Urban Europe and NSFC

Europe – China joint call on Sustainable Urbanization in the Context of Economic Transformation and Climate Change: Sustainable and Liveable Cities and Urban Areas

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FFG (Austria), project 870234

UNCNET

Urban nitrogen cycles: new economy thinking to master the challenges of climate change

D1/3: Report from second project plenary

Due date of deliverable: **01/07/2021** Actual submission date: **14/10/2021**

Start Date of Project: **01/04/2019** Duration: **35 + 6 months**
Organization name of co-chairs for this deliverable: **IIASA, PKU**

Authors: Katrin Kaltenegger, Samuel Gueret, Wilfried Winiwarter, Lin Zhang

Dissemination Level		
PU	Public	☒
PP	Restricted to other programme participants (including funding agencies)	☐
RE	Restricted to a group specified by the consortium (including funding agencies)	☐
CO	Confidential, only for members of the consortium (including funding agencies)	☐

1. Executive Summary

The second project plenary and annual meeting was held September 16-17, 2021 as an online meeting due to ongoing travel restrictions. The conference revealed significant progress in all work packages as well as significant progress in the development of urban N budgets in all test areas. A way forward towards comparing the urban N budgets of the respective test areas was established feeding into the development of workable guidance principles to create urban N budgets. Stakeholder involvement as well as developing a "summary for policy makers" will be essential to disseminate project outcomes.

2. Objectives:

The Annual Plenaries had been included in the project concept already in the proposal phase. Plenaries serve to take stock of progress, identify issues that do not work properly and especially allow to take correcting interventions wherever points of information transfer have not been sorted out properly. They complement the work within the respective participating institutions, the bilateral interactions and the regular “project conferences”. Originally seen as the points where communication could be extended to personal interaction, this second project plenary had been intended to be organized in Shijiazhuang, China, but had to be moved to a Zoom conference again.

The main objectives for the second-year project plenary were three-fold. The first objective was to establish the current state of each work package and adjust the deadlines for the respective deliverables to the progress as well as to the project extension of 6 months. The second objective was to discuss the progress on urban N budget in all test areas to collectively find a way forward towards a comparison between the cities. Results from discussions and comparisons will be used as input to reach Milestone 3 (workable guidance principles to create N budgets). The third objective was to identify country-specific science-policy interaction modes which will serve as input to Milestone 2 (Policy impacts identified) as well deliverable D9/2 (Policy meeting as a satellite to the INI 2020 conference) as the latter will more generally focus on science-policy interaction due to the cancellation of the policy meeting.

3. Activities:

Presentations were prepared by all project partners to present the progress per work package and progress on N budgets per test area. Concerning the stakeholder process (WP8) and the policy impacts, an interactive exercise was undertaken using Miro and ZOOM.

4. Results:

- After discussing the work needed to finish upcoming deliverables, next steps (including data needs from project partners) as well as new deadlines were agreed on for the respective deliverables of each work package.
- Building on the status of each work package it was agreed to start the comparison between the whole budgets and/or budget components (such as the Agro-Food chain). Possible indicators to look at (NUE, N surplus, average N loss per capita) were discussed.
- Ideas for further UNCNET publications were discussed establishing the data as well as collaboration needs for each paper.
- A Miro board to be filled with information on science-policy interaction for each test area was opened and will be further distributed within the partner institutions. Results will be used as input for M2 and D9/2.

- It was established that a “summary for policy makers”, including references to the full final report, will be a major output of the project
- Give-aways for the stakeholder workshops and further dissemination of the project idea and results were discussed in more detail.

Further details on the results can be found in the attachments.

5. Milestones achieved:

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6. Deviations and reasons:

This project plenary was originally scheduled for July 2021 and planned to take place in Shijiazhuang (China). However, due to travel restrictions as a consequence of the Corona pandemic still in place the event was delayed and shifted to an online meeting.

7. Publications:

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8. Meetings:

UNCNET second project plenary, ZOOM teleconference, September 16-17, 2021

9. List of Documents/Annexes:

- Agenda
- Minutes
- Presentations

REFERENCES

ANNEX

Agenda for annual meeting:

Thursday 16.09.2021

09.00-10.30 am Europe, 3.00-4.30 pm China: Progress by work packages & status of deliverables

11.00-12.30 am Europe, 5.00-6.30 pm China: Progress by cities, comparisons between cities & scenarios

Friday 17.09.2021

09.00-10.30 am Europe, 3.00-4.30 pm China: Stakeholder process & workshops & policy paper

11.00-12.30 am Europe, 5.00-6.30 pm China: Final report & Summary for policy makers / dissemination & WP1 & AOB

Wilfried Winiwarter is inviting you to a scheduled Zoom meeting.

Join Zoom Meeting
https://us02web.zoom.us/j/85870609012?pwd=L2NHd3RxVHk5aE94T1duUTY3RXFMUT09

Meeting ID: 858 7060 9012
Passcode: 585924

Dial by your location
    +43 670 309 0165 Austria
    +48 22 398 7356 Poland
Meeting ID: 858 7060 9012
Passcode: 585924
Find your local number: https://us02web.zoom.us/u/kbRwLDI6lN

Minutes

UNCNET Annual Meeting

September 16-17, 2021

Minutes

Participants (alphabetical):
Barbara Amon, Zhaohai Bai, Xiangwen Fan, Samuel Guéret, Katrin Kaltenegger, Monika Suchowska-Kisielewicz, Wilfried Winiwarter, Lisa Wolf, Lin Zhang, Feng Zhou

Action items

Block 1
16th of September: 09.00-10.30 am Europe, 3.00-4.30 pm China

Progress by work packages & status of deliverables
WP1 – Coordination (IIASA - Wilfried)

- Deliverables are very important for Austrian funding agency (Poland and China seem more interested in scientific publications)
- Project has been extended for additional 6 months by the Austrian funding agency
- Excel sheet on status of deliverables needs revisions (available on internal website)
    - New deadlines of deliverables
    - Report from 2nd project conference – Samuel, Wilfried & Katrin will compile report for September 21
    - Final project report: Deadline moved to project end, August 2022
- Project extension China is under review by NFC
    - But funding can be used after project end
- Project extension Poland: application form awaits signature of vice rector of university and still is to be sent to the funding agency but no problems to be expected
    - Extension of 12 months to finalize work
- Even though project extensions might differ in time – deliverables should be finalized within the 6 month extension
    - Please check updated list on internal website

WP2 – Model Framework (Concept of Urban N Flows) (IIASA – Samuel)

- Next deliverable on probability considerations
- Uncertainty treatments – revised concept
    - Revisions are needed as inconsistencies have been discovered between concept developed in D2/2 and the available data

- Aim is to facilitate implementation in STAN
  - STAN
    - Uncertainties need to be normally distributed (mean & standard deviation, needed for error propagation & data reconciliation)
    - Standard error (SE) needed (**not** standard deviation (SD))
      - Uncertainty of estimate of measured parameter (e.g. mean) / standard deviation of sampling distribution of estimated parameter
      - Inversely proportional to sample size
- Different approaches to calculate SE for different data availability
  - Single data point
    - Use uncertainty levels (UL) (as suggested in D2/2)
      - BUT do not assume a triangular distribution but consider the distance between lower boundary (single data point / UL) and the upper boundary (single data point * UL) to be 4*SD (95% of sample point within this interval) & divide this range by 4 to arrive at SD
  - Several data point
    - 2 data points
      - Take one data point as lower boundary & the other one as upper boundary & divide range by 4 again to arrive at SD (again assuming 95% of sample point within this range)
    - More than two data points
      - Assume normal distribution, calculate SD according to formula
  - SE is the SD divided by root of sample size

- Standard error required as input in STAN by all the research teams

- Future activity
  - Revision of D2/2 final concept of N flows & uncertainty consideration – finished within next few weeks
  - Drafting D2/3 probability approaches for N flows– finished end of November
  - Exploring linear inverse modeling & stochastic approaches in the context of underdetermined systems

WP3 – Atmospheric Impacts and Effects (PKU - Lin)

- Next deliverable on mitigation scenarios
- Goal: NH_3 estimates over cities in Poland, China & Austria to evaluate PM2.5 & effects
- Progress within UNCNET

- Extended NH_3 emission estimates to 2005-2016
    - See 2018 paper in ACP for bottom-up estimates of agricultural NH_3 emissions
    - Change in fertilizer types over years found – stable NH_3 emissions even though fertilizer use increased
    - NH_3 emissions driven by SO_2 emission reduction
    - Different sectoral emission shares between BTH and Beijing areas. Agriculture responsible for 80% and 43% of NH_3 emissions in BTH and Beijing areas respectively
- Assessed response of PM2.5 to NH_3 emission reduction
    - PM2.5 -> non-linear response to NH_3 emission reductions (see Liu et al. 2020).
- Improved resolution to 1km
    - NH_3 emissions in Beijing highly influenced by traffic
    - Still problem modelling urban & suburban sites (discrepancies to observations especially in summer)
        - Different degrees of data correlations between urban (poor correlation) and suburban (good correlation) sites
        - Maybe a big source was not accounted for in model

