



2021 SHOWCASE



UKRI GCRF South Asian Nitrogen
Hub

ABOUT SANH

SANH Aims

The UKRI GCRF South Asian Nitrogen Hub (SANH) is a partnership that brings together leading organisations from across South Asia and the UK to reduce the adverse global impacts of nitrogen pollution on the environment, health, and wellbeing. By using nitrogen sustainably, with less waste, we can improve human health, protect the environment and reduce the impact of climate change.

About the 'Showcase Report'

This Showcase Report aims to highlight the achievements of our SANH Partners and Work Packages. Despite the challenges of the past year, our partners have continued their incredible dedication to our project and have made a massive amount of progress. We want to thank all of our members for their hard work and amazing achievements.





RESEARCH PROGRAMME 1

Building the Nitrogen Policy Arena for South Asia

Photo: Colombo Declaration, October 2019

WORK PACKAGE 1.1

Mapping nitrogen policies across South Asia, developing tools for policy makers and engaging with the South Asia Nitrogen Policy Arena.

SOUTH ASIA NITROGEN POLICY DATABASE

Partners in Work Package 1.1 have been busy collating both direct and indirect nitrogen policies from across South Asia, to create the largest known directory of nitrogen policies in the region.

965 POLICIES

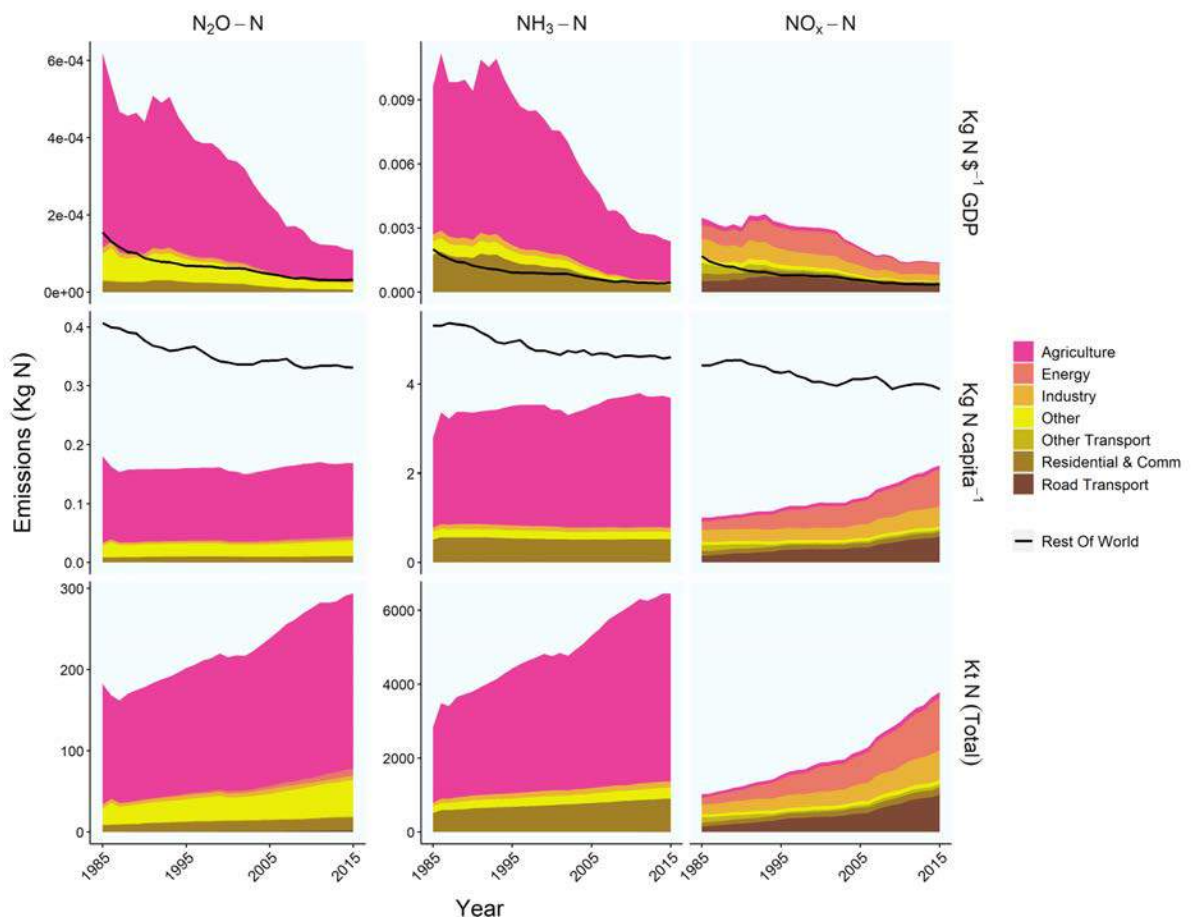
have been included in the database. This provides an incredible resource for both SANH partners and the wider scientific and policy community. The policies have been classified according to a variety of parameters including the sink (air, water etc.) and sector (agriculture, industry etc.) they address and by type of policy. Further analysis has contributed to an academic paper, 'Analysis of N-relevant policies' (comparison with Kanter et al. 2020, Nature Sustainability), which will be published later this year.

Work Package members at the University of Edinburgh presented this work to its Centre for South Asian Studies in December. They are using the results to contribute to Chapter 4 of the International Nitrogen Assessment. WPI.1 will also present at a panel on 'Nitrogen Pollution: an environmental challenge for South Asia' for the BASAS (British Association for South Asian Studies) April 2021 conference in Edinburgh.

NATIONAL NITROGEN POLICY POSITION PAPERS

WP 1.1 partners, from their respective countries, will be using the collated database of nitrogen policies to create national position papers outlining the current policies for each country in South Asia. The team at KIIT have also developed a paper entitled 'Nitrogen Fertilizer Use in Indian Agriculture: A Policy Analysis' and which has been sent for publication to the journal 'Advanced in Management'.

Visualisation Example from WP 4.1: N emissions (kt) for South Asia, split into two y-axes (for N₂O, NH₃ and NO_x). These visualisations are used in policy briefings created by WP I.I.



