Nitrate Modelling Workshop Report

Environmental Change, Adaptation and Resilience Programme

Open Report OR/23/009

BRITISH GEOLOGICAL SURVEY

ENVIRONMENTAL CHANGE, ADAPTATION AND RESILIENCE PROGRAMME

OPEN REPORT OR/23/009

Nitrate Modelling Workshop Report

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Summary

This report details the findings of a workshop held by the Environment Agency (EA) and British Geological Survey (BGS) about Nitrate Modelling on 7th February 2023. The workshop was attended by over 80 delegates and was a part of the “Impacts of climate and land use change on groundwater quality” project, which is a three-year collaborative project between the EA and BGS.

The BGS nitrate modelling work, including a part of PhD study co-funded by Defra, BGS and Jilin University, and nitrate-related work of the EA, Water Companies and Natural England was presented at the sessions of “pollutant sources from the soils” and “nitrate transport and legacy in the groundwater system”. The delegates were divided into seven groups for breakout discussions.

Based on the notes recorded from the seven groups, there are five key themes for future work related to nitrate in groundwater:

- Improved conceptualisation of nitrate processes based on enhanced use and collection of data
- Improved representation of processes in models
- The need for modelling across different spatial and temporal scales
- Training, knowledge, model and data exchange
- Public engagement and action on-the-ground

The discussions in this workshop provided some guidance for identifying the next steps for nitrate work covered by the three-year project, and provided a starting point for greater engagement with stakeholders.

1 Introduction

The “Impacts of climate and land use change on groundwater quality” project is a 3 year collaborative project between the Environment Agency (EA) and BGS, currently in the 2nd year. As a part of this project, on Tuesday 7th February 2023, the BGS and EA held a workshop on “Nitrate Modelling”. The workshop aim was to work with the EA and other stakeholders to explore ways of making a difference in managing nitrate water pollution from diffuse agricultural sources while optimising the income of farmers. The objectives of this workshop include:

- To disseminate the data, tools and knowledge from BGS’s nitrate modelling work
- To help researchers understand real requirements/problems/knowledge when sustainably managing water quality and improving food production
- To develop ideas to bridge the gaps between research and real practices by applying the outcomes of nitrate modelling work to help better manage groundwater pollution

This workshop contained three sessions (please see the appendix A for more information about the workshop agenda):

- Session 1: Pollutant sources from the soils
- Session 2: Nitrate transport and legacy in the groundwater system
- Session 3: Breakout room discussion

BGS nitrate modelling work, including a part of PhD study co-funded by Defra, BGS and Jilin University, was presented at the workshop.. The nitrate-related work of the EA, Natural England (NE) and UK Water Companies was also presented at the workshop by Giles Bryan (EA), Jan Hookey (EA), Helen Wake (NE) and Simon Deacon (Portsmouth Water) respectively.

The workshop was attended by 88 delegates over Microsoft Teams. The delegates were divided into 7 groups for breakout discussions. Each breakout group recorded notes relating to the two general questions on the topics of sessions 1 and 2, including prompt questions (see Appendix B for details). Appendix C presents the questions and answers from the Microsoft Teams chat.

In this report, we provide a brief overview of the workshop attendees and then synthesize the notes made from seven breakout rooms. It should be noted that the topics discussed herein represent the opinions raised at the workshop, and do not necessarily reflect the positions of the authors, BGS or the EA.

2 Workshop delegates

Up to 88 delegates participated in the workshop, and Figure 1 provides a detailed breakdown of the delegates by organization type. Nearly half of the attendees were from water companies, and the second-largest group of delegates was composed of staff from the Environment Agency. The remaining participants were from the BGS, Natural England, Defra and other external organizations (e.g. SEPA, NRW). This diverse community of interest is well-placed to help explore ways of understanding how models can be better deployed to understand the issues around diffuse agricultural sources of nitrate in groundwater.