- Estimated soil NO_x & emissions & impacts on ozone air pollution
    - Soil NO_x emissions can sometimes reach up to 20% of anthropogenetic NO_x emissions in summer – driven by fertilizers (60% from total soil NO_x emissions)
        - Not well recognized in past
        - Effects on air quality not well evaluated
            - Soil NO_x needs to be reduced (and accounted for) to reach maximum reduction of Ozone

- 2 papers published in 2021 for UNCNET (see UNCNET webpage):
    - The nonlinear response of fine particulate matter pollution to ammonia emission reductions in North China (ERL)
    - The underappreciated role of agricultural soil nitrogen oxide emissions in ozone pollution regulation in North China

- Next steps:
    - City level NH_3
    - Set up atmospheric chemistry model simulation for Europe (Zehui Liu will visit IIASA)
    - Work on D3/3 impact of mitigation pathways on PM2.5– finished in December
        - Examples of work on Europe not needed for this deliverable

WP4 - Soil Impacts and Leaching (PKU – Feng)

- Deliverables D4/1 and results needed for D4/2 already achieved. D4/2 and D4/3 were worked upon during 2020-2021

- Quantify regional N leaching
  - Develop N input & irrigation dataset
  - Land surface modelling to simulate N leaching & volatilization
    - Updated models
    - Input data:
      - Bulk density
      - Clay content
      - Total N in soil
      - Climate variables
      - Rooting depth
      - Land use
      - N application rate over urban grasslands & forests
      - Groundwater levels & N concentration
        - Available for China but needed Europe
    - Field experiments for model validation on 11 sites
  - Mitigation measures
    - Quantify crop response to N surplus
      - Crop specific, global data
      - Yield - N rate response curve
        - used for optimization
        - 4R principle
          - NH_3 emissions can be reduced significantly
  - Difficulty of gathering information → Used local contacts. Not sure whether it will be possible to collect any data for Europe.
  - Crop yield can be increased by up to 11% even with strong N surplus reductions
  - NUFER model was used to quantify impacts of N leaching. Synergies to be expected with Lin's team

  - Future steps
    - Extend model to Europe
    - N leaching modeling and optimization of urban agricultural management
    - Mitigation assessment for soil N leaching
    - D4/2 N leaching & health effects– finished by next week
      - Needed from European partners: N application rate per crop type & groundwater N concentration & levels will be needed

        - D4/3 optimization for mitigation of groundwater N pollution considering climate change– deliverable on methodology of mitigation scenarios finished by November
            - Mitigation scenarios can also be used for D3/3 & as general scenarios
        - Highly resolved land-use dataset would be available for Vienna but maybe not for Zielona Gora

WP5 - Urban Agriculture (CAS – Fan)

- General tasks
    - Investigating N flows & provide guidance for assessment
    - Specific urban agricultural challenges will be investigated
    - Linking urban N flows from agriculture to general framework
- Completed
    - Draft on urban agriculture & final concept
    - Industry, urban agriculture pool
- Future Plans
    - Comparison between different test areas in progress – whole budget comparison needed – End to be expected by mid-November 2021
    - N flow of wastewater & combustion in progress – End to be expected by September 2021
    - Linking of urban agricultural flows with sustainable development goals to be started
    - D5/3 final urban agricultural N flows with uncertainties & SDGs– finished by December
    - Lisa will send paper on links between SDGs

WP6 - Quantifying N Pools and Recycling N Flows (UZG – Monika)

- Integration of analytical data is done
- Several tests in waste treatment plants undertaken -> results will be shared by end of year
- Assessing recycling potential will be started and finished by January 2022
- Scenario development will be started soon
- Two UNCNET-related publications in 2021 :
    - N and P accumulation in horizontal subsurface flow constructed wetland
    - "Influence of storms on the emissons of pollutants from sewage into waters" in press. Expected to be published in Oct 2021
- D6/2 uncertainty guidance document will be finished by November
- D6/3 extrapolation of methods will be finished by April (including input from IIASA)
- Katrin check publications

WP7 – Urban N Budgets (IIASA)

- D7/2 final urban N budgets until February 2022
- D7/3 comparison of cities & N flows including scenarios until April 2022

Block 2

16th of September : 11.00-12.30 am Europe, 5.00-6.30 pm China

Progress by cities, comparisons between cities & scenarios

Vienna (Katrin)

- Intention to implement scenarios – suggestions as follows:
    - EAT Lancet diet - link between human health and environmental issues (planetary boundaries). Recommendations of different daily crops intake following a specific diet.
        - Effect of diet change could be rather slow as most production takes place outside of cities
    - N scenarios by Kanter et al. (2019) INMS set of scenarios
        - Different ambition level targets for livestock manure, air pollution, wastewater, manure recycling and crop using several indicators
    - City specific scenarios
        - Climate Strategy Vienna - specific goals such as
            - "-50% CO_2 emissions from traffic per capita by 2030"
            - "zero waste by 2050",
            - "climate neutral by 2040",
            - ..
        - Probably not for China (only national targets) & Zielona Gora
    - 4R scenario from Feng
    - Combination of scenarios
    - Relocation of agriculture
        - Plans in China to move pig production closer to city again
        - Not so significant in Austria

- Comparison of data
    - Comparison carried out between Vienna area and Klagenfurt (city in southern Austria) region:
        - Cluster agro-food chain Households/Industry/Urban animals/ Urban plants/ Waste and Wastewater
        - Per capita and per area comparison used
        - Other indicators might also be used as the latter are not relevant for all flows
        - Strong N content discrepancies sometimes observed (e.g., for sludge)
    - Need of harmonizing the input for improving interpretation of results comparison (population, total area, agricultural area, ..)

- Would be useful for comparisons to compile N application per crop type for other research areas
- General methodology explained:
  - General checks
  - Identify largest flows or cluster/flows of interest
  - Decision on indicators
- Upload documentation with flow information for each research area on UNCNET intranet
- Possibility to compare certain components of urban N budget (especially if not enough data is available)
  - AgroFood Chain
  - Combustion Chain
- Average losses per capita – compare with global data (180mio t)

Shijiazhuang & Beijing (Fan)

- Industrial pool
  - Linking CHANS model with STAN
    - Translation from parameters coming from CHANS to parameters needed for STAN in terms of input/output
    - Data taken from statistical yearbook and formal interviews
    - Description of each of the calculation process input/outputs
- Currently working on household, wastewater & combustion pools as per the Urban N budget
- STAN implementation including uncertainty calculations as next step
- Providing data for comparison of cities with appropriate indicators in a next step
  - First compare peri-urban & urban area of Shijiazhuang & Beijing (e.g. N per agricultural area, overall NUE, N per head of wastewater & waste)
- Comparisons between peri-urban and urban already carried out for Chinese cities
- Scenarios not yet looked at

Zielona Gora (Monika)

- Presentation of the STAN model implementation for Zielona Gora in 2020
  - Not all flows have been derived: Trade pool is the least defined. Mostly due to lack of data
  - Largest flows were from Industry to Households and from Households to Wastewater.
- Urban animals and urban plants further separated for comparison with peri-urban area
  - Large share of pets traded in Zielona Gora

- Differences between Zielona Gora city (urban greens & pets play bigger role) & Zielona Gora new district (urban agricultural land & livestock plays big role)
  - Urban plants – city : Largest flow comes from urban green to horticulture and from trade to agricultural land
  - Urban animals - city : Largest flow comes from trade to pets and from pets to waste and pets to urban plants
  - Urban plants – New district : Largest flow from trade to agricultural land, from agricultural land to trade
  - Urban animals – new district : Flows from trade to livestock and livestock to urban plants are the largest ones
- General indicators for urban animals to horticulture & urban greens needed as no data is available

Block 3

17th of September : 09.00-10.30 am Europe, 5.00-6.30 pm China

Stakeholder process & workshops & policy paper

Bringing together our work & disseminating our work will be key

Urban Stakeholder meeting (Lisa)

- Aims & status quo of WP8
  - Informing & involving stakeholders
    - Not always easy to convince stakeholders of importance of urban N budgets – focus is more on climate issues and emissions of CO_2, while N often is not on agenda of city planners
  - Develop practical approaches/solutions to integrate urban N budgets
- Approach in Austria
  - Work so far:
    - Selecting & approaching stakeholders – stakeholder mapping
      - Has also been done in Poland and can be compared
      - Various circles of related to degree of commitment (decision makers, involved, interested)
    - Edit scientific approach in UNCNET for use with lay audience
    - Allow stakeholders to "buy in"
    - First two workshops held in November 2020
  - N budget carried out for Klagenfurt/Villach by Katrin. Will provide better base for discussion with the stakeholders.
  - Future plans:
    - Next workshop on October 12th in Klagenfurt at Lakeside Park