POLICY BRIEFS FOR POLICY MAKERS AND PRACTITIONERS

Policy Brief for the SACEP Regional Workshop

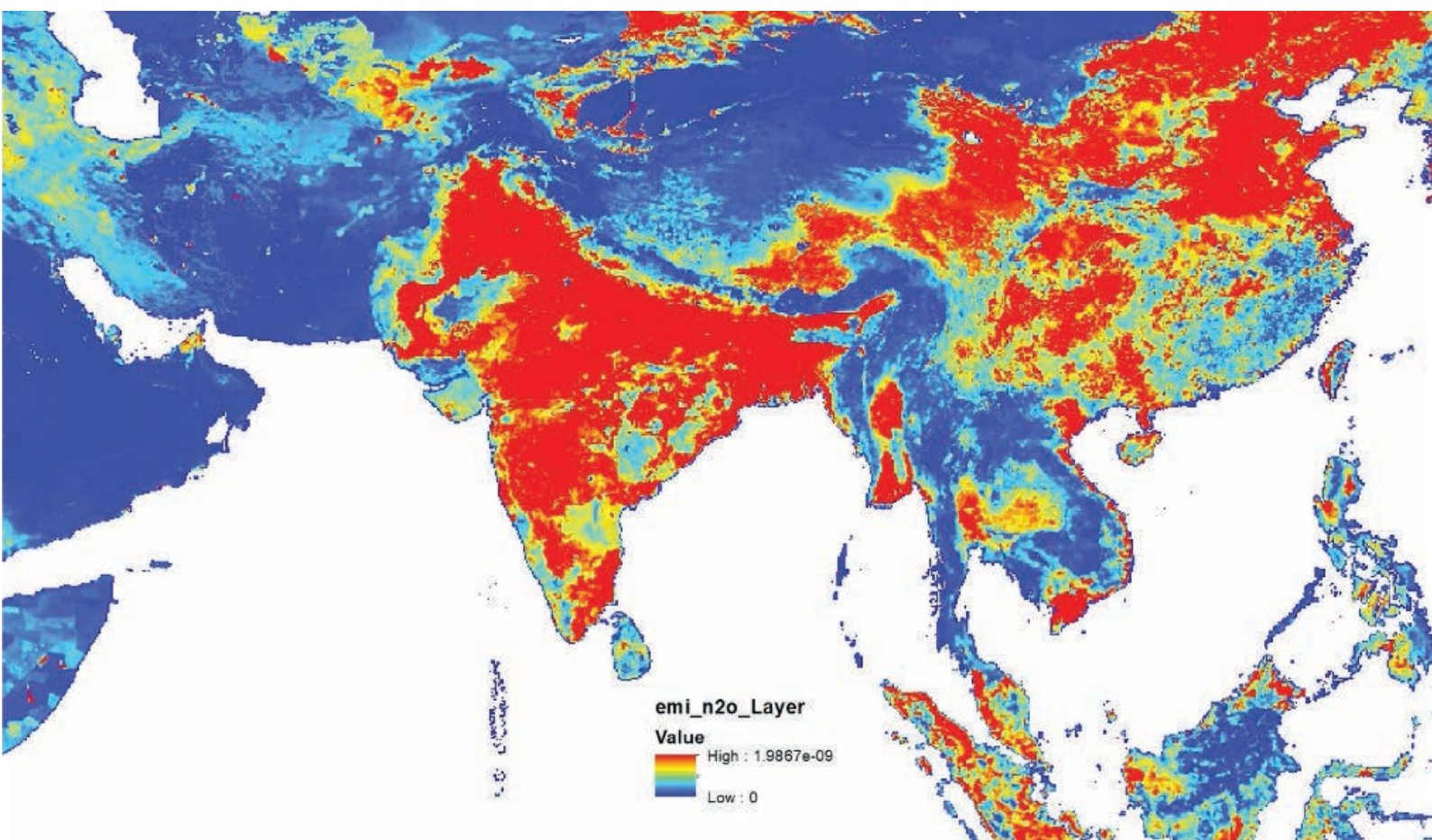
WP I.I has a major focus on engaging and informing policymakers on the issue of nitrogen pollution. In advance of the June 2020 SACEP Regional Workshop on the Nitrogen Roadmap for South Asia, WP I.I prepared a policy briefing note to better inform government representatives and policymakers of the key nitrogen science in the region.

Policy Paper on Gaps and Opportunities for N policy in South Asia, with SACEP

In partnership with SACEP, WP I.I utilised Nitrogen policy questionnaires completed by South Asian Governments and the WP I.I Nitrogen Policy Database to develop a Policy Paper that highlights gaps and opportunities for nitrogen policy in the region. The paper is being circulated through SACEP to members in draft form and will be a valuable resource for governments for improving nitrogen management and policy. This will be furthered through SANH's engagement with governments through the SANH Regional Engagement Group.

WORK PACKAGE 1.2

Developing future nitrogen scenarios. Understanding the drivers of nitrogen losses, actions taken to reduce these losses, and barriers to reducing nitrogen losses. Helping design policies to reduce nitrogen losses.



N2O emission from agriculture soil - 2015

UNDERSTANDING CURRENT DRIVERS OF NITROGEN LOSSES

WP 1.2 have been using EDGAR time series emission data from 1970–2015 to identify the main sectors for all nitrogen species, to further understand the drivers of nitrogen pollution for every South Asian country. To ensure the validity of the results, WP 1.2 have also collected national datasets and used the information collected by the SACEP nitrogen questionnaires. WP 1.2 already have some interesting results. In all countries except the Maldives, the biggest sector contributing to N₂O emissions is from managed soil. Using the sector results, WP 1.2 have already been able to start to look at national differences such as indirect N₂O emissions from atmospheric deposition as a larger contributor in countries such as the Maldives and Sri Lanka compared to Afghanistan and Bangladesh. This information, with the assistance of WP 1.1, will help inform policy-makers of sectors to prioritise when working to reduce nitrogen waste in their countries. WP 1.2 have been focussing their attention on sector-specific spatial maps for N₂O emission to identify emission hotspots.

SACEP NITROGEN QUESTIONNAIRES

SACEP circulated a Nitrogen Policy questionnaire to all South Asian governments with questions on land cover, fertiliser use and prices, fertiliser subsidies, and policies that focus on nitrogen pollution. The results of these surveys have been used across SANH, particularly in WP 1.2 and WP 1.1 where the results are being used to understand current legislation/policies on nitrogen management. This helps inform how new policies can be developed or existing policies can be implemented to reduce nitrogen pollution into the future.



FUTURE NITROGEN SCENARIOS AND MITIGATION

WP 1.2 has a strong focus on developing future mitigation scenarios for the region. They are currently reviewing all N₂O mitigation measures and technology to evaluate their cost and mitigation potential to construct different pathways to halve nitrogen waste and reduce N₂O emission by 2030. WP 1.2 and WP 1.3 are also working together to research the barriers in implementing technologies to reduce N pollution which will feed into the future scenarios. WP 1.2 is also closely collaborating with the modellers across RP4.

The University of Kabul are also trying to enhance their linkages with factories in Kabul to further discussions on nitrogen sources and links to business.



NITROGEN AND HEALTH

SANH Partner, London School of Hygiene and Tropical Medicine (LSHTM), are working with WP 1.2 to look at how changes in future food consumption can be taken into account in future nitrogen scenarios.

LSHTM and WP 1.2 are also collecting information and health data on nitrogen and its impacts on human health which will further feed into the future scenarios and other work being done across the Hub.



WORK PACKAGE 1.3

Increasing understanding on how farmers use nitrogen and the factors they use to make decisions on nitrogen use for both crops and livestock. Investigating nitrogen solutions to ensure that they are socially and culturally acceptable.

Surveys on Farmer Nitrogen Use

Despite being drastically impacted by COVID-19, WP 1.3 have prepared a detailed protocol for analytical methods, suitable for researching the links between socio-economic aspects and sustainable practice uptake and nitrogen use efficiency. They have also drafted their questionnaires for primary data collection. Although the pandemic has delayed fieldwork, many partners are looking to go out into the field in the coming months.

The household survey has now been approved by the Government of Bhutan and is ready for the pilot study in March this year. KIIT in India is also looking to start the surveys soon and Pakistan is aiming to start survey work in May 2021. A UK ethical review has been carried out too. Cool Farm Alliance, an NGO representing the agriculture industry, have also worked with WP 1.3 to develop a survey, which is undergoing final review, to gain an understanding of their members' approached to Nitrogen management

