, the type of bacteria involved in the process, and the amount of oxygen and liquid in the manure system. These are the types of variables that our research into Nitrous Oxide can provide insight into.

### Nitrous Oxide, Transport and Fuels

In the transport/fuel sector $N_2O$ emissions are a product of the combustion and the additives in fuel. While there are tremendous efforts being undertaken by the transport/fuel sector to reduce $N_2O$ emissions, reductions at the agricultural level that are being addressed in our programme may help to develop a decrease in emission that will help transport/fuel sector to address further its overall $N_2O$ emission level.

### Nitrous Oxide and Waste Management

$N_2O$ may be generated during denitrification of the nitrogen present domestic human sewage. The nitrogen is usually in the form of urea, ammonia and proteins and these compounds are converted to nitrate via nitrification. Denitrification occurs under anaerobic conditions (in the absence of oxygen), and involves the biological conversion of nitrate into dinitrogen gas ($N_2$), but $N_2O$ can be an intermediate product of this process.

### Nitrous Oxide and Environmental (or Conservation) Management

The intensification of agricultural production through the application of nitrogen fertilisers has contaminated freshwaters to such an extent that integrated approaches are now being developed to limit the polluting effects on drinking water and the eutrophication of aquatic ecosystems. Innovative solutions include combined land management practices, for example planting cover crops and minimum tillage, and land conversion to less intensive uses, for example grassland, woodland and reconstructed wetlands. These environmental and conservation measures have the potential to generate $N_2O$ in chemically reducing environments such as riparian buffer zones, reconstructed wetlands and coastal salt marshes and it is this pollution 'swapping' of nitrate for $N_2O$ that needs further research into how land management practices may affect $N_2O$ emissions.

### Nitrous Oxide and Climate Change

The role of $N_2O$ in forcing climate change depends on knowledge of natural and anthropogenic sources of this greenhouse gas as well as production and consumption mechanisms within the atmosphere, oceans and terrestrial freshwater components of the Earth System. At global scales, high $N_2O$ concentrations are observed in ocean environments in eastern, upwelling basins where oxygen is limited, and such a situation can also be expected in coastal waters receiving nitrogen-rich fluvial inputs, for example in the Mississippi delta region of the Gulf of Mexico. Further research into the fluxes of $N_2O$ within the Earth System is therefore important to us in our understanding of the role of $N_2O$ in climate change.

Much of the research at UEA should lead to mechanisms to alter or modify soil management, and thus reduce the level of $N_2O$ emissions leading to climate change effects. The ability to address such a fundamental source of emissions that affects many sectors - agriculture, the production of food, bio-fuels, natural fibres and natural products - will have a far-reaching impact on the level of $N_2O$ emitted and go a very long way to reducing the impact of this greenhouse gas on climate change. This $N_2O$ programme is an extremely important counterpart to the Carbon Connections programme specifically aimed at reducing the carbon emissions, where both will lead to a synergistic effect on climate change.

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