        - Starting with Plenum with a short overview on project for participants who haven't been to first Workshop
        - Then division into 3 groups (working on 3 topics)
            - General information
                - Discussion of Agro-Food chain Klagenfurt/Villach
                    - Always good to have concrete numbers & take-home messages
            - Expectations
                - What are you expecting? What would help you with your own work
            - Future developments, future projects & future collaboration
        - If participant number is low format will be changed to interactive round tables or stations depending on participant number
        - Workshop will include post cards or playing cards
            - Design unchanged with respect to previous UNCNET meeting
            - 10 post cards to be created
            - Some on project in general
            - Some containing hard facts
            - Post cards for each pool in Agro-Food chain
            - Post cards with statements & messages
                - Please add what you would like to share
        - Duration of 3h
        - You can find all information on second workshop & stakeholder mapping on Miro board (https://miro.com/app/board/o9J_lIwPC6k=/)
            - Invitation to workshop available in English can be downloaded from Miro
- Miro – science & policy interaction
    - All partners are invited to share their experience/expectations of influencing policy-makers through scientific excellence (https://miro.com/app/board/o9J_lIwPC6k=/)
        - Please add at least one key message that you would like to communicate to policy makers/city authorities/general public
        - Please add communication methods between science & policy makers/city authorities/general public
        - Please add an example (can be a rough idea only) of opportunities cities have to implement scientific results
        - Feel free to keep adding comments & forward to colleagues Miro board will be open until April 2022 (https://miro.com/app/board/o9J_lIwPC6k=/)
        - In Austria: responsibilities are allocated to specific administrative levels – there are at least three administrative levels (city / province / country). The differentiation between city authorities & policy makers is not quite clear, needs to be more specific, as seems to point to the same thing only at different administrative levels.

Also for Poland and China, different administrative levels co-exist, but may have different responsibilities and duties.

- Experience from Europe: Policy makers will not directly pick up scientific results and implement. They might grasp the idea that a problem exist and commission a specific study themselves. If based on work under contract for an authority, chances are much higher this can flow into a policy process.
  - In Austria, it may sometimes help to attract the attention of media (press, radio and TV stations)
- Potential obstacles in interaction outside science:
  - Stakeholders could be “scared-off” if they hear results that (indirectly) criticize/question/suggest changes (to) their work
  - Individuals within a large general public may feel intimidated by results and react emotionally (“Climate change skeptics”)

WP8 – stakeholder involvement

- Maybe useful to combine several deliverables into one report & divide into different sections as several are due at same date – new deadline: June but depends on final workshop

Block 4

17th of September : 11.00-12.30 am Europe, 5.00-6.30 pm China

Products of UNCNET: Final report & Summary for policy makers / dissemination & WP1 & AOB

Future plans:

- For funding agencies in Poland & China scientific publications are important: paper ideas (please also update Katrin on any new UNCNET publications)
  - Paper comparing between Poland & Austria, cities of similar size (e.g. Klagenfurt/Villach with Zielona Gora)
    - Monika will come up with scheme similar to Katrins Agro-Food chain
    - Katrin & Wilfried will decide on whether to include Villach or only focus on Klagenfurt
  - Paper on reduction of agriculture NH_3 emissions based on European approach& influence on PM2.5 in China (collaboration between Lin, Barbara & Zhaohai)
  - Paper on urban air shed situation in Vienna & Zielona Gora with focus on N & differences in atmospheric differences (collaboration between Lin, Wilfried & Monika - Zehui Liu will visit IIASA in February 2022 to set up model for Europe)

- Paper on methodological approaches (STAN & uncertainties (dealing with unknown flow) & trend analysis) involving all – Katrin or Samuel
- Paper on N cycles in all cities (need to find key messages first) – Wilfried leading
    - Maybe helpful to not focus on detailed data to facilitate paper development – BUT data needed to implement to STAN
    - Present results on 19th of November & then work on paper
- Policy paper is a possibility but not a priority – Wilfried
- Scenario paper (including dietary changes, mitigation measures, technological advances) – Katrin leading
    - Katrin will implement scenario to Vienna urban N budget & inform partners of methodology
    - Yixin Guo paper on dietary change scenarios could be of interest here
- Publication of stakeholder involvement in large scale projects (generally but using project results) in combination with SDGs – Lisa
    - Indicating the lack of implementation of certain tools
    - Report is available but it would be interesting to turn report to paper (focusing on methods)
    - Lisa will talk to colleagues & come up with Exposé (& will get consultation/support if needed)

- "Summary for policy makers" as a major output of the project
    - Not as scientific as full report but with references to full report
- Post cards/playing cards
    - Lisa will come up with structure & send it out
    - Lisa will need text/statements/input for postcards
    - Also possible to add QR code with link to paper (DOI) etc (also a possible backside of playing cards)
    - Suggestion: add block including playing cards to Miro
        - Feel free to add ideas to Miro (https://miro.com/app/board/o9J_lIwPC6k=/)
    - Nice give-away which funding agencies will be happy with

AOB

- Future work & collaboration beyond UNCNET needs to be discussed
    - Hard to get funding for China & Europe jointly but there are other forms like student exchange, scholarships, the IIASA YSSP program
    - If we want to proceed this path of urban N cycles we need to demonstrate the benefit of the results – will require more information (flyer) on practical output

Next Meetings

- Stakeholder meetings (physical meetings)
  12.10.2021, Klagenfurt
  14.10.2021, Vienna (tentative, needs final confirmation)
- Project conference:
  19.11.2021 - 08.30 am Europe, 3.30 pm China **(please adjust to changed time!)**
  11.02.2022 - 08.30 am Europe, 3.30 pm China
  28.04.2022 - 09.00 am Europe, 4.00 pm China
- Final meeting (physical if possible):
  - Involve stakeholders in English language
  - Presenting results to interested public
  - Suggestion: 2 day meeting between May 30^{th} to 3^{rd} of June (make sure it does not collide with Austrian world summit – check with Markus)
    - First idea for May 30-31 and internal workshop to final report on June 1^{st}

International Institute for Applied Systems Analysis
IIASA www.iiasa.ac.at

UNCNET

Urban N Budget Vienna

Uncertainty treatment – Revised concept

Samuel GUÉRET
Katrin KALTENEGGER
Wilfried WINIWARTER

September 16th, 2021

IIASA
Chinese Academy of Sciences
Uniwersytet Zielonogórski
E.C.O. Institut für Ökologie
Peking University 1898
brainbows

Plan

- Introduction
- Keystone STAN assumptions
- Revised uncertainty treatment
- Data exchange and conclusion

Motivation

Inconsistencies upon current concept review

Revised concept

Formalization of harmonized uncertainty treatment concept

Facilitation of STAN implementation

STAN Assumptions and theoretical considerations

- Uncertain quantities normally distributed in STAN
  - Mean (μ), Standard Deviation (SD)
- Standard Error (SE) required as input in STAN

Standard Deviation	Standard Error
Measure of the sample variability around the sample mean	Uncertainty around the estimate of a measured parameter (*e.g.* mean)
Does not tend to change with the sample size	Inversely proportional to the sample size
$SD = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i-\mu)^2}\text{, where } \mu = \frac{1}{N}\sum_{i=1}^{N}x_i$	$SE = \frac{SD}{\sqrt{N}}$

SE is the SD of the sampling distribution of the estimated parameter !

Uncertainty treatment (I) – Single data point (N=1)

Previous concept based on deliverable D2/2

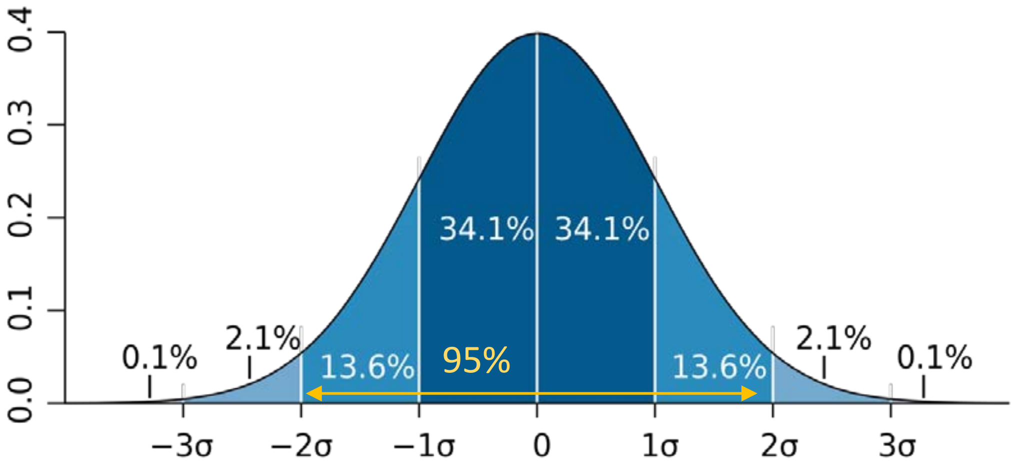
Normalized triangular distribution & Uncertainty Factors (UFs) from EPNB
(Winiwarter & EPNB, 2016. http://www.clrtap-tfrn.org/sites/clrtap-tfrn.org/files/documents/EPNB_new/EPNB_annex_20160921_public.pdf - pp. 12-13.)