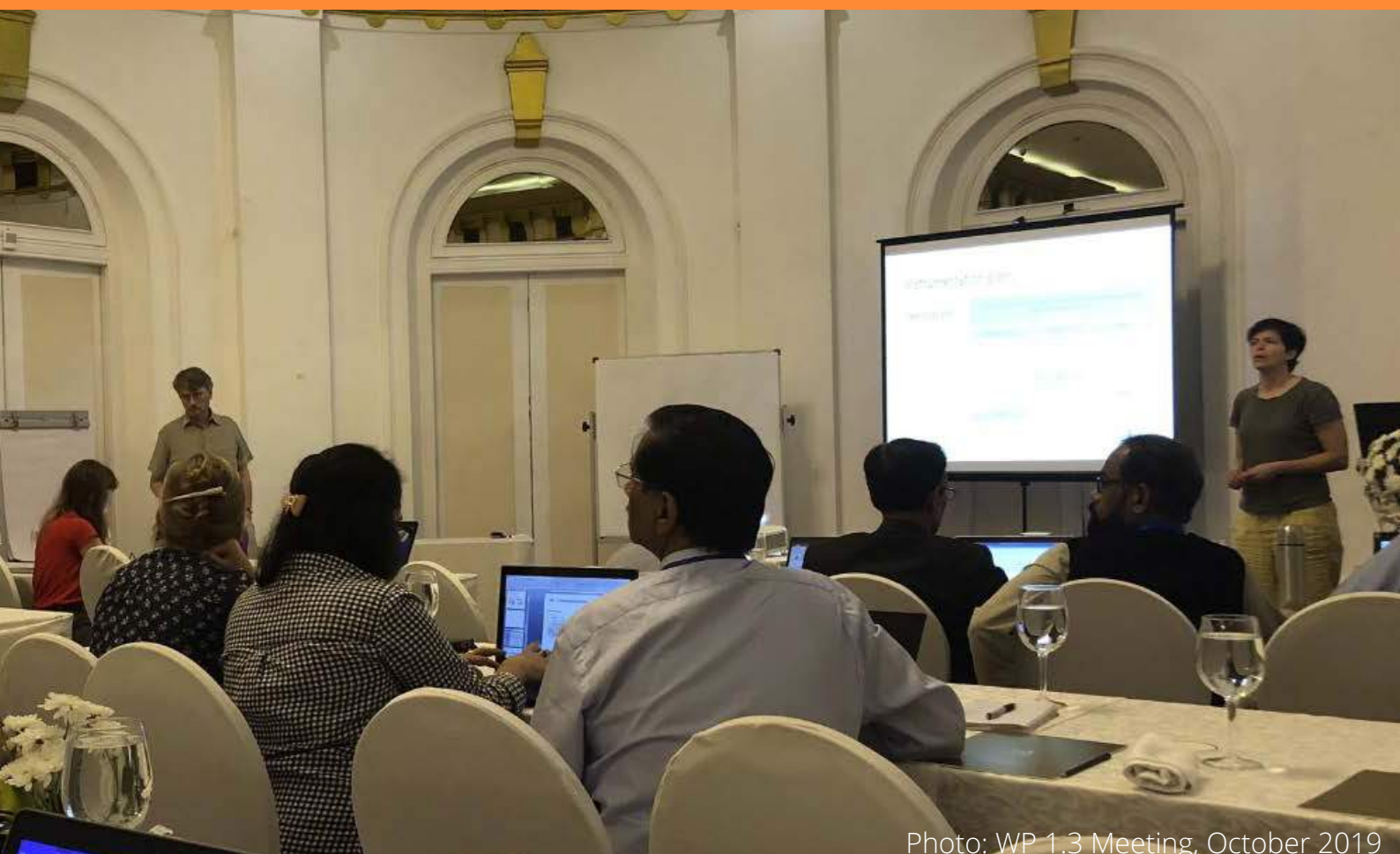


Photo: WP 1.3 Meeting, October 2019

Work Package 1.3 Literature Reviews

A Systematic Review of factors that influence farmer's adoption of sustainable crop farming practices: Implications for sustainable nitrogen management in South Asia

- A review of 100+ scientific papers on the barriers and drivers of uptake of sustainable nitrogen practices in South Asian.

Risk attitude and fertiliser use. A review with a focus on South Asia

- A review of the current literature on the drivers of fertiliser use in South Asia. Risk averse farmers tend to use more fertiliser in order to reduce production risk.

Determinants of briquette urea technology adoption

- WP 1.3 partners in Bangladesh have written a paper that explores the factors that have prevented the adoption of briquette urea technology in the country. This technology can increase nitrogen use efficiency.

Wheat growers' nitrogen use efficiency: Levels, social-economic determinants and emissions

- Partners in Bangladesh have been analysing household data collected earlier to look at the variety of different social and economic factors that impact farmer's nitrogen use efficiency in wheat production in Bangladesh.

Fertiliser Subsidy and its sustainability for Nepal

- Partners in Nepal are conducting a review that analyses historical and current fertiliser subsidies in Nepal and whether these subsidies impact environmental sustainability.

Driver of Nitrogen Use in Pakistan

- Our partners in Pakistan are working on a paper on the drivers of nitrogen use in Pakistan and are editing a book on "Nitrogen Assessment: Pakistan as a Case-Study" which will be published by Elsevier in July 2021.

Use of Nitrogen Fertiliser among small and marginal farmers in India: Important drivers

- KIIT have started a Draft Working Paper titled "Use of Nitrogen Fertilizer Among Small and Marginal Farmers in India: Important Drivers" in conjunction with WP 1.3.

WORK PACKAGE 1.4

Analysing current nitrogen management apps and software being used in South Asia. Developing a free to use nitrogen management app in conjunction with Cool Farm Alliance to assist farmers.

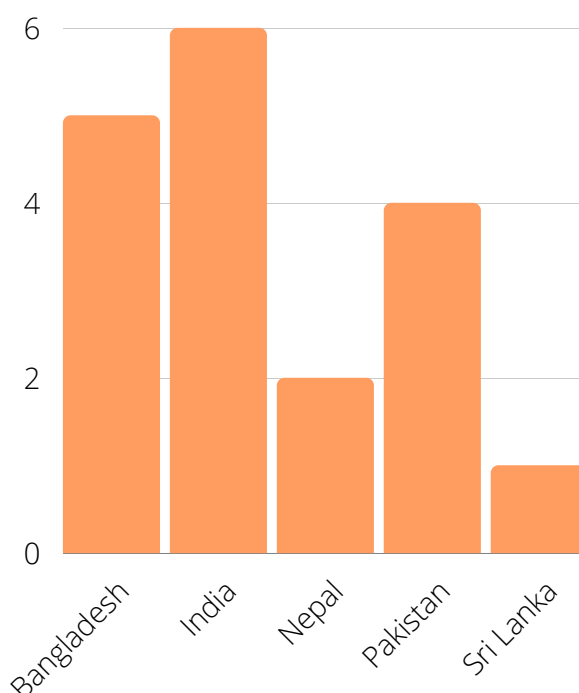
WP 1.4 have collected a large number of nitrogen management apps that are being analysed to help inform whether new nitrogen management tools need to be developed and how new apps can help farmers better manage nitrogen compared to those currently on offer.

18 Nitrogen management apps have been identified and collected in South Asia.

The apps collected have been characterised and analysed based on a variety of criteria including:

- Regions of applicability and current use
- Target users
- Which agricultural products it assists with
- The quality of nitrogen guidance
- Whether the app is free and transparent

Number of Apps identified per country



WP 1.4 are using this information in conjunction with their review on best nitrogen management practices in the region to develop the plans for the new nitrogen management app they will be developing.



RESEARCH PROGRAMME 2

Nitrogen solutions to maximize resilience, co-benefits &
reduce trade-offs

Photo: WP 2.2 surveys, KIIT, India



Photos: BIRRI

WORK PACKAGE 2.1A

Conducting agronomic experiments to test different nitrogen management techniques to increase nitrogen use efficiency, profitability and yield for major crops in South Asia.

AGRONOMIC EXPERIMENTS

WP 2.1a is currently working on plot based experiments to test different measures to increase nitrogen use efficiency and reduce nitrogen losses in typical farms across the South Asian region. Despite the impacts of COVID-19 and multiple lockdowns, there has been a great level of progress. Experiment and baseline cropping have commenced in Bangladesh, India and Pakistan. Experiments will commence in Afghanistan, Nepal and Sri Lanka when the covid-19 situation allows.

Four common treatments are being used in the experiments as well other innovative management practices such as using different fertiliser types, inhibitors and tillage treatments. At each experimental site measurements are taken of baseline soil and climatic conditions, crop yield, crop nitrogen uptake, nitrous oxide emissions using static chamber measurements, nitrate leaching using porous cups and ammonia volatilization using a chamber based approach.