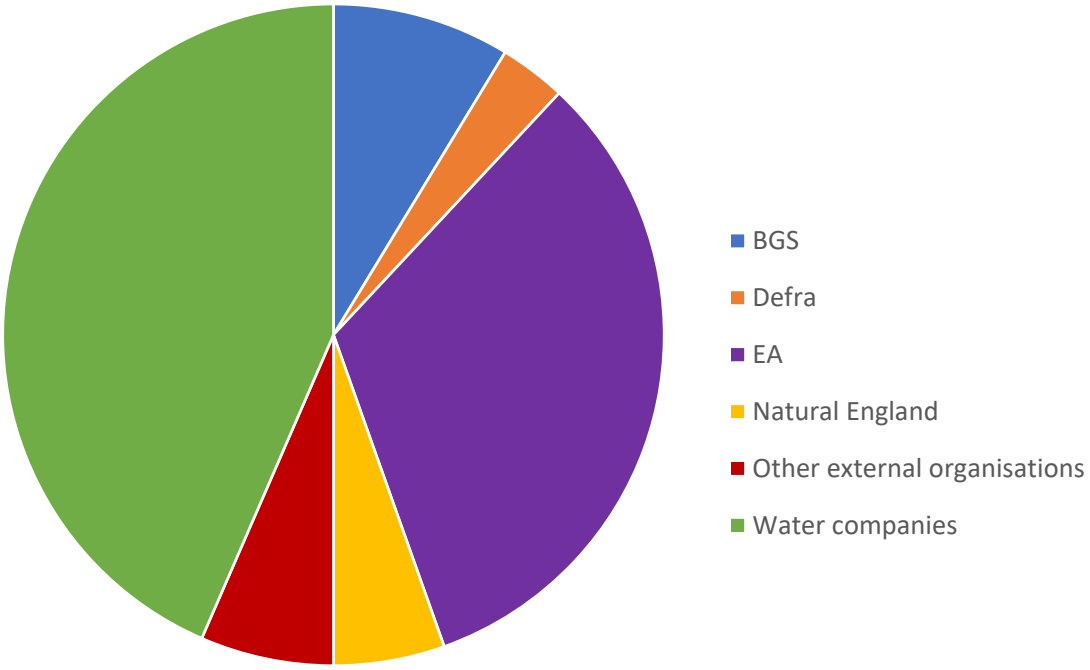

Figure 1. Breakdown of workshop delegates by organisation

3 Breakout Room Discussions

The discussions were undertaken by asking two open questions for the topics of “pollutant sources from the soils” and “nitrate transport and legacy in the groundwater system”:

- How can existing modelling support your ongoing work related to managing nitrate in groundwater?
- What are your needs for future modelling work related to nitrate in groundwater?

Prompt questions to stimulate debate were also prepared for the two topics mentioned above in case some breakout rooms need them. These are shown in Appendix B. Each group provided two feedback points in the plenary session.

3.1 GROUP 1

Recorder: Sean Arnott (EA)

Water company perspective - catchment management work will impact on groundwater sources across these changes.
Regional groundwater models with MT3-D, flows-source Modelling with water quality modelling. To be able to target key areas to target where the focus of modelling work should occur.
For wetlands - catchment areas and flow-paths, groundwater contribution, and seepage points to wetlands, etc. Rainfall, aerial, and surface waters contributions, etc. Could the NCEA work help contribute to this understanding?
SPZ and use of regional models and capturing the inputs to groundwater contribution zones. How does one go into a more detailed approach? Dolines and further monitoring on quick input areas. Would this be further monitoring? Are we capturing everything in the aquifer? Is it representative?

Use of tools better to capture bypass recharge and rapid transport mechanisms through the environment. Are we capturing the WQ spikes? Are we capturing all the dilution?
Can we use the models? Can we spread the use the models further? Can we train more people in the use of modelling nitrate Leaching Tool training? Can we show what the models do so people understand?
We need to understand the use of models. What are the internal and external knowledge required for the use of the models? Conceptual modelling understanding?
Model understanding the sources of what is happening with nitrate. Sometimes levels drop and why is this occurring? 2012 sources went up and back down again?
We need to better understand seasonal behaviour. Do we know what these impacts are? Do we need more monitoring to understand the nitrate system better? Climate change and conceptual modelling?
Climate change and modelling capability? And how do we share these models better? Can we setup training across the models to allow people to better understand what these models can do? Where do we/they turn for advice?
Nitrate Losses the majority of nitrate from the soils will either enter the sources and the river. How many models will model this process? Swann model to fill in the gap between the soil and water processes.
Catchment management work – partnership work with Anglian Water focuses on areas and looking at land changes, we some additional ground-truthing. The delay of the effects of the nitrates. The monitoring will take decades?
NCEA assessment works – We are looking at the modelling of WQ design phase. Early in the design phase.