Discrepancy between mean and data point for large UFs

Revised concept directly assumes normal distribution

Mean matching collected data point

SD chosen so that mean $\pm$ 2*SD covers 95% of events



Adapted from Standard deviation - Wikipedia

Uncertainty treatment (II) – Single data point - Example

Industry pool - milk import from NÖ-M

Data point $x = 1{,}850$ ton N ; UF = 1.1

UI = [x/UF; x*UF] = [1,673; 2,027] ton N

Range of UI : r = (x*UF) – (x/UF)= 354 ton N

SD = r/4 = 88.5 ton N ; $SE = \frac{SD}{\sqrt{1}} = SD$

$\boxed{\text{95\% events in } x \pm 2*SD = 1{,}850 \pm 177 \text{ ton N}}$

Uncertainty treatment (III) – Several data points (N≥2)

Similar concept than for single data point

Mean corresponding to the statistical mean of the dataset

No use of UFs

- N=2: UI bounded by the two collected values and SD = r/4
- N>2: SD computed using its formula (cf. slide 4)

Overview - Data exchange

	N=1 (x)	N=2 (x_1, x_2), $x_2 > x_1$	N>2 $(x_1, x_2, \ldots, x_N)$
Mean (μ)	$\boldsymbol{x}$	$(\boldsymbol{x_2}$ - $\boldsymbol{x_1})/2$	$\frac{1}{N}\sum_{i=1}^{N} x_i$
Standard Deviation (SD)	$(\boldsymbol{x} * \mathrm{UF} - \boldsymbol{x}/\mathrm{UF})/4$	$(\boldsymbol{x_2}$ - $\boldsymbol{x_1})/4$	$\sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2}$
Standard Error (SE)	$\frac{SD}{\sqrt{N}}$		

STAN implementation requires SE for each flow

Uncertainty output : $\mu \pm$ 2*SD

Other suggestions possible but need of consistency

Future prospects

Revision of deliverable **D2/2**

Drafting of deliverable **D2/3**

("Using probability approaches to inform, revise and improve contributions on the respective nitrogen flows")

Exploration of Linear Inverse Modeling and stochastic approaches in the context of underdetermined systems

Thank you for your time !
Any questions ?

Atmospheric Impacts of Reactive Nitrogen

UNCET-WP3 updates

Lin Zhang, Youfan Chen, Zehui Liu, Xiao Lu, Jiayu Xu

Peking University

17 September 2021

UNCNET WP3 work tasks

- **Ammonia emission estimates**

NH_3 emissions based on different scenarios of urban agriculture and considering different mitigation pathways of nitrogen management

- **Atmospheric chemistry model evaluation**

Evaluate model simulation of $PM_{2.5}$ concentrations at fine resolution.

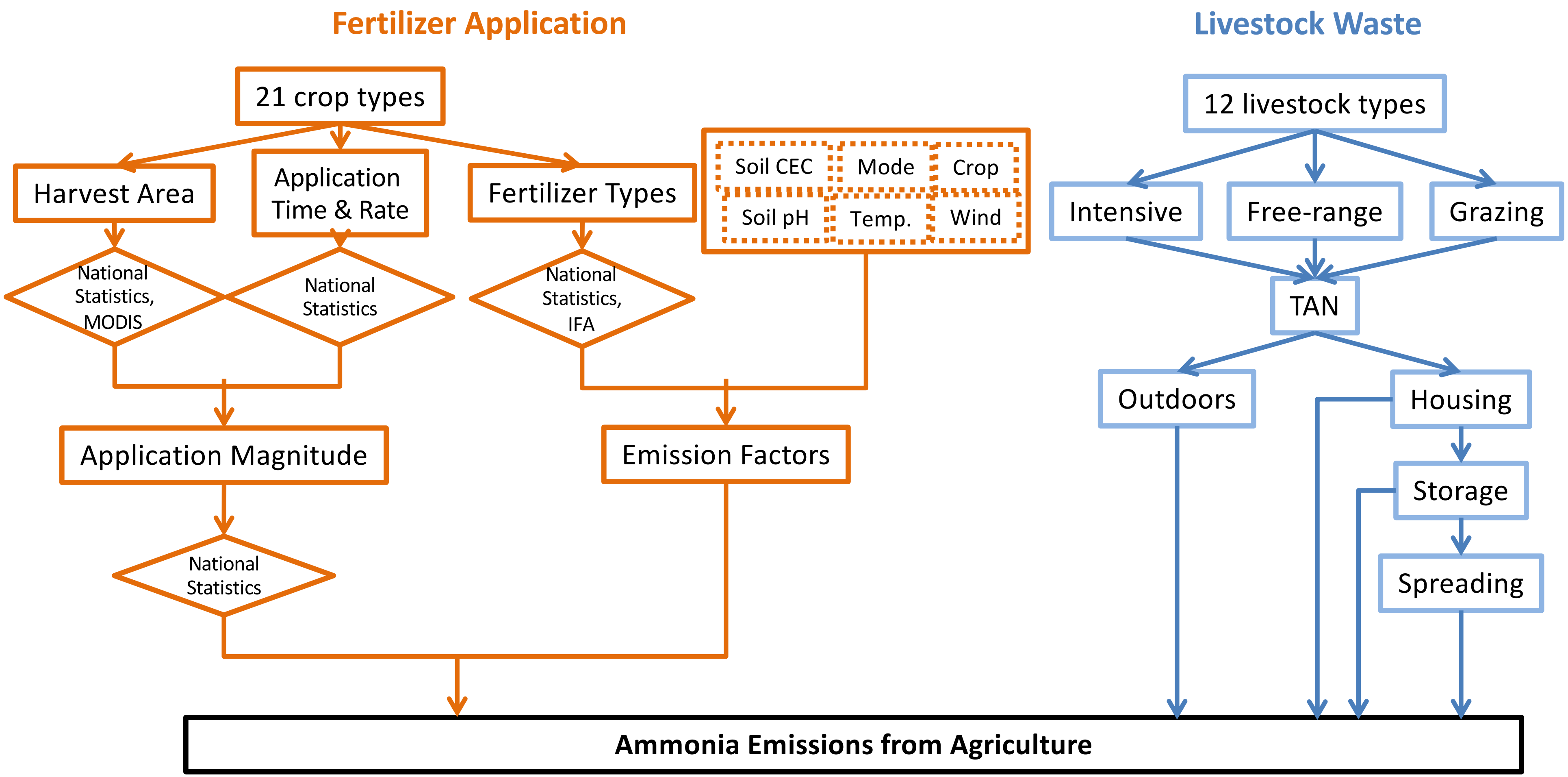
- **Atmospheric impact analyses**

Quantify how changes in nitrogen emissions affect the $PM_{2.5}$ concentrations in the urban atmosphere.

Progress in 2011

- Extended Chinese agricultural NH_3 emissions to 2005-2016
- Assessed the response of $PM_{2.5}$ air pollution to NH_3 emission reductions in Beijing-Tianjin-Hebei (BTH)
- Constructed the NH_3 emission inventory over BTH at 1 km resolution
- Estimated soil NO_x emission over BTH and its impacts on ozone air pollution

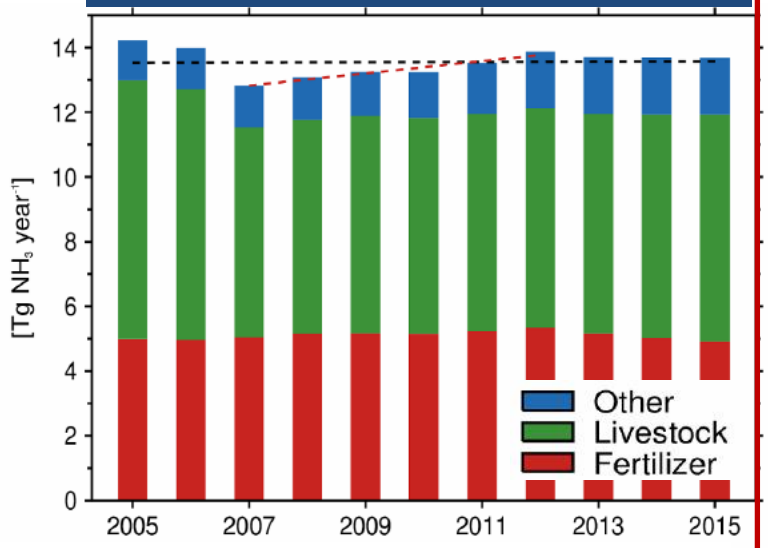
Bottom-up estimates of agricultural NH_3 emissions



[Zhang et al., Atmos. Chem. Phys. 2018]