Soil Sampling for basic analysis



WP 2.1a Experiments by the University of Agriculture, Faisalabad, Pakistan (left)

Experimental plots at BRRI, Bangladesh (right)

Land preparation and field marking for wheat trials



Current status of the experiment on 20 February 2021



TRAINING AND ENGAGEMENT

WP 2.1a have also had a strong focus on capacity sharing and training during the past year. Members of the work package have been engaging strongly with WP 3.3 to create training videos of a range of nitrogen measurement techniques. A training lecture was also delivered on ‘Soil health status and nitrogen management in Bangladesh’ organized by the National Agriculture Training Academy, Gazipur, Bangladesh, and a presentation was given by one of the WP 2.1a leads, to an Upsign conference on UK-Pakistan cooperation in agricultural research in November 2020.

WP 2.1a members also made an EU application to Horizon 2020 submitted in Jan 2021. The proposed project would build on the work carried out in SANH on improving N use efficiency in horticulture and included partners from the University of Delhi, the Indian Farmers Fertiliser Cooperative and SRUC.

WORK PACKAGE 2.1B

Screening rice and wheat populations for genes associated with better nitrogen use efficiency. Physiological and molecular studies on genotypes differing in nitrogen use efficiency to find genetic lineages of rice and wheat which waste less nitrogen.

RICE SCREENING

Despite the challenges of the pandemic, WP 2.1b have worked very hard to absorb all covid-19 related delays and are on schedule for all activities. Partners in India, Bangladesh, and the UK have grown the BAAP seeds at two different nitrogen levels. Samples from these experiments have been measured, data compiled, and the first Genome Wide Association (GWA) mapping conducted. WP 2.1b partners in India have also completed detailed physiology screenings of 10 rice cultivars and have compiled all the yield and yield component data from the experiment.

Chemical analyses have also been completed and they are now conducting statistical analysis.

WHEAT SCREENING

Partners in Pakistan have been busy bulking wheat lines and are expecting to get 450 lines with sufficient seeds for the genetic experiments. In India, WP 2.1b partners have sown 15 wheat lines (November 2020) under 4 N levels and are monitoring that experiment now. Our partner IARI has also welcomed a new PhD student who will be phenotyping >300 wheat genotypes under two N levels over the coming few years.

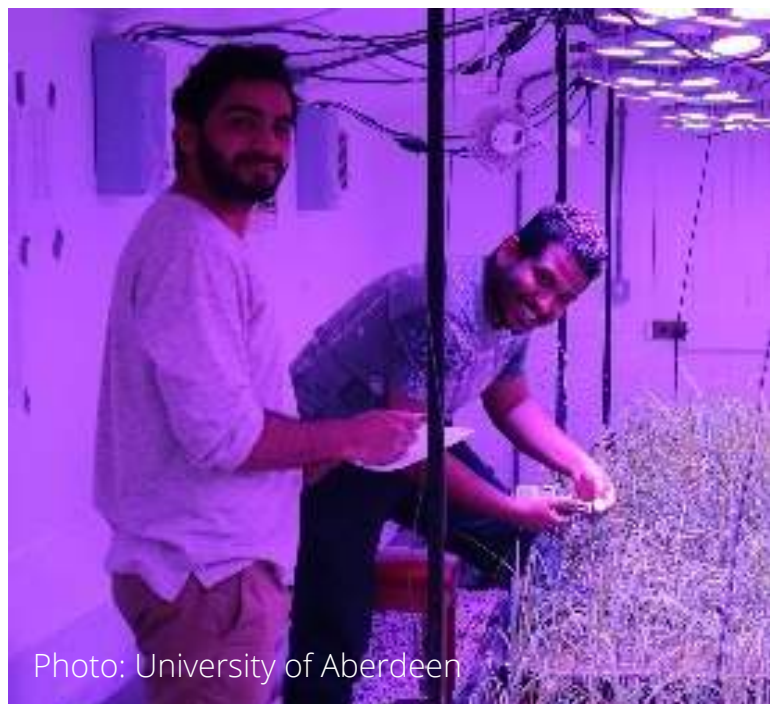


Photo: University of Aberdeen



Land Preparation for wheat sowing for bulking of seeds



Fertilizer application 2nd Installment

Tagged wheat genotypes at field



Growing well

Weedicide application

Photo: University of Faisalabad

PROTEOMIC STUDIES

Two PhD students from SANH Partner AMU in India were hosted by the University of Aberdeen in the UK and conducted proteomic studies to investigate how different levels of nitrogen impact protein expression in rice. They grew 229 individual accessions of BAAP rice at 100% and 0% recommended nitrogen levels. After extracting protein and RNA samples, the proteomics identified 300 proteins with a significant difference in abundance at the different nitrogen levels. There was a significant difference between rice genotypes, some were very nitrogen responsive while others were less so. The analysis of the GWAS data and proteomic profiling is in process.

TRAINING AND ENGAGEMENT

There have been many developments in WP 2.1b's capacity sharing and stakeholder engagement. The University of Aberdeen is currently planning an online training workshop on GWA mapping in the BAAP in June 2021. SANH's work has highlighted in a talk on "Nitroponics in Agriculture" to the Aberdeen Climate Action's Climate Cafe on 7th July 2020, which attracted about 60 viewers. Four SANH PhD students also participated in a special training session by National Institute of Genomics and Advanced Biotechnology (NIGAB) and the National Agriculture Research Council (NARC) entitled "training and tools of biotechnology and bioinformatics". SANH partners, in India, have also been engaging with other projects such as those looking at the molecular understanding of nitrate uptake in aerobic rice and the physiological and molecular basis of ammonia volatilization losses from rice canopy.

Photo: IARI wheat experiments



Photo: BRRl rice plots



Photo: BRRl rice plots

WORK PACKAGE 2.2

Conducting surveys to find out more about the nitrogen hotspots in villages in South Asia. Completing on-farm testing of promising options to increase nitrogen use efficiency, profitability, yield and ease of use in villages across South Asia.

Photo: KIIT, India, WP 2.2 surveys



Photo: KIIT, India, WP 2.2 surveys



Photo: University of Agriculture, Faisalabad, Pakistan, WP 2.2 surveys



Photo: University of Agriculture, Faisalabad, Pakistan, WP 2.2 surveys



WP 2.2 SURVEYS

Covid-19 has caused a variety of challenges for WP 2.2 and delayed fieldwork. However, partners in Afghanistan, Bangladesh, India and Pakistan have been able to visit villages safely and completed the first survey for WP 2.2. The results of these surveys have been analysed and used to identify the different farm types in the different villages. In Afghanistan, farm sizes tended to be smaller and focus on crops compared to India where livestock were more common. The next more detailed survey is complete and will be conducted when safe to do so. Already, there have been opportunities to learn lessons that can be shared across the UKRI network such as that in countries like Bangladesh, compensating farmers for their time is important but this is not suitable in countries like Afghanistan.



Photos: Rajshahi University, Bangladesh WP 2.2 surveys

LITERATURE REVIEW

WP 2.2 partners have been working on a literature review as part of a paper on comparing carbon and nitrogen budgets across villages in South Asia.

ETHICAL REVIEW

Due to the large amount of survey work, WP 2.2 has been one of the leaders in SANH in terms of ethics and ethical approvals. WP 2.2's surveys have now obtained ethical clearance in the UK, India, Pakistan, Afghanistan and Bangladesh. WP 2.2 members are now using their experience to help other work packages in SANH undertake ethical reviews and ensure that their work is conducted to the highest ethical standard.



Photos: Rajshahi University, Bangladesh WP 2.2 surveys



Photos: University of Kabul, Afghanistan, WP 2.2 surveys



Photos: University of Kabul, Afghanistan, WP 2.2 surveys

WORK PACKAGE 2.3

Researching technology for the viable recapture of gaseous and aqueous reactive nitrogen and use this to create valuable fertiliser products.