Plenary feedback:

- A better understanding of the site-specific conceptualisation of total N processes in soils, water and flow paths
- More use of models to better understand conceptualisation and processes. A better understanding of what models can and can't deliver and how to access these models

3.2 GROUP 2

Recorder: Helen Bray (EA)

Understanding what models are available and what they can do, can the pros and cons of each model be shared and what levels they work best at Training and support from the EA on nutrients, nutrient models and catchment management. What's best practice, where does the data for the models come from, more around the practicalities of getting the right data into the model, accessing the data rather than running the model. Could there be online training?
A model that can do both catchment management options and cost benefits/cost effectiveness. Something is needed on the economics of catchment management. Budget can be limiting so it needs to be prioritised to give the highest N reduction per pound.
A model that enables us to influence farmers and can communicate with them Use of the model as an engagement tool that farmers and land owners can understand
Is there a risk of legal challenge if regulatory action is based on modelling? Is the legal basis the modelling or the data that provides the modelling?

Publicity and resources are key to getting results on the ground, generally these need to be improved.
Focussing the actions on current nutrient losses and making sure they're below the DWS regardless of what's happening in the aquifer. For water companies the routes through the aquifer system need to be accounted for and understood so that treatment can be managed for going into supply - catchment understanding is still needed to take account of nutrient flushes after heavy rainfall for example.
There's no landowner responsibility to ensure pollution isn't occurring on their land, for example under EPA Part2A the land owner can be held liable for the pollution not just the person who caused the pollution.

Plenary feedback:

- Training – better understanding of what models are available and what they can do, can the pros and cons of each model be shared and what levels they work best
- Publicity and resources are key to getting results on the ground

3.3 GROUP 3

Recorder: Tim Besien (EA)

Scale of problem is huge! Budgets limited in terms of changing agrcultural practice. Need to have a detailed understanding of the problem. Reducing uncertainty. Nitrate treatment v expensive. Holistic nitrate models needed – borehole catchment scale predictions essential. Water companies use Farmscoper and NLT. Need more resolution at the borehole scale. The current models don't quite deliver. Apportionment, models needed at borehole scale, holistic modelling approach – all important.
Need modelling results at borehole catchment scale. Need high level of confidence to make decisions. Need to understand nitrate concentration differences within the same aquifers. Need high quality data – very important. Need to invest in high quality data to feed models. Need data from observation monitoring boreholes as well as abstraction boreholes. Lots of work on modelling but sometimes not sufficient monitoring data.
Process based models. Can't monitor everywhere – a process-based model can help to understand how nitrate is behaving in the catchment. Is a process-based model useful? YES! But need to understand how the model works. Needs to be transparent. Need to understand the uncertainty!! Need to put effort into collecting the data first. Need high quality input data, which often isn't easily available without investing significantly in data collection. Are there any other methods? Porous pots, Nutrient Management Planning? Alternative data collection methods? Remote sensing? Porous pots – can be useful but they are expensive, difficult to maintain, data can be difficult to interpret. Realtime online water quality sensors – can be used to calibrate process based model.
Land use – regional groundwater models – traditionally they have a fixed land use over time. But!! Land use changes and this could be important. Should consider changes when modelling, e.g. arable to urban following construction of new housing developments.
Future modelling needs - Time bomb modelling – shows a steep decline in nitrate concentrations. Are we really going to see this decline in nitrate concentration? Need to review trends to see if models are robust. Are all inputs of N considered? Is there some hidden/unaccounted N?
High resolution land use data.