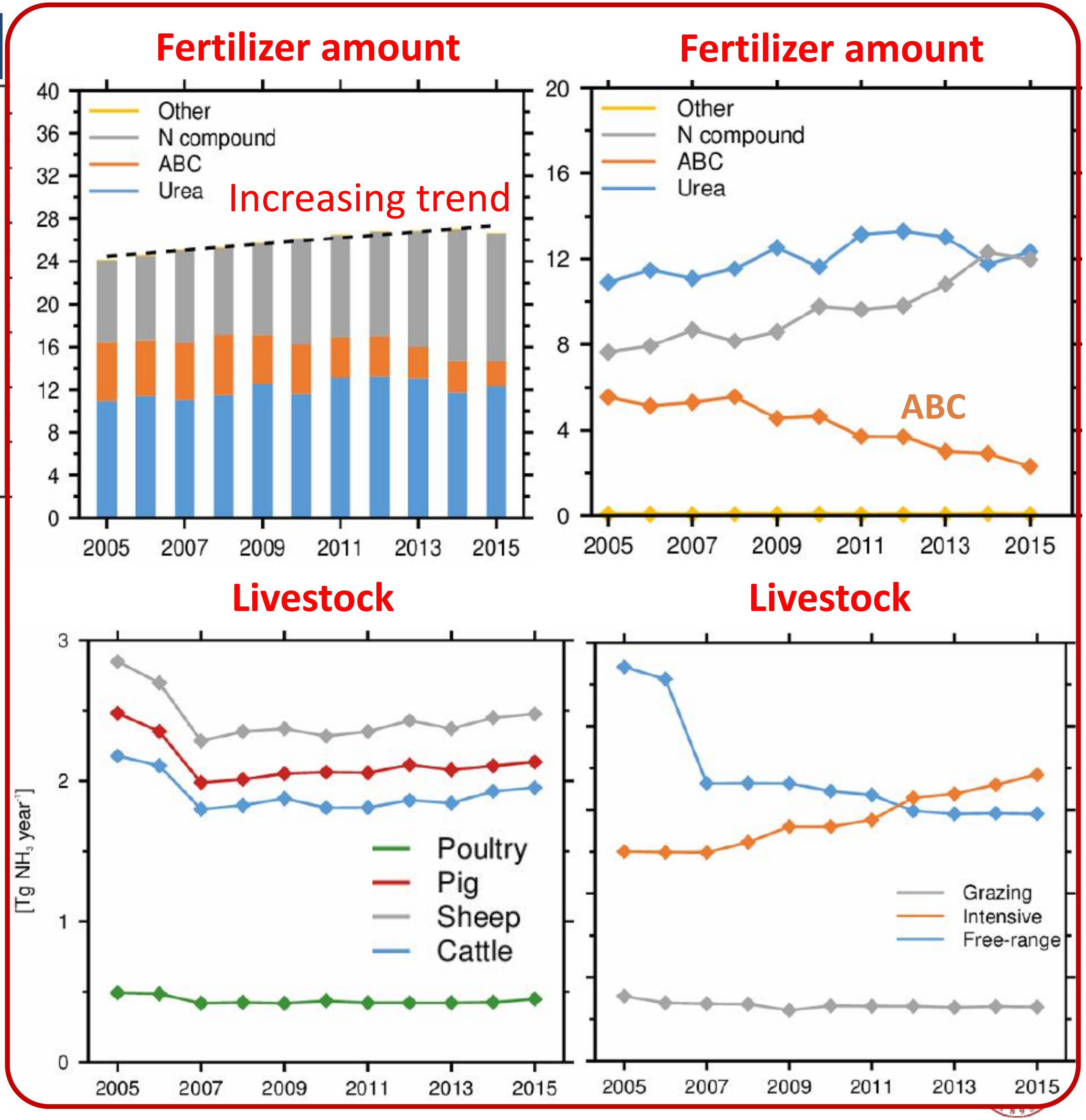
Interannual variation of NH_3 emissions over 2005-2015

NH_3 emissions over 2005-2015



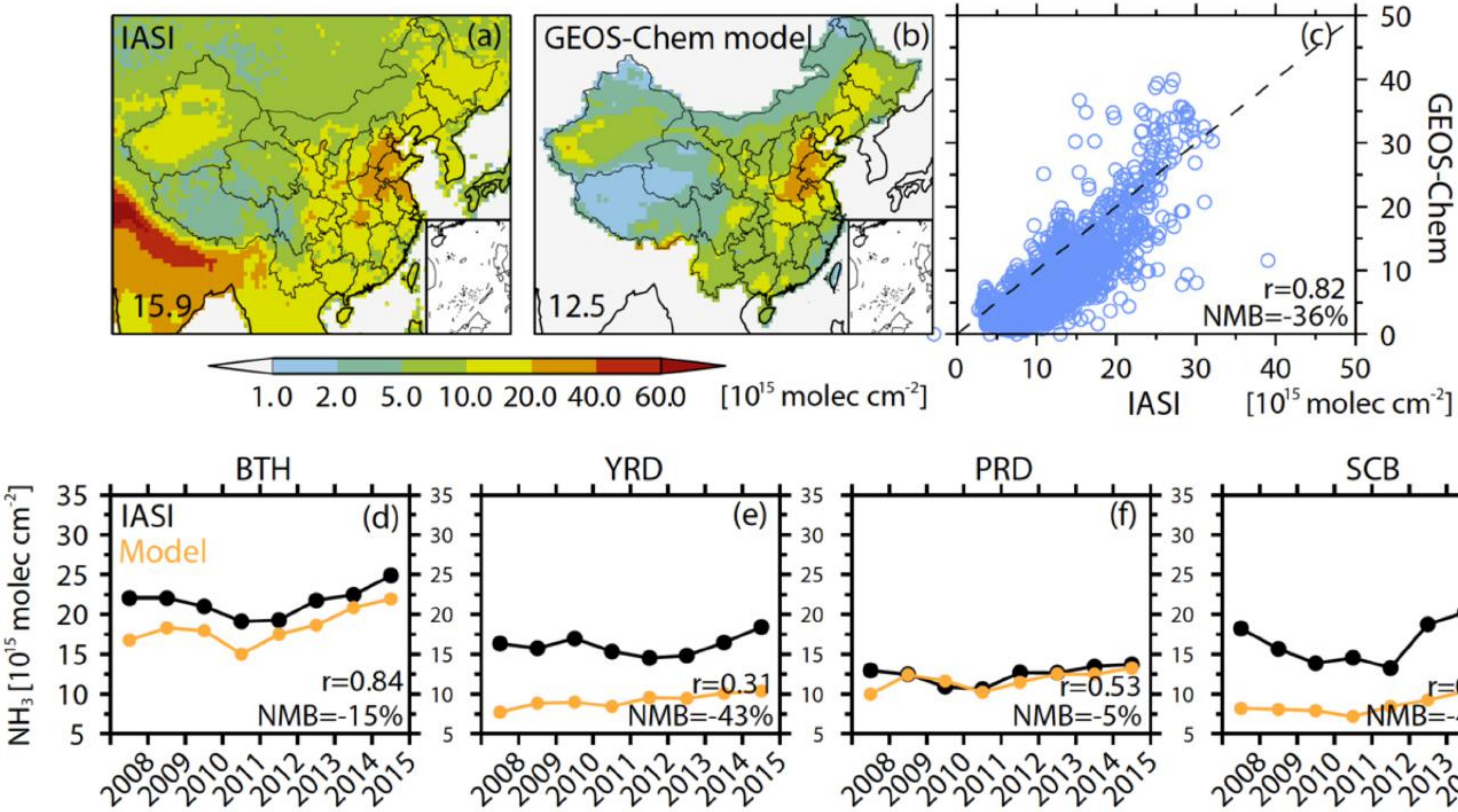
- NH_3 emissions from fertilizer use remained stable due to the switch of fertilizer from ABC to urea.
- The lower NH_3 emissions in 2007 were caused by changes in free-range animals.

[Chen et al., Environ. Res. Lett., submitted]