Our SANH Partners at KIIT, India and the University of Edinburgh, UK, have been developing a group of adsorbent materials for removal of N-containing compounds from aqueous waste system and gaseous NO_x and NH₃.

Current activities have focused on the synthesis of adsorbent materials from industrial solid waste. These solid process wastes were collected from mineral and metal processing industries from the state of Odisha and Gujarat, India. These waste materials were processed via solid-state techniques for the synthesis of zeolite based sorbent materials. The materials were sent to the analytical centre for characterization and the second phase of results was obtained in February 2021. Inorganic zeolites were used for sorption of nitrate and ammonia from aqueous systems. These samples are being analysed for their adsorption capacity using UV spectrophotometers.

WP 2.3 have also introduced a new research assistant to the team who has undergone safety inductions to start testing commercial zeolites to get a basis for comparison.

COLLABORATION WITH INMS ACTIVITY 2.3

WP 2.3 and the GEF-UNEP 'Towards an International Nitrogen Management System' (INMS) project Activity 2.3 are joining forces to include nitrogen recapture technologies in the INMS Nitrogen Measures Database. The database will be an incredibly useful tool for researchers and industry to identify the best techniques and measures to implement to reduce nitrogen pollution in a cost-effective way.



RESEARCH PROGRAMME 3

Improving understanding and awareness of key nitrogen threats. Exploring the impact of nitrogen on ecosystems. Creating nitrogen education resources.



Photo: Lichen Taxnomic Workshop, Nov 2019



Photo: Lichen Taxnomic Workshop, March 2020

WORK PACKAGE 3.1

Investigating the impact of nitrogen air pollution on valuable lichens in the Himalayan forests in India, Nepal, Bhutan and Pakistan.

LICHEN TAXONOMY AND FIELD WORK

Lichens are used in WP 3.1 as a marker for how nitrogen is affecting the ecology of Himalayan forest; they are a sensitive bioindicator for nitrogen air pollution, but also valuable commodities used in trade as well as providing cultural ecosystem services. WP 3.1 has been able to make amazing progress over the past year. The work package involves sampling lichens to understand how nitrogen is impacting their diversity and sustainable harvest. In order to standardise this sampling across nations, there have been multiple in-person (pre covid-19) and virtual taxonomic training workshops. These capacity-building sessions have provided opportunities for students to get more involved with SANH, and opened engagement with new stakeholders such as India's National Botanical Research Institute. This training has been used by researchers who have now been able to go to the Himalayan forests in Bhutan and India to start the fieldwork, which had been delayed due to national lockdowns. WP 3.1 have also welcomed several new students across both the UK and South Asia. Ten students from TERI SAS in India were funded by leveraging a ProsperNet grant from the United Nations University, which is an amazing achievement, and their research will be focusing on the various impacts of nitrogen on lichens in the Himalayas. Two new Ph.D. students have also started work on nitrogen enhancement experiments in both the UK and Sri Lanka.



Photo: Glencourse Fumigation Site



Photo: Sri Lanka Fumigation Site

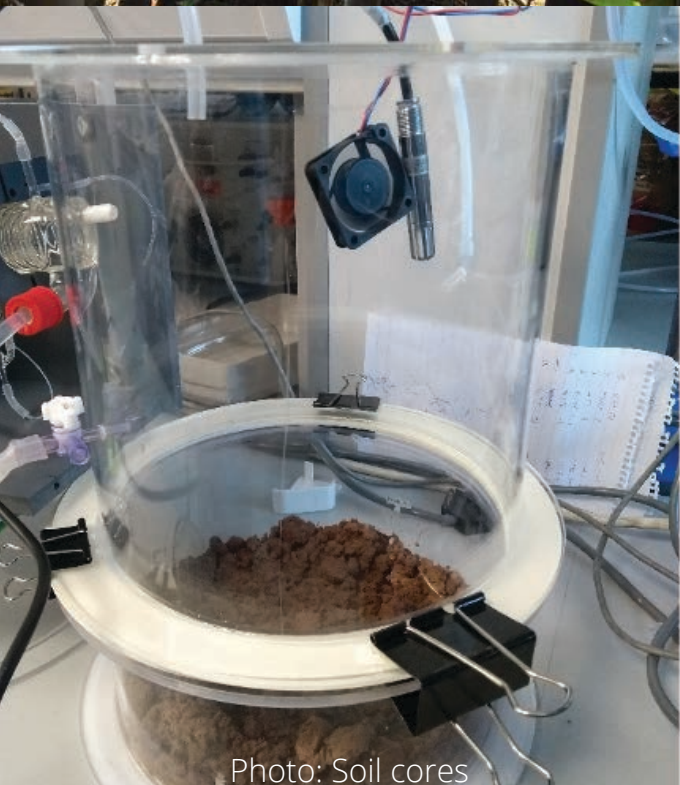


Photo: Soil cores

LITERATURE REVIEW

During periods of national lockdowns, when field work was not possible, WP 3.1 have focussed on conducting rigorous literature reviews to provide a strong basis for subsequent field work. WP 3.1 are undertaking a systematic review of critical levels and loads established for lichens from previous literature, and are working with WP 4.2 to map these thresholds across the Himalayan region and assess the expected area of pollution impact (which can be tested by the field studies).

ENHANCEMENT EXPERIMENTS

In order to understand the impacts of ammonia on lichens in forest ecosystems, facilities are being tested and set up in both Glencourse, UK and the Dilmah Tea Gardens, Sri Lanka. In the UK, UK-CEH have established the design of a nitrogen enhancement system and is conducting a trial in Glencourse, Scotland. This will then be replicated in Sri Lanka near the Dilmah Conservation Centre. Two new PhD students have started work, one in the UK focussing on changes in nitrous oxide emissions with increased ammonia and one in Sri Lanka studying changes in lichen diversity and physiology with increased ammonia. Both are currently undergoing training in field techniques to assist with this work. The enhancement facility provides a great opportunity to work with industry and build awareness on nitrogen, through the co-operation with one of the most famous tea companies in Sri Lanka, Dilmah.

NEW PARTNERSHIPS

The work of WP 3.1 has now expanded to include Pakistan. WP 3.1 is now working with Hazara University Mansehra who will help establish protocols for fieldwork and identification of lichens in Pakistan. This now means that all Himalayan countries in South Asia are included in the study.

WORK PACKAGE 3.2

Identifying the impact of nitrogen pollution on coral reefs and if nutrients predispose and prevent recovery from temperature-driven coral bleaching events in India, Sri Lanka and the Maldives.

CORAL REEF MONITORING AND WATER QUALITY MEASUREMENTS

Through multiple workshops and meetings, WP 3.2 have solidified and continually improved protocols and methods for coral reef monitoring and water quality measurements. Although the covid-19 pandemic has delayed some fieldwork there has still be a vast amount of progress.

Coral reef sites for coral monitoring have been identified by MMRI in the Maldives and include established resorts as well as inhabited islands. In Sri Lanka there are two sites, one on the east and one on the west. Partners in India have a vast number of field sites with 6 sites in the Lakshadweep islands as well as more in the Gulf of Mannar and the Andaman and Nicobar islands. Field work includes taking measurements of live coral cover, sedimentation rates, coral recruitment and more to help determine the health of the reefs and whether they may be impacted by nitrogen. Buoys are also used to collect water quality data as well.

Also to collect data on water quality, there have been some cruises already completed as well as two planned for April/May 2021 which cover the major coral covered coastal areas of South Asia.