Plenary feedback:

- Data quality – need to invest in high-quality model input data (OBH data, USZ profiles, porous pots etc. This needs to come before modelling
- Model scale – Need models at all scales. National models (for policy development), aquifer /regional groundwater models (to understand regional issues) and borehole catchment scale local models to work with farmers to manage nitrate leaching

3.4 GROUP 4

Recorder: Natalie Kieboom (EA)

List of tools available with strengths and weaknesses for practitioners to understand appropriate tool for different applications (including scales of application)
Pilot trials on selective number of farms. Training is needed e.g. NLT for Portsmouth.
Perhaps revisiting of sources and sectors contribution to the problem. Much of the modelling was done >6 yr s. View that perhaps every 10 yrs may be enough depending on particular land use changes (e.g. more wheat Portsmouth but is this sustained), arable reversion possible but how significant, and, water use/demand/availability and potential trading.
What losses can be anticipated from different soil and agricultural regimes.
Land use change and management scenarios. E.g. less tillage, stubble management
Rainfall recharge is key to this. When rain falls, intensity and duration leading to decline in effective rainfall. Linking forcasting with farmers and changing rainfall/recharge and temperature to inform farm management and timing of applications.
Knowledge exchange. Good data sharing and practice sharing amongst WCs catchment work. Sharing learning. A lot there. A lot of appetite to impart information to go from practitioners to farmers.
Understanding more around karst in GW modelling, preferential flow paths to be able to manage the peaks and link this spatially to underlying geology (Alistair L).
Requirements – SMN, SNS. Getting farmers and agronomists to understand and amend their nutrient management or plans. This positive for farmers in terms of saving.
Requirements/education/support to explain FRfW with technical support from EA. Area agricultural advisors/specialists and need for compliance.
Oversight by group to support water companies (WC), EA and others to deliver, share data, information and join up modelling e.g. to get BGS work into WC . Integration of tools, data, management, and monitoring.
Monitoring to be able to show improvements. Need for oversight on monitoring across stakeholders to coordinate. GW Q network. WCs (Portsmouth) drilling new boreholes.
Monitoring to understand N fate below the root zone. Unsaturated zone poor water monitoring. Perhaps some trials in different catchments. WCs would support this.
NO3/Pesticide legacy 50-60m UZ in Lincs Lmst.Time lag significant. Isotopic and poor water sampling. Evidence base was essential underpinning subsequent modelling, planning.
Understanding flow source modelling and SPZ remodelling.
Lag time and age of water helpful for trend modelling for WC abstractions.
Need for doing sense checking and recalibration of models. For NO3 trend did the recalibration result in changes? Portsmouth found NO3 peak and tail of trend changed. Some

other sources showed worse picture. Track changes across models done by WSP, atkins reviewing last 2 sets of trend data (Portsmouth)
Want to know what NO3 reduction is needed in different soil types/catchments. Source apportionment modelling in Portsmouth quantify this, then need to demonstrate effectiveness.

Plenary feedback:

- Knowledge exchange – sharing good practice. Need more coordination across catchments. Work is too siloed at present
- Unsaturated zone understanding is a significant gap in nitrate transport. Need more data and case studies for calibration modelling. Knowledge exchange of learning from BGS, Atkins, WCs etc. Diffusing nitrate timebomb modelling possible task (Simon Deacon). Different WCs have very different approaches

3.5 GROUP 5

Recorder: Elizabeth Flint (BGS)

Modelling nitrate trends with regards to future abstraction trends, in the context of future licenses and future climate change.
How do we navigate the complexity of all these future changes within modelling?
Will there be need for treatment 10/15 years down the line?
Looking into the disconnect between models and on the ground observations (e.g. is it the modelling methodology/differing catchments?)
Is there a better process for putting the vast number of groundwater datapoints (quality/abstraction) into BGS models?
Improve timeliness/efficiency of putting data from water companies into models.
Improve source apportionment not just from agricultural land, but also from non-agricultural sources such as landfill/equine/sewered/non-mains sewage areas.
Need an investigation into data gaps within models.
Uncertainty associated with model outputs, and how do these get communicated within water companies?
Will there be a predictive element of models, with regards to climate extremes, or will these events be used in hindsight to understand trends?
Look into historic climate/nitrate data, particularly at extreme points, not just the general trend.
Need to further understand why seemingly similar catchments (i.e. similar land use) have differing nitrate trends.
Concern about how representative models are on a local scale
Use of flow source modelling - currently trying to link land use trends and nitrates Probabilistic modelling
Nitrate trend analysis/source apportionment investigations are used and giving expected results.
Models are used with caution and limitations need to be communicated with stakeholders
Models in isolation are useful, but when combined often can be misleading.
In Scotland, models are used with monitoring data. Forecasts are made using trend analyses with monitoring data.
Difficulty in linking academic research/prediction models to current decision making within water companies.