Drivers of recent atmospheric NH_3 increases over China

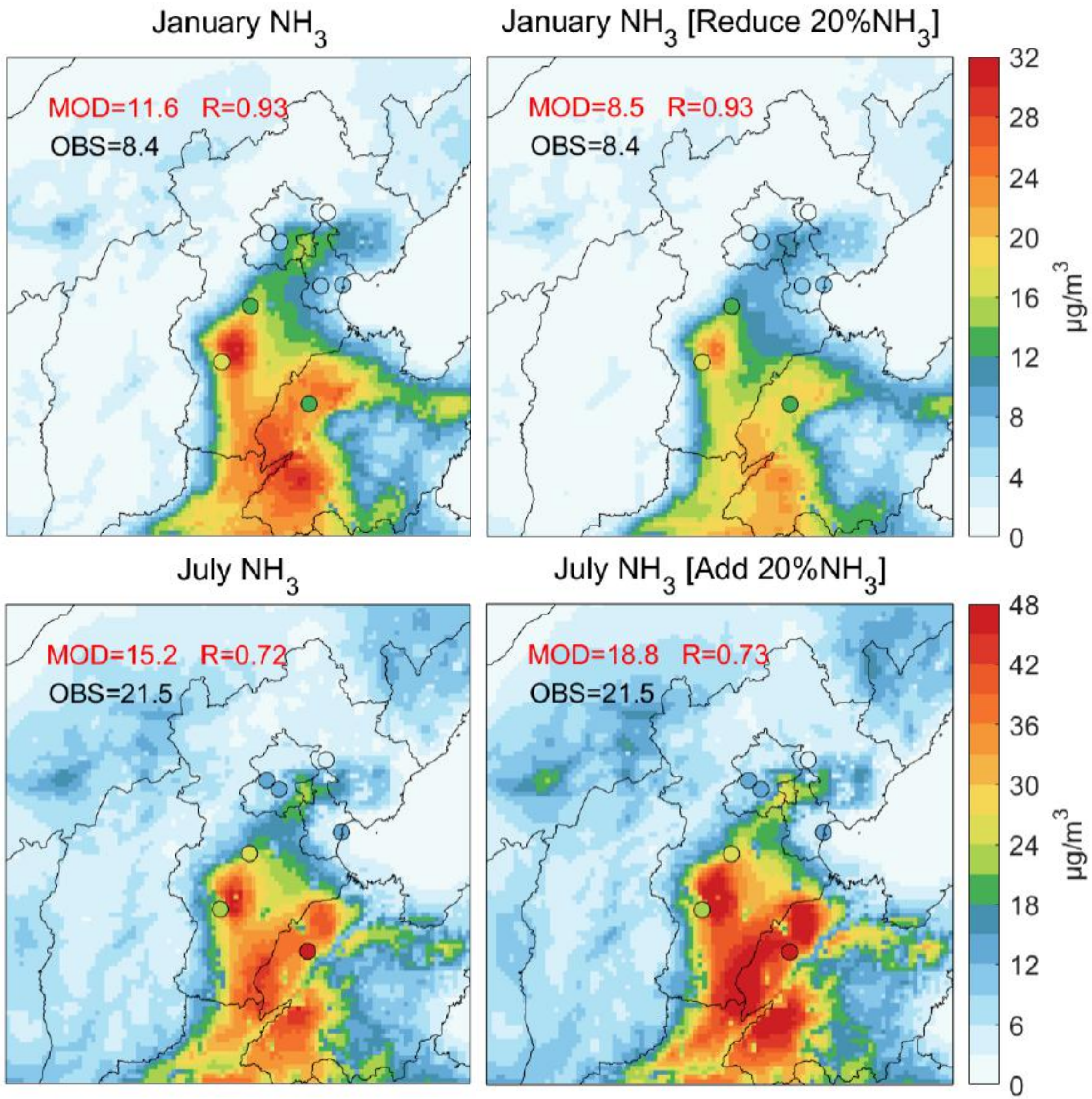
2008-2015 NH_3 columns

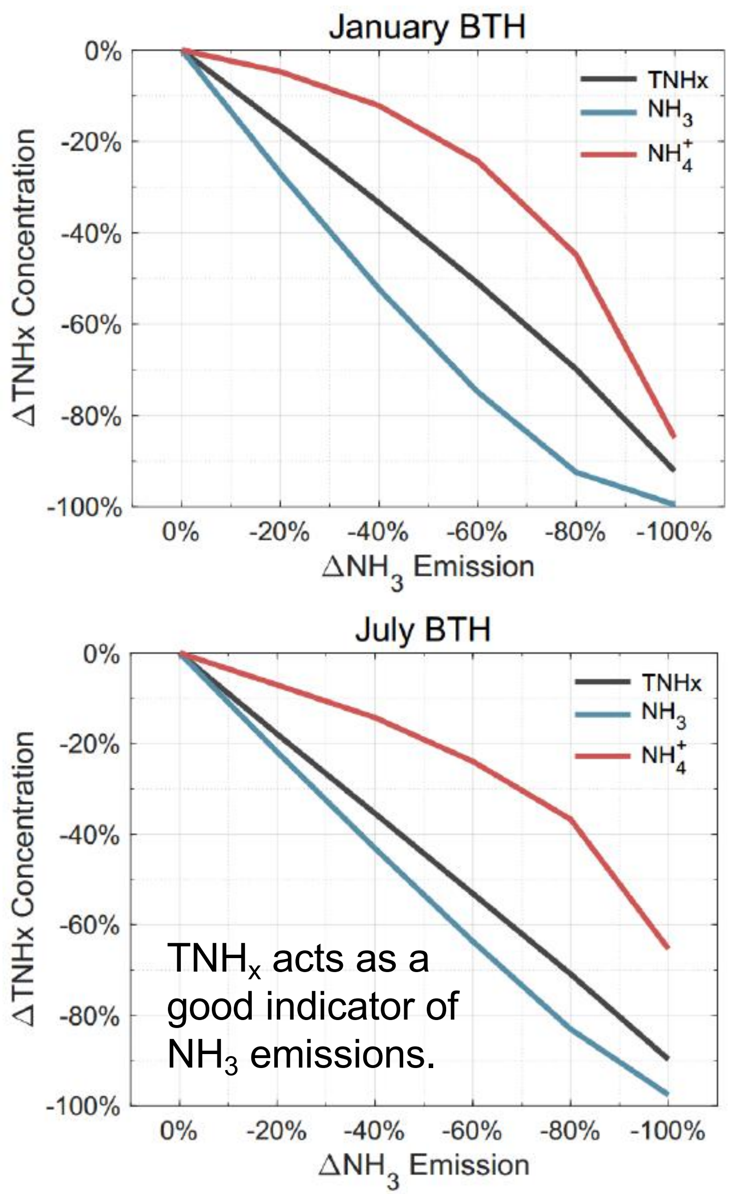


Rising atmospheric NH_3 levels in eastern China since 2011 as observed by IASI satellite are mainly driven by rapid reductions in SO_2 emissions.

[Chen et al., Environ. Res. Lett., submitted]

Evaluation of surface NH_3 concentrations over North China



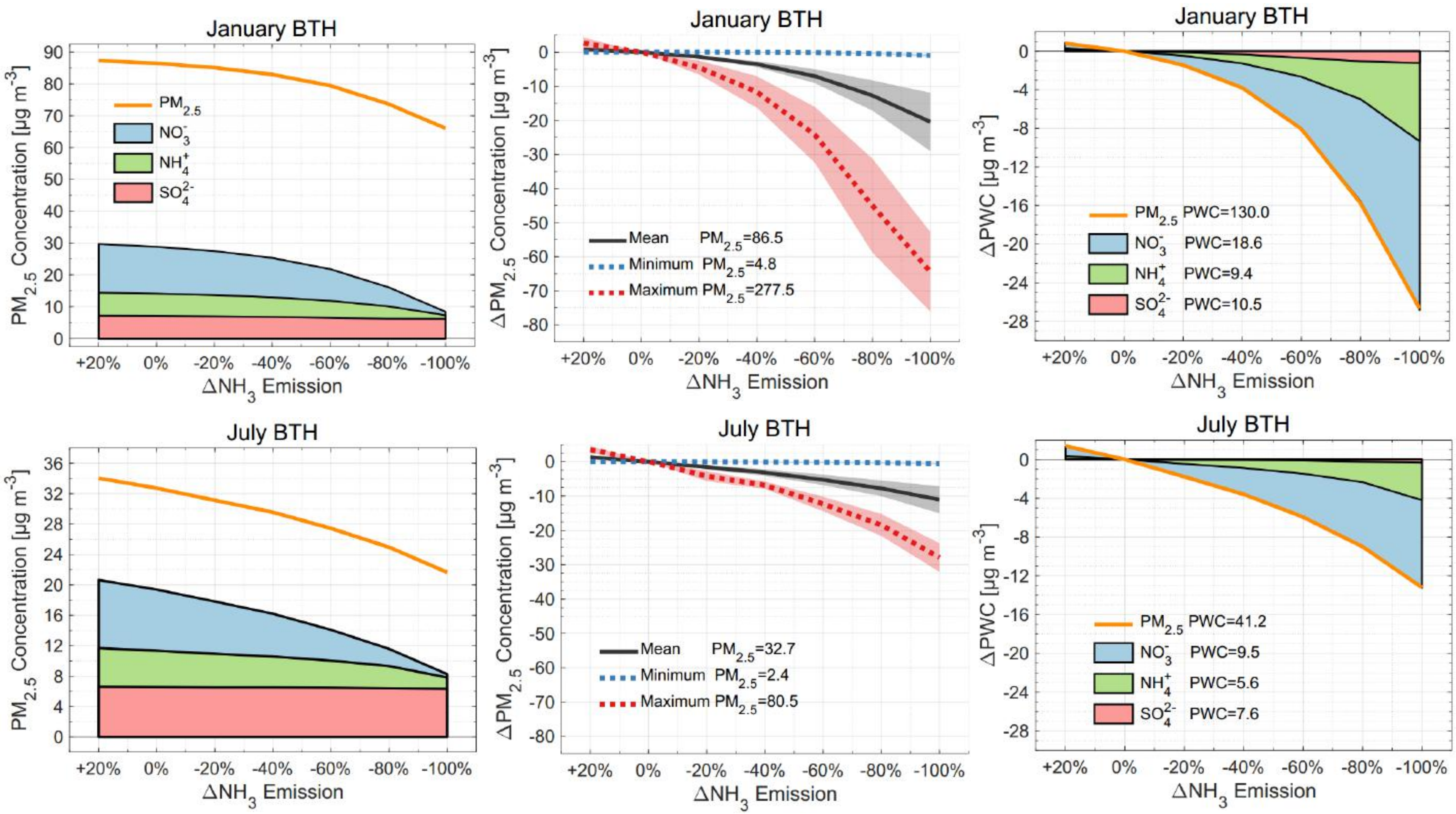


Circles: NH_3 measurements from Dr. Yuepeng Pan, IAP

[Liu et al., Environ. Res. Lett., 2021]