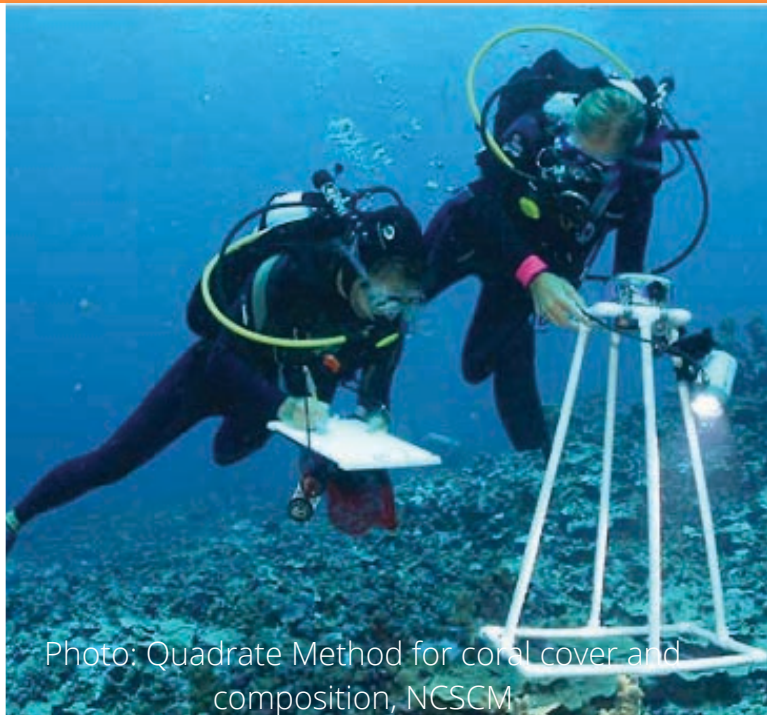


Photo: Quadrant Method for coral cover and composition, NCSCM

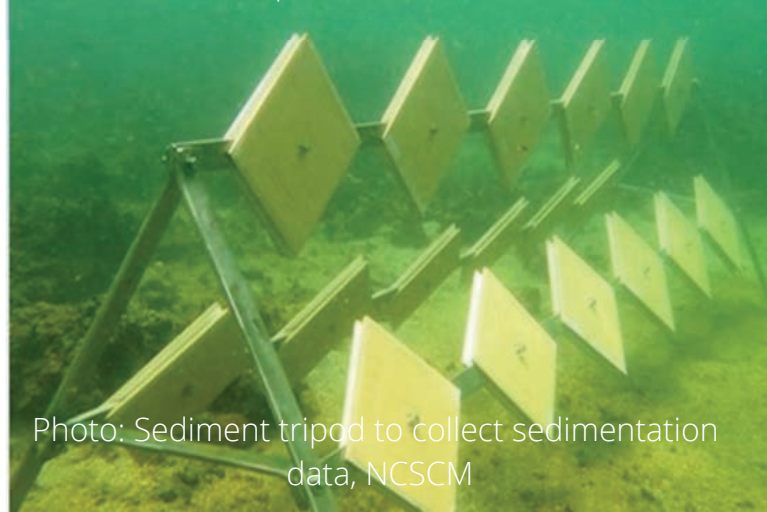


Photo: Sediment tripod to collect sedimentation data, NCSCM



Photo: Sediment trap to collect sedimentation data, NCSCM



Photo: Maldives Stakeholder Engagement, March 2020



Photo: Retrieving CMS module for further processing to look at coral recruitment, NCSCM



Photos: Coral survey methods NCSCM

STAKEHOLDER ENGAGEMENT

Partners in the Maldives have been engaged in a variety of different stakeholder engagement events over the past year. Partners in the Maldives met with policymakers and the session allowed knowledge to be shared between stakeholders and suggestions were made on how the work of SANH can align with the needs of the Maldivian people for example modelling not only agricultural islands but large urban islands such as Malé. WP 3.2 has also been interacting with the GEF 6 ocean science projects.

LITERATURE REVIEWS

WP 3.2 have been working on two literature reviews that provide a solid foundation of the current knowledge of the impact of nitrogen on coral reefs. The first literature review explores the current data available in South Asia on how nitrogen impacts coral diversity and cover. Partners at PML and in the Maldives are also conducting a rapid evidence assessment on how the impacts of nitrogen pollution on marine environments affects coastal communities. This will provide a basis for further survey work that will be conducted when covid-19 restrictions allow.

WORK PACKAGE 3.3

Creating massive open online courses on nitrogen in the majority of South Asian languages. Work Package 3.3 focuses on creating other educational resources and tools to raise awareness on nitrogen in the region.



NITROGEN MASSIVE OPEN ONLINE COURSES

Nitrogen science education is now more accessible than ever, with the launch of the 'Nitrogen: A Global Challenge' Massive Open Online Courses (MOOCs) in Hindi (India), Sinhalese (Sri Lanka), Urdu (Pakistan), Bengali (Bangladesh), Nepali (Nepal) and Dari (Afghanistan) with Dhivehi (Maldives) and Dzongkha (Bhutan) to come. In a time where free online educational resources are increasingly needed, Work Package 3.3 have made incredible progress in accelerating the launch of the MOOCs, allowing people from across the world to learn more about sustainable nitrogen management. The courses cover a variety of topics including nitrogen uses, the impacts of pollution on air, land, and water as well as some of the solutions for better managing the nitrogen challenge around the world. You can access the courses for free on ed X at <https://www.edx.org/search?tab=course&q=nitrogen>.

NITROGEN METHODS

There is on-going work to produce a new training course, titled: Nitrogen-related field measurements: Techniques, analyses and calculations. The team hopes to finalise the training course by the end of April. The training material will be available for all the colleagues in SANH. This will allow for online capacity building and will eventually be available for free to the wider public.

SOCIAL SCIENCE

WP 3.3 are planning a social science online course that will outline different strategies that can be used in social science research. This is being created in conjunction with our RP I partners. They also are working on another massive open online course on nitrogen and its impacts on planetary health and climate change.

AWARENESS RAISING

WP 3.3 member, Andi Moring, has been creating a range of videos to raise awareness on nitrogen with the wider public which ties into SANH's stakeholder engagement. Check out SANH's youtube channel at: <https://www.youtube.com/channel/UC-zAHVo2h6GF66WLjoVhMnA>



Photo: Images from the Nitrogen Measures MOOC



Photo: Images from the Nitrogen Measures MOOC



Photo: Images from the Nitrogen Measures MOOC



RESEARCH PROGRAMME 4

Integrating regional nitrogen flows & impacts in South Asia

WORK PACKAGE 4.1

Harmonising datasets across SANH. Creating spatial-temporal models for the full nitrogen cycle in South Asia.

Work Package 4.1 have been developing a standardised suite of datasets that will be used across the Hub for a range of modelling and review work. Partner institutions have been busy collecting a range of national and global datasets including data on livestock, fertiliser use, daily weather data, crop data, soil data, crop management data, and more.

WP 4.1 has also created a working document outlining which datasets are available for each country from different sources. This helps SANH members to easily identify what they can expect to be available for their use. It also helps identify gaps in datasets which can then be filled. These documents present spatial data and associated data tables that can be zoomed in/out of and panned across, for example, the existing emission, deposition, livestock, human population and landcover data that we have prepared for use by the modellers. The datasets (derived from global data collections e.g. from FAO, EDGAR, etc.) can be viewed without any requirement for GIS skills and assessed against each country's national knowledge and datasets. They then will be used to elicit feedback on the data quality of these "first round" of datasets, to then inform the next iteration of harmonised model input datasets to be prepared and shared. Work Package 4.1's dataset collection and harmonisation work will help the future modelling work and allow for RP 4 to look more at the flows of nitrogen in the air, land, and ocean.

WP 4.1 have also been collaborating with RPI on a joint peer-review paper, contributing maps and novel graphics to characterise atmospheric N emissions across South Asia's emission sectors by country (with the University of Edinburgh and other partners) which will be used to provide more information on nitrogen to policy makers in the region. WP 4.1's dataset collection and harmonisation work will inform the future modelling work and allow for RP 4 to produce a holistic picture of the flows of nitrogen across air, land, freshwaters and ocean.