Plenary feedback:

- Strong need for water company data to inform modelling approaches
- Need to incorporate future complexity in models (e.g. future abstraction changes, climate change)

3.6 GROUP 6

Recorder: Mark Whiteman (EA)

Southern Water nitrate schemes – building NO3 treatment, based on nitrate modelling work.
Future need – potential for inc NO3 concs due to changes in abstraction rates (no deterioration), e.g. Nottinghamshire. Env benefit to rivers, but may mobilise more soil nitrate. Have previously used blending, but carbon-intensive and expensive. Blending options are reducing.
Analysing trends – don't match at some sites with where treatment plants have gone in. Model trends – in unsaturated pore water may be important, rather than N in gw trends.
Looking at long term historical issues – knowing when we will see benefit, and what level of mitigation we need to put in. e.g. if catchment funding stopped now, would mitigations be sufficient? Could modelling help with this?
Catchment modelling to determine validity of scheme – modelling results suggest benefit but with long payback period – makes it hard to get funding for catchment approach versus end of pipe solution.
Important to know nitrate application rates – is this a gap? Yes, this is difficult, varies seasonally. Precision systems help gather this data, but need agreement to use the data from land managers. Vary variable data at field scale.
Isolated housing developments without connections to foul sewers. In theory new developments with connections should reduce nitrate inputs? Land use change is important – what happens to water modelling, e.g. groundwater flows. How will recharge change?
NEAP-N, modelling climate change impacts on nitrate inputs. NEAP-N is an empirical model, not open source. Would be good to have open source code for anyone to use.
Training in the use of models – e.g. nitrate leaching tool.
Remote sensing of land use changes/seasonal changes is useful (already available). Some of the data stored by EA/NE, access to data could be improved. Utilising the information that is already available would be helpful. Try and join up the data – some open source, knowing what is out there and what can be used. Better data sharing, up to river basin scale.
Favourable land use scenarios – very variable, e.g. thin chalk, clay soils. May get high leaching from e.g. grassland over chalk. Farmscoper – useful for capturing this detail (soil, depth to groundwater etc.). At catchment scale to manage land use for best N reduction.
Improving efficiencies not just land use change 'Nitrate use efficiency' e.g. by cover crops.Hard to model efficiencies.

Plenary feedback:

- Models need to be open source and should include changing land use

- Want to see how soon benefits from nitrate reduction measures will be realised and uncertainty

3.7 GROUP 7

Recorder: Daren Gooddy (BGS)

Effectiveness of monitoring. Peaks taking us by surprise.
Scale of modelling.
Building unsaturated zone into saturated zone models. Better process understanding of what is happening in soils. Soils not well represented
Fracture flow versus matrix movement How can we predict future behaviour? Models as good as the data you put in
Need to understand how boreholes respond to recharge Better understanding of rainfall intensity Spiking on start-up
Differences between north and south use of groundwater
Cost benefit analysis as a use for models. Economics Scavenging effects Changes in land-use
Need multiple sources of water (groundwater and surface water) for climate change.
Future modelling work needs to understand the impact of rainfall intensity on nitrate movement

Plenary feedback:

- Models need recalibration based on extremes (rainfall intensity) to better predict peaks and to well represent land-use change
- Model outputs need to be simplified to be more useful for lay-persons. What do model results mean

4 Key Themes for Future Nitrate Work

Based on the breakout room discussions and the plenary feedback, five key themes for future nitrate work were identified. These are detailed herein.