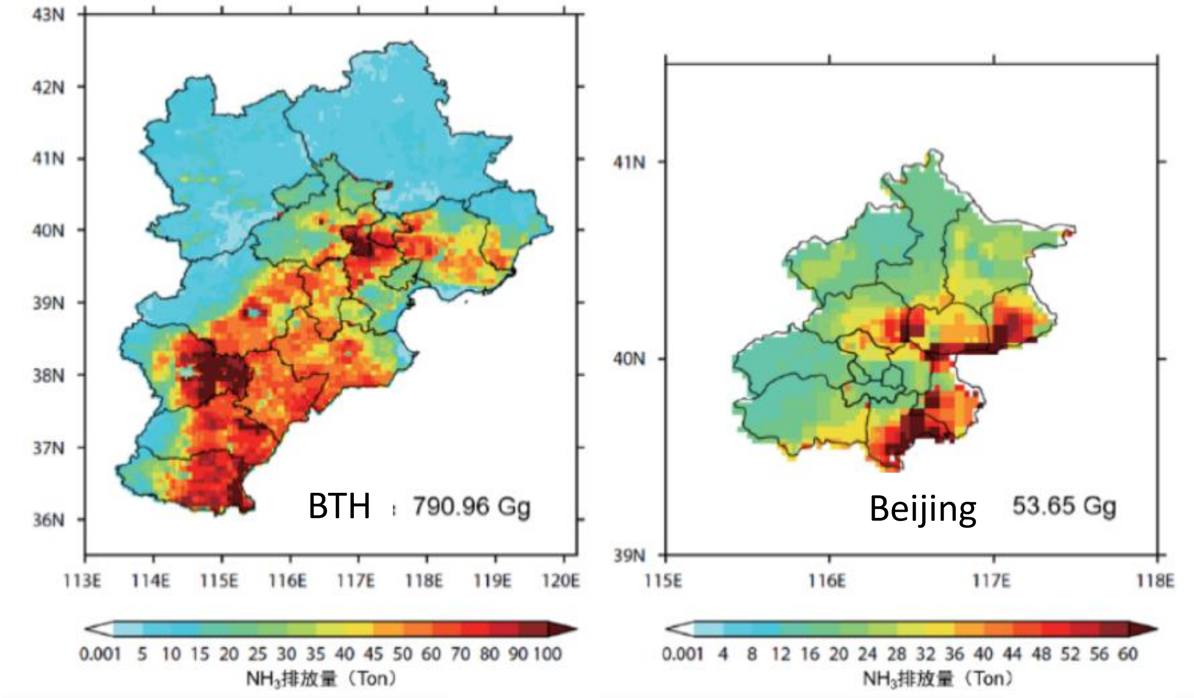
Impacts of NH_3 emission reductions on $PM_{2.5}$ air pollution

$PM_{2.5}$ mean level | **$PM_{2.5}$ extreme cases** | **Population weighted $PM_{2.5}$**

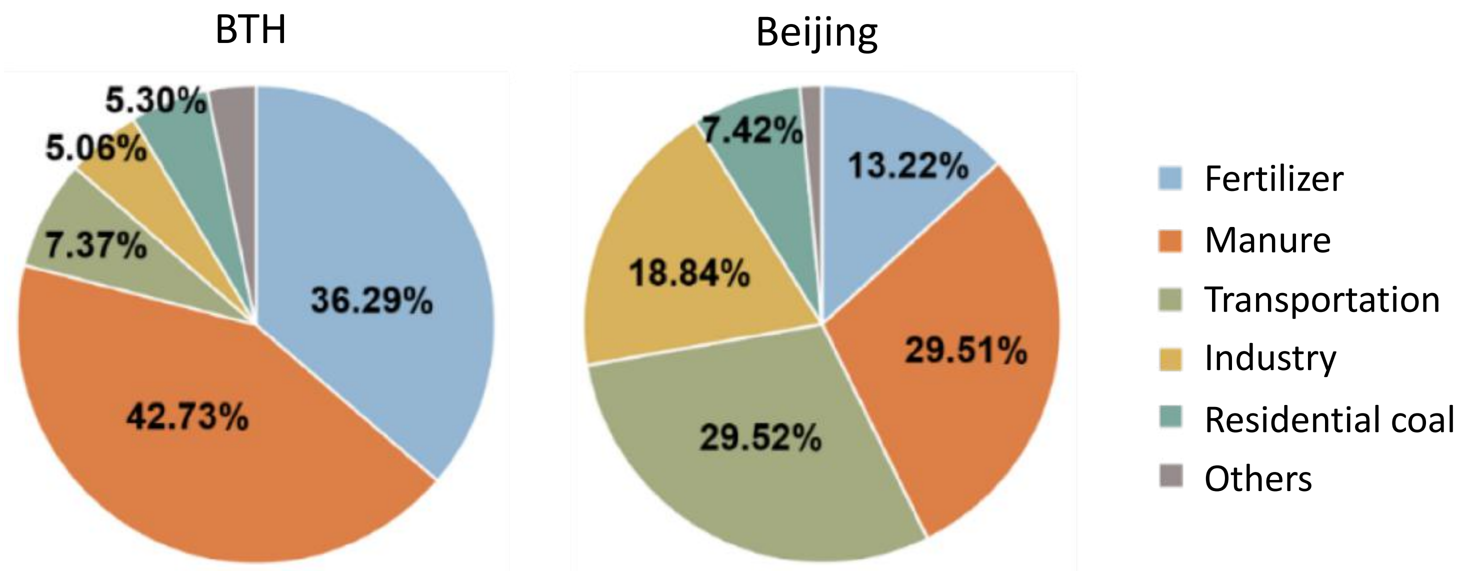


[Liu et al., Environ. Res. Lett., 2021]

A fine–resolution NH_3 emission estimate in Beijing-Tianjin-Hebei (BTH)



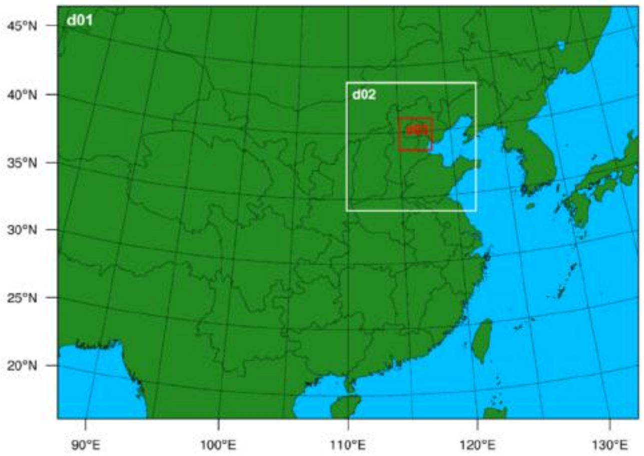
- For the year 2016 NH_3 emissions in Beijing account for 6.8% of those in BTH;
- Agriculture 80% in BTH



[9]

Distinct model underestimates at urban sites; missing source?