WORK PACKAGE 4.2

Developing atmospheric models to assess how nitrogen emissions impact human health and ecosystems. Establishing a measurement system across South Asia to provide nitrogen emission measurements for the model.

MEASUREMENT NETWORK

WP 4.2 has been busy identifying and selecting appropriate sites for the measurement network of ALPHA ammonia and DELTA multi-pollutant samplers as well as wet deposition sites. Sites have been identified in every South Asian country, except Nepal. This primary data will supplement historical data from 2014, 2015 and 2018 for the assessment of the models being created by the WP 4.2 modeling team. WP 4.2 is testing different Alpha sampler coatings in India to ensure that the samplers work well across South Asian conditions. There has also been a major focus on training at South Asian laboratories in the operation of the UK developed samplers.

MODELLING

The WP 4.2 modeling team have streamlined the roles within the team to maximise the work output. The team in Nepal will apply the WRF-Chem model for forward modelling of N impacts and scenarios, whilst the Chennai team will build up EMEP modelling capability in India. The modelling teams are setting up their models and are completing the first runs for status quo emissions, for comparison with the historical measurement data. Model outputs have helped identify sites for the lichen and measurement networks (WPs 3.1 and 4.2). The inverse modelling tasks have been distributed between Indian and UK partners, with focussing on ammonia, N₂O and then NO_x and are delivering first results.

HEALTH IMPACTS

The London School of Hygiene and Tropical Medicine is conducting a systematic literature review on the health impacts of air pollution from agriculture, working closely with the UK NIHR funded project AMPHoRA (Investigating air pollution controls from agriculture to protect health). This review will help interpret WP 4.2's models, linking changes in pollution to health outcomes.

WORK PACKAGE 4.3

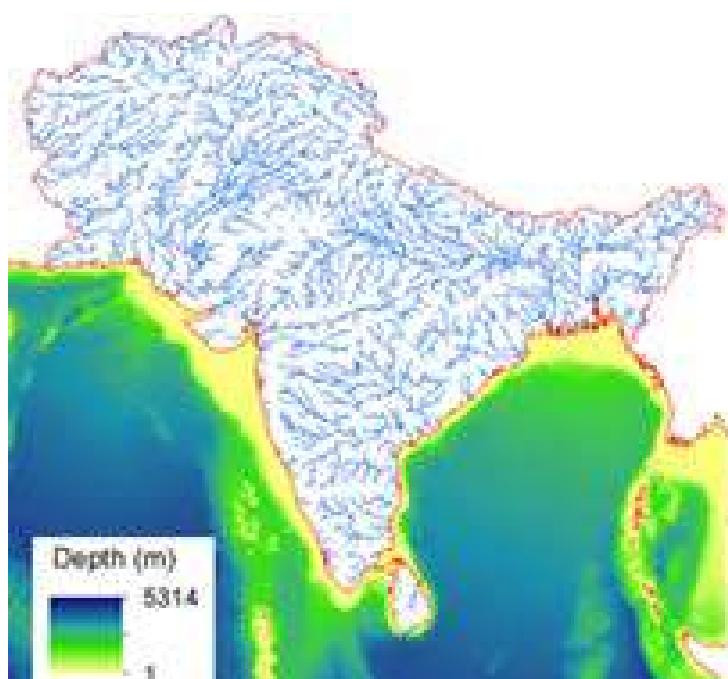
Using models to understand how nitrogen flows through and impacts freshwater, coastal and marine areas and the subsequent impacts on human health, fisheries and other ecosystem services.

MODELLING OF FRESHWATER, COASTAL AND MARINE WATERS

WP 4.3 have been able to make significant progress on the modelling aspect of the work package. For the freshwater modelling the first simulation of freshwater is complete with the nutrients flux in progress. Likewise the marine models are also progressing well as they can use publically available datasets. Atmospheric data to drive freshwater and marine models have been collated from ERA5.

Oceanic datasets to drive marine models have also been collated from COPERNICUS, World Ocean Atlas, GLODAP and similar. The coupled hydrodynamic and ECO lab model has also been run to study the seasonal nutrient flows for the three riverine estuarine systems such as Hooghly (Ganges), Bhitarkanika (Mahanadhi), and Godavari estuaries using field measured data of the year 2017 and 2018.

Domain of SANH Marine Modelling



PRIMARY DATA COLLECTION

Data collected from completed cruises in India has been shared across WP 4.3 for modeling inputs. Compiled nutrient data is also being used from around 600 sampling points from estuarine and coastal waters of India.

In the near future, there are plans for three research cruises that will collect further primary data on nutrients. These cruises will cover the entire offshore areas of Sri Lanka, the Maldives and the east coast of India with the data to be used in both WP 4.3 and WP 3.2.

HEALTH STUDIES

WP 4.3 partner, London School of Hygiene and Tropical Medicine have conducted a systematic review of all the literature on the impact of nitrate and nitrite contamination in drinking water and its risks to human health. This paper includes a review of over 115 papers and it is the first paper to conduct a systematic review on this topic. The preliminary conclusions indicate that for every 10mg/L increase of NO₃ in drinking water, the chance of developing stomach cancer more than doubles. These conclusions are based on case-control studies and more research needs to be done in cohort studies to look at this in further detail and whether nitrogen pollution also increases other kinds of cancer.

NITROGEN POLLUTION CAUSES...

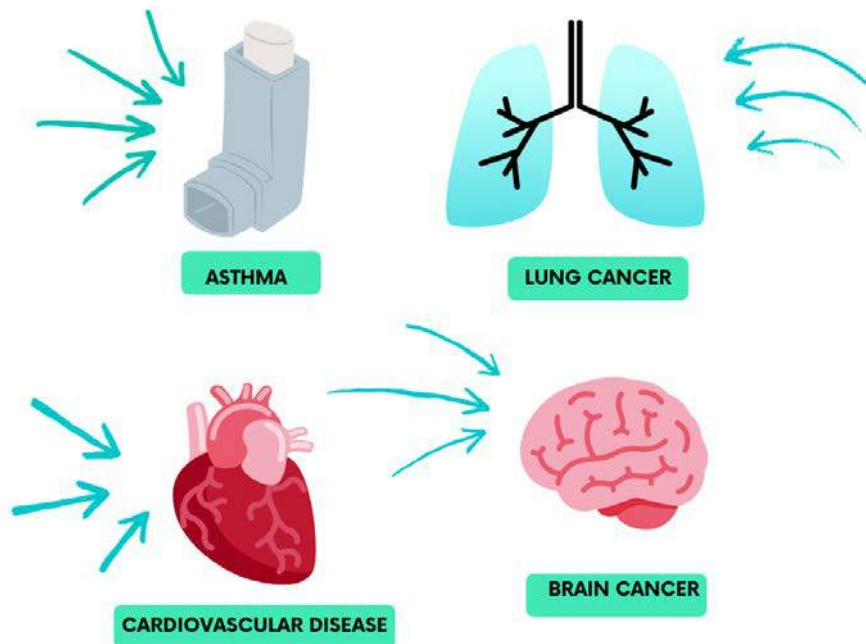


Photo: BIRRI rice plots

WORK PACKAGE 4.4

Modelling the impact of sustainable nitrogen management on nitrogen emissions and greenhouse gases, in relation to climate change.

LAND USE IN SOUTH ASIA

WP 4.4 has been using FAO data in investigating land use in South Asia including areas of crops/pastures, livestock numbers, N₂O/CH₄ sources from synthetic/organic N, crop residues, irrigation (and others).

This time series from 2010-2018 provides important baseline information that will help inform the models. There have already been some preliminary results for example that maize, rice and wheat only contribute to 46% of crop harvested areas in 2018. They have also identified large increases in mineral fertiliser use in Afghanistan, Bhutan, the Maldives and Nepal. There has also been significant reductions in fertiliser use in Sri Lanka and little change in use in Bangladesh, India and Pakistan from 2010 to 2018.