4.1 IMPROVED CONCEPTUALISATION OF NITRATE PROCESSES BASED ON ENHANCED USE AND COLLECTION OF DATA

It was stated the conceptual understanding of processes related to nitrate in groundwater remains poor in a number of aspects. This includes the processes of nitrate transport in the unsaturated zone, the role of rapid bypass flow, the impacts of high intensity precipitation impacts (spikes vs. dilution), controls on seasonality in nitrate concentrations at abstraction boreholes, soil nitrogen losses and nitrogen source apportionment to wetlands. Some of these processes are particularly pertinent in the context of climate change (e.g. changing rainfall seasonality).

Improving the understanding of these processes was stated to be an important pre-cursor to further model development to reduce both uncertainty in predictions and poor model performance. There should be greater use of existing data to better conceptualize nitrate transport in groundwater systems from sources to receptors (boreholes). There are vast water company datasets for nitrate in groundwater and these need to be better utilised across all of the UK, both for conceptualisation and process understanding and to feed in to models. There may be benefit in pursuing geostatistical approaches, which are common in large sample hydrological studies, but underutilized in a groundwater quality context.

Ongoing monitoring of nitrate in groundwater is essential to provide evidence for change associated with catchment management. Concern was raised that there was possibly too much focus on new model development now at the expense of high quality monitoring data, especially in light of the outstanding conceptual uncertainties stated above. Potential areas of new data collection could include collection of unsaturated zone porewater profiles. The NCEA programme, currently in the design phase, could potentially deliver new monitoring.

4.2 IMPROVED REPRESENTATION OF PROCESSES IN MODELS

There is a need for existing models (e.g. EA regional groundwater models, published BGS models) to improve representation of key processes related to nitrate in groundwater. This includes the soil nitrogen processes, representation of by-pass flow and rapid transport, near-borehole processes (e.g. the role of pumping and matrix diffusion). To deliver this, however, an improved conceptualisation of these processes based on existing data is required (section 1 above).

Limitations in process representation are exacerbated when considering future changes in climate, land use and groundwater abstraction. For example, EA regional groundwater models typically consider static land use. Future land use changes are likely to affect both recharge rates and soil N processes. Changing groundwater abstraction patterns associated with the need to reduce potential abstraction impacts on stream flows is also likely to change modelled transport pathways and receptors for nitrate in the saturated zone. It was acknowledged that these multiple competing future stressors will likely make interpretation of results challenging. There is also a desire to link models of nitrate in groundwater to cost-benefit analyses/economic models, to evaluate the economics of catchment management.

4.3 THE NEED FOR MODELLING ACROSS DIFFERENT SPATIAL AND TEMPORAL SCALES

Models at a range of different scales are required for different needs. National scale models are needed for policy development. Regional scale models are needed to understand the extent of the problem across aquifers. However, it was stated that the most important scale is at the borehole scale. Borehole scale models are required as these are the receptors with most at stake in terms of investment risk (i.e. the costs of installing a nitrate treatment plant). Consequently, there needs to be a high degree of confidence in the models to be able to make decisions based on model outputs. Temporally, models need to cover seasonal behaviour and short term extreme events as well as long trends.

4.4 TRAINING, KNOWLEDGE, MODEL AND DATA EXCHANGE

It was acknowledged that nitrate modelling work is too siloed at present. There was a strong desire for greater sharing of models (e.g. EA regional models, the nitrate leaching tool, BGS models) and the data that support the models, and for future models to be open source. This needs to be backed up by sharing of knowledge and experiences in model development and applications.

A key aspect of this will be delivery of training to facilitate use of models and data. This includes both practical considerations (i.e. how to run the models), but importantly training in the advantages and disadvantages of particular models, what model limitations are, what are appropriate and inappropriate applications, what scale to apply models at, and how to interpret model results. It was suggested that an oversight group of the Environment Agency, Water Companies and BGS could be formed to achieve this.

4.5 PUBLIC ENGAGEMENT AND ACTION ON-THE-GROUND

In addition to the technical sharing of models and data, models outputs also need to be made available in a format that is accessible to the public and farmers. This also needs to convey the uncertainty in model results.

Whilst there are a number of areas where the existing conceptual understanding (section 4.1) and model process representation (section 4.2) of nitrate in groundwater is limited, it was stated that these limitations should not preclude action now to reduce nutrient losses from soils. There was a desire to have a “twin track” approach: (1) Use existing models to support on-the-ground actions to reduce nutrient losses, whilst (2) further developing the conceptual understanding of nitrate transport in groundwater and improving process representation in models.

5 Conclusions

This report documents the findings of the BGS-Environment Agency workshop on “Nitrate Modelling” held in February 2023. Workshop delegates identified five key themes for future nitrate modelling: (1) Improved conceptualisation of nitrate processes based on enhanced use and collection of data, (2) Improved representation of processes in models, (3) The need for modelling across different spatial and temporal scales, (4) Training, knowledge, model and data exchange, (5) Public engagement and action on-the-ground. These themes workshop will be used to identify future nitrate-related work under the Climate and Land Use Change and Groundwater Quality project.

Appendix A: Workshop Agenda

09:00 – 09:10	**Welcome & Introduction (Matt Ascott, BGS)**
SESSION 1 **Pollutant sources from soils** Chair: Daren Gooddy, BGS	
09:10 – 09:20	Soil water and nutrient cycling model – nitrogen (SWAN-N) and its applications Lei Wang & Yuanyin Li, BGS
09:20 – 09:30	A land-use change and nitrate leaching model (LUC-NIF) Yuanyin Li, BGS
09:30 – 09:40	Managing pollutant sources from soils: an EA perspective Giles Bryan, EA
09:40 – 09:50	Pollutant sources and nutrient neutrality: a natural England perspective Helen Wake, Natural England
09:50 – 10:15	Q&A & Discussion
10:15 – 10:25	Break
SESSION 2 **Nitrate transport and legacy in the groundwater system** **Chair: Daren Gooday, BGS**	
10:25 – 10:35	A nitrate time bomb model Lei Wang, BGS
10:35 – 10:45	Simulating groundwater nitrate concentration trend under climate change and land-use change at the national and catchment scale Yuanyin Li, BGS
10:45 – 10:55	An EA perspective on modelling nitrate transport in groundwater Jan Hookey, EA
10:55 – 11:05	A water company perspective on modelling nitrate transport in groundwater Simon Deacon, EA
11:05 – 11:30	Q&A & Discussion
11:30 – 11:40	Break
SESSION 3 **Discussion** **Chair: Amy Capon, EA**	
11:40 – 11:45	Introduction
11:45 – 12:30	Breakout discussions, discussing:

	How can existing modelling support your ongoing work related to managing nitrate in groundwater? What are your needs for future modelling work related to nitrate in groundwater?
12:30 – 12:55	Feedback
12:55 – 13:00	**Wrap up (Sara Gomes)**

Appendix B: Breakout Group Prompt Questions

Breakout room prompt questions – Pollutant sources from soils

Question 1: Regarding pollutant sources from the soils, are these datasets/tools useful for your work? and how could these datasets/tools be further developed/customised to become useful?

Question 2: Would real-time datasets/functions be useful for your work?

Question 3: What are the favourable land-use change scenarios for DEFRA/EA/water companies?

Question 4: What are the gaps/real requirements in your work related to pollutant sources from the soils?

Breakout room prompt questions – Nitrate transport in groundwater

Question 1: Does your work need to consider the nitrate/pesticide legacy in the groundwater system?

Question 2: How could the NTB datasets and modelling functions be further developed to help your work?

Question 3: Are there any activities that need to consider the impacts of climate change and land-use change on groundwater nitrate concentrations and soil water and nitrogen processes at both catchment and national scales?

Question 4: What are the gaps/real requirements in your work related to nitrate legacy in the groundwater system?

Appendix C: Comments in MS Teams Chat

[10:00]

Hi, one other thing, Giles mentioned that the farmers submitted the NLT to them so they didn't have to go out to all the farms to obtain the data. How is compliance on the ground being checked? We are aware that nutrient plans tend to sit on a shelf and not necessarily reflect what occurs on the ground.