INFOCROP MODELLING

WP 4.4 are also conducting training on the Infocrop model. Online training videos alone are not enough to provide full information hence planning is underway to advertise regarding an Infocrop training course for SANH scientists/students and provide electronic lectures as well where SANH members can interact and ask questions. They are also developing some training videos about InfoCrop in conjunction with WP 3.3 to provide training during the pandemic. Training on platforms like zoom can gather a large audience and serves as a great place to share ideas, undertake exercises and ask questions.





STAKEHOLDER ENGAGEMENT

Engaging with policy makers, civil society, and business

Farmer Engagement

Farmers are one of the major stakeholders regarding nitrogen use and management. SANH has been working closely with farmers to ensure they are included in SANH's work. All face-to-face meetings were conducted either prior to the pandemic or when considered safe to do so by local authorities.

SRI LANKA

Colleagues in Sri Lanka have been heavily engaging with local farmers as part of RP 2. They have held farmer's meetings to discuss the work of SANH and the issue of nitrogen. Our partner, the University of Peradeniya, have met with groups of farmers growing different kinds of crops such as vegetables and rice to discuss nitrogen and SANH.

AFGHANISTAN

SANH partner, the University of Kabul, has also been working with farmers in Afghanistan as part of RP 2. A great effort has been made to build trust with partners and explain the work of SANH and how nitrogen is impacting the environment.

Photo: University of Peradeniya meeting with vegetable farmers



Photo: University of Peradeniya meeting with a group of paddy farmers



Photo: Farmers expressing his views at a farmers meeting (University of Peradeniya)



BANGLADESH

Our partner, BSMRAU, hosted a farmer/scientist dialogue event in March 2021. It was an excellent interactive event to discuss agricultural management options to sustainably use nitrogen. The event was attended by scientists from across Bangladesh, farmers and policymakers and was covered by local media and newspapers.



Photo: Farmer/Scientist dialogue (BSMRAU)

Article from Bangladeshi newspaper 'Daily Industry'

Farmers-scientists dialogue on 'Agricultural management options to address the impact of climate change' held
Daily Industry (7/03/2021)

Climate change is a concern for agricultural sustainability. Use of higher rates of nitrogenous fertilizers contributes to climate change. The scientific community aware about the impact of climate change on agriculture, while it is not well understood by our farmers. Therefore, as a part of awareness raising program, a Farmers-Scientists dialogue on 'Agricultural Management Options to Address the Impact of Climate Change' was held at Tudongbar of Kapiasia on March 13, 2021 at 3:00 pm under the auspices of South Asian Nitrogen Hub (SANH) and MCCA project of KGF. The event was hosted by Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU). Prof. Dr. Md. Giasuddin Miah, honorable Vice-Chancellor of BSMRAU was present as the Chief Guest and Masudun Raheem Uddin as farmer's representative chaired the dialogue. Professor Tahsinul Kabir, Treasurer of BSMRAU was present as the special guest. Prof. Dr. Md. Mizanur Rahman, Dept. of Soil Science, BSMRAU, Tudongbar village, professor of BSMRAU, was the moderator of the program. In the occasion, about 200 farmers of the village, scientists from different departments of MCCA project of KGF, scientists of research organizations including BARI and BRRI, KGF personnel, Upazila Agriculture officer, Upazila Livestock officer and journalists from electronic and print media were present. Chief Guest stated that BSMRAU always highlighted the climate change issue in education and research. He mentioned that BSMRAU has already developed some climate smart crop varieties and technologies to cope up with the adverse situation. Therefore, he emphasized for up scaling of the technologies through proactive extension activities. As nitrogen is considered as one of the driving forces enhancing the climate change issues, therefore the honorable chief guest advised the farmers for rational use of fertilizer-N in different sectors of agriculture like crop sector, aquaculture, animal husbandry etc. All the speakers of the dialogue including the farmer's representatives expressed the importance of ensuring coherence among the farmers, researchers and extension personnel to address the climate change issue through agricultural management options for sustainable agricultural production.



Photo: Farmer/Scientist dialogue (BSMRAU)

INDIA

Our Indian partners have been working closely with farmers as part of RP 2 and are planning on hosting farmer/scientist dialogue meetings to talk to them further on the issue of nitrogen. These meetings will take place when safe to do so.



Photo: Partners from KIIT, India meeting with farmers

NITROGEN SUSTAINABILITY IN PAKISTAN SEMINAR

Nitrogen application in Pakistan has risen steeply in recent decades and has detrimental environmental impacts. The UKRI GCRF South Asian Nitrogen Hub in conjunction with the University of Faisalabad conducted a seminar on nitrogen sustainability in Pakistan in 2020. The seminar highlighted how the Pakistani government could reduce nitrogen emissions on both a national and international level. This was a great opportunity to raise awareness on the issue of nitrogen pollution on a national policy scale and how through sustainably managing nitrogen, we can protect the environment.



SACEP Director General Abas Basir Credit: SACEP

SACEP REGIONAL WORKSHOP

The SACEP Regional Workshop on developing a Roadmap for Sustainable Nitrogen Management in South Asia included representatives from all South Asian governments who discussed their current national policies on nitrogen and shared recommendations on how nitrogen can be better managed across the region. The event was attended by government representatives from all eight South Asian countries. Many members of SANH were involved with the meeting and work package 1.1 created a policy briefing note to better inform policymakers of the key nitrogen science in the region. This workshop was the first of many policy engagement events which aim to raise awareness of the issue of nitrogen pollution and its impacts.



NATURE-POSITIVE FOOD SYSTEMS FOR A HEALTHY PLANET AND HEALTHY PEOPLE

A session on Nature-positive Food Systems for a Healthy Planet and Healthy People was held on 20th February 2021 where the SANH Director Prof. Mark Sutton was a panel member for this meeting as part of UNEA 5. The session examined the following questions:

- Why a transformation of our food systems is integral for nature and economies.
- How does Regenerative Agriculture connect us back to nature.
- How can we promote Nutrient Use Efficiency (NUE) with as much as 80% currently being lost to the environment.



OXFORD REAL FARMING CONFERENCE

The Oxford Real Farming Conference (ORFC) took place with over 5000 people attending online and with 500 speakers from 80 countries talking about all things ‘farming’. Multiple SANH partners were a part of these discussions and joined the expert panel for the event. They discussed the international nitrogen challenge and possible options for using nitrogen more sustainably. In particular, SANH members highlighted zero-budget natural farming practices in India and how creating women's groups can help drive change.



CHELTENHAM SCIENCE FESTIVAL

SANH Director Mark Sutton, helped raise awareness on the issue of nitrogen pollution and its impacts on Climate Change at the 2020 Cheltenham Science Festival. The discussion focussed on the actions we can take, such as changing our diets and having more virtual meetings, to reduce nitrogen pollution and fight against climate change.



Image from KIIT conference brochure

RE-INVENTING THE FUTURE OF WORK AND BUSINESS: CHALLENGES, OPPORTUNITIES AND THE PATH AHEAD

SANH Partner KIIT, India, held an international conference with over 350 delegates from over 15 countries, and over 200 research papers were presented in 13 parallel sessions. SANH PI Mark Sutton and members from KIIT discussed the role of sustainable nitrogen management and future options for industry and business.

Attendees at the E-briefing of the nitrogen working group

FIRST E-BRIEFING FOR THE UNITED NATIONS NITROGEN WORKING GROUP

The first e-briefing for the United Nations Nitrogen Working Group, held from the 8th-9th June 2020 was a fantastic opportunity for nitrogen scientists to engage with international policymakers and representatives from around the world. Over 200 government representatives, convention members and SANH and INMS scientists attended the session which focussed on the challenges and opportunities of nitrogen management, including how countries can use the assessment as a basis for evidence-based policy making.