[10:02]

Giles mentioned there is a need to have the presence of the regulator to make sure the farmers comply with recommendation about use of Nitrates. I am concerned about the resources needed from EA for this approach will be severely limiting the effectiveness of this

[10:11]

The Easinet page for the NLT (last updated last week!) says the tool is "in the final stages of user testing... [and]... national roll out is expected very soon." Is Giles or Tim able to be more precise? Do they have a target date this year? Environment Agency - Nitrate leaching assessment tool

[10:23]

I would agree now with Giles that a voluntary only approach is not sufficient. We have a major chalk groundwater source where we have been working for 10 years and 'maybe' we have flattened some of the peaks possibly the trend is lower than it would have been otherwise, but it is still now too high for us to avoid putting in nitrate treatment. So we will have to spend £multi millions on a nitrate works but the company has released an additional sum (small fraction of capex but very significant increase on previous),for enhanced catchment management, where we are taking a much more open approach to funding including farm infrastructure. The EA (Giles) are workin with us writing to all farmers in the catchmnt and follwing up high risk farmers with visits. We followed up with a letter offering farmers our help with completeing the NLT tool (and funding. The result is that within the space of 6 months we have seen an exponential rise in farmer engagement and we hope that this will impact n trend to the extent that it will limit level and duration of treatment required. Very good support from EA here driven by Giles

[11:11]

We have Flowsource models that predict N trends under various catchment management scenarios. We are not alone I'm sure in finding that local predictive models are not that accurate, for a variety of reasons. However, according to MOTTS, even if the predicted trend is not that accurate, the overall degree of effect of CM should be approximately realistic, as that relies on the more well known parameters in the model. We are yet to see if this is correct though!

[11:11]

If I am not wrong, all the models presented today assume a constant pumping regime throughout time and do not take into account the fact that the global pumping rates are changing (reducing) due to sustainability reduction requirements to meet WFD water resources targets. As such, the GW scavenging effect now in place from the various "pump and treat" schemes for PWS or otherwise, will not be there in the future and may have already changed in the baseline periods used. How can this aspect feature in the modelling undertaken and how important is it for decision making irrespective of all other measures?

[11:13]

On capturing inputs - I'm absolutely sure we're not, at a local level.

[11:14]

Porous pot monitoring will be valuable to help demonstrate improvements delivered by different measures. Ideally this monitoring needs to continue to be funded.

[11:15]

We do a lot of porous pot monitoring so I agree Giles - this is key monitoring to show effectiveness but he they cost a lot of money to install and monitoring

[11:22]

From the modelling of SPZ, SGZ, the Lincolnshire zones for potable supplies have been done on a protected yield basis at or around Recent Actual. Proposed changes for sustainability in Lincolnshire are not impacting Recent Actual quantities, changes are 'on paper' ...but like so many things approaches are area specific

[11:27]

We have a very similar challenge at Anglian - modelling is just not forecasting, especially in our chalk aquifers. These sources are typically showing protracted (and insignificant) response to catchment management interventions. Nitrate stored in (and released from) pore matrix is certainly the prime suspect. We saw substantial mobilisation during extreme wet periods in 2019/20 and 2020/21 which have been quite protracted and still haven't recovered back to the baseline. These have also been substantially above the error margins of modelled forecasts.

[11:27]

Do we need to better simulate change in land use and 4R recharge in the GW models from 1960s to date? As many times GW models have land use as fixed input to 4R throughout all model period

[11:29]

We are seeing the same in Southern - very high groundwater levels and high nitrate spikes... Also abstractions are a pumped source - so offers - some dilution as pulling in water from high as well as 'low in the aquifer;... understanding unsat (pore water) concentrations is important

[12:37]

Many thanks for organising this. I also need to go now. Have a good rest of the meeting. Giles

[12:41]

There is a need to understand the implications of nitrate modelling - if the message to the farmers is that if they make a change today, in 45 years time we will see an improvement at the receptor, they will quickly lose interest...as will my finance director! If however, that is true, then we might require a lot of additional treatment!