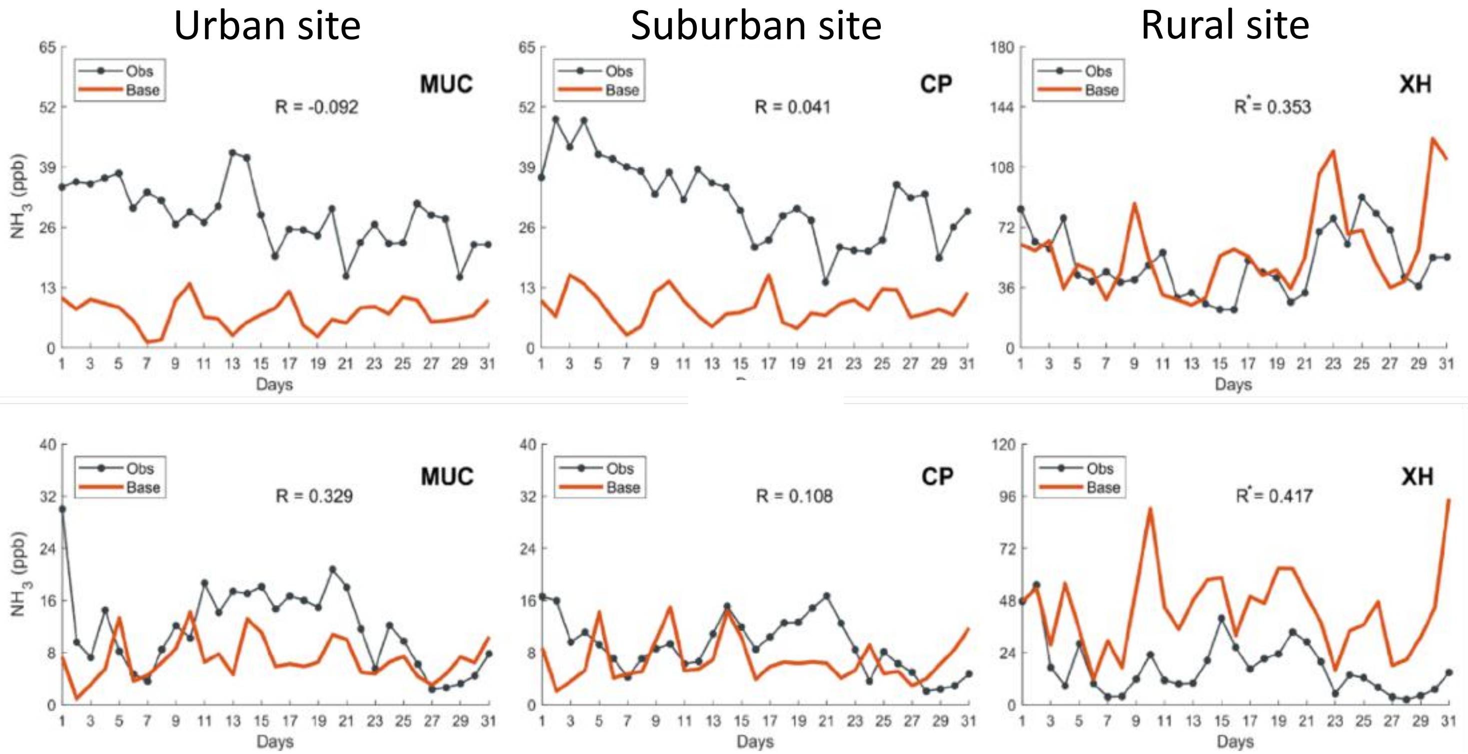
WRF-Chem 27/9/3 km



- Significant model underestimates at urban and suburban sites, particularly in August;
- Good agreement at the rural site

August

December



Model

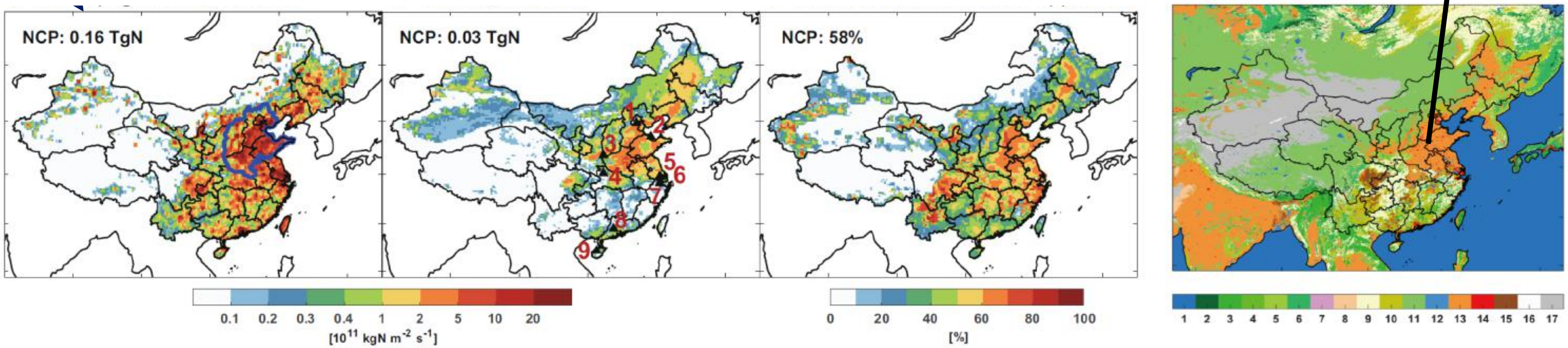
Observations

Soil emissions as an important NO_x source

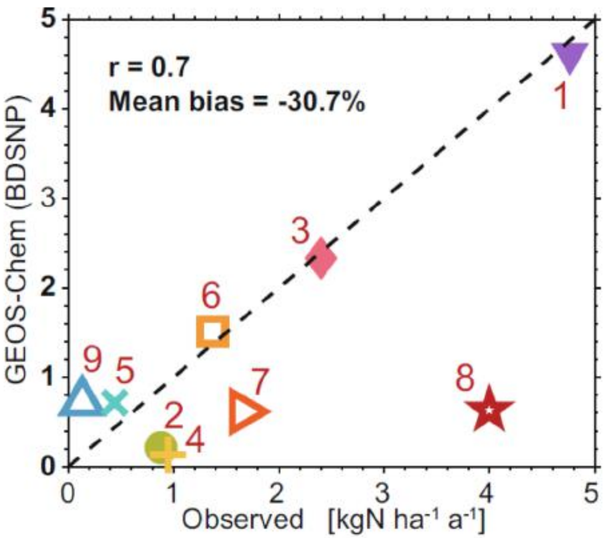
North China Plain, July 2017

Anthropogenic NO_x Emis. **Soil NOx Emis.** **Soil from fertilizer (%)**

cropland



Obs. vs modelled soil NOx



Soil emissions are calculated by the Berkeley-Dalhousie Soil NOx Parameterization (BDSNP) in the model

$$Emis_{soil} = A'_{biome}(N_{avail}) \times f(T) \times g(\theta) \times P(l_{dry})$$

available soil nitrogen mass: natural pool + fertilizer application + nitrogen deposition

Temperature, moisture dependence, and pulsing term

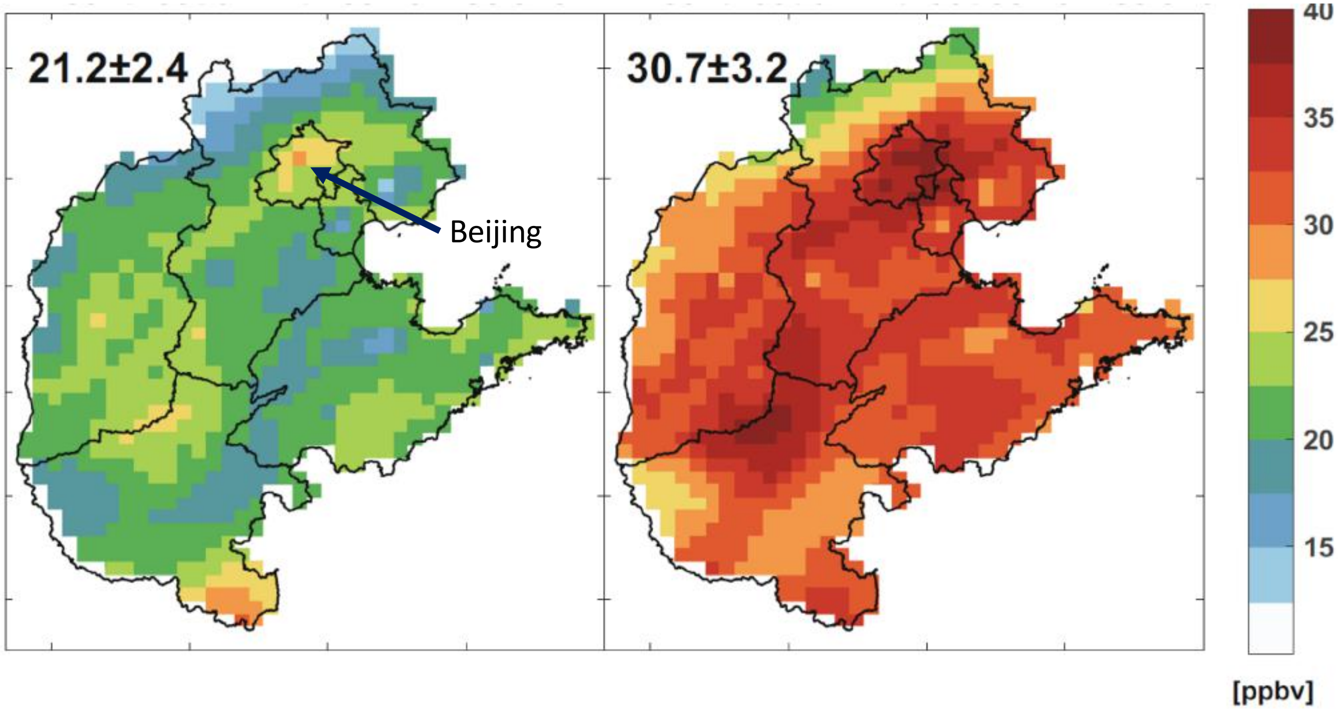
[Lu et al., Nature Communications, 2021]

Soil NO_x emissions significantly change anthropogenic ozone contributions

Anthropogenic ozone enhancement
(estimated as ozone difference wt/wrt China anthro. source)

with the presence of soil NOx
(real case)

without the presence of soil NOx
(or if model neglects soil NOx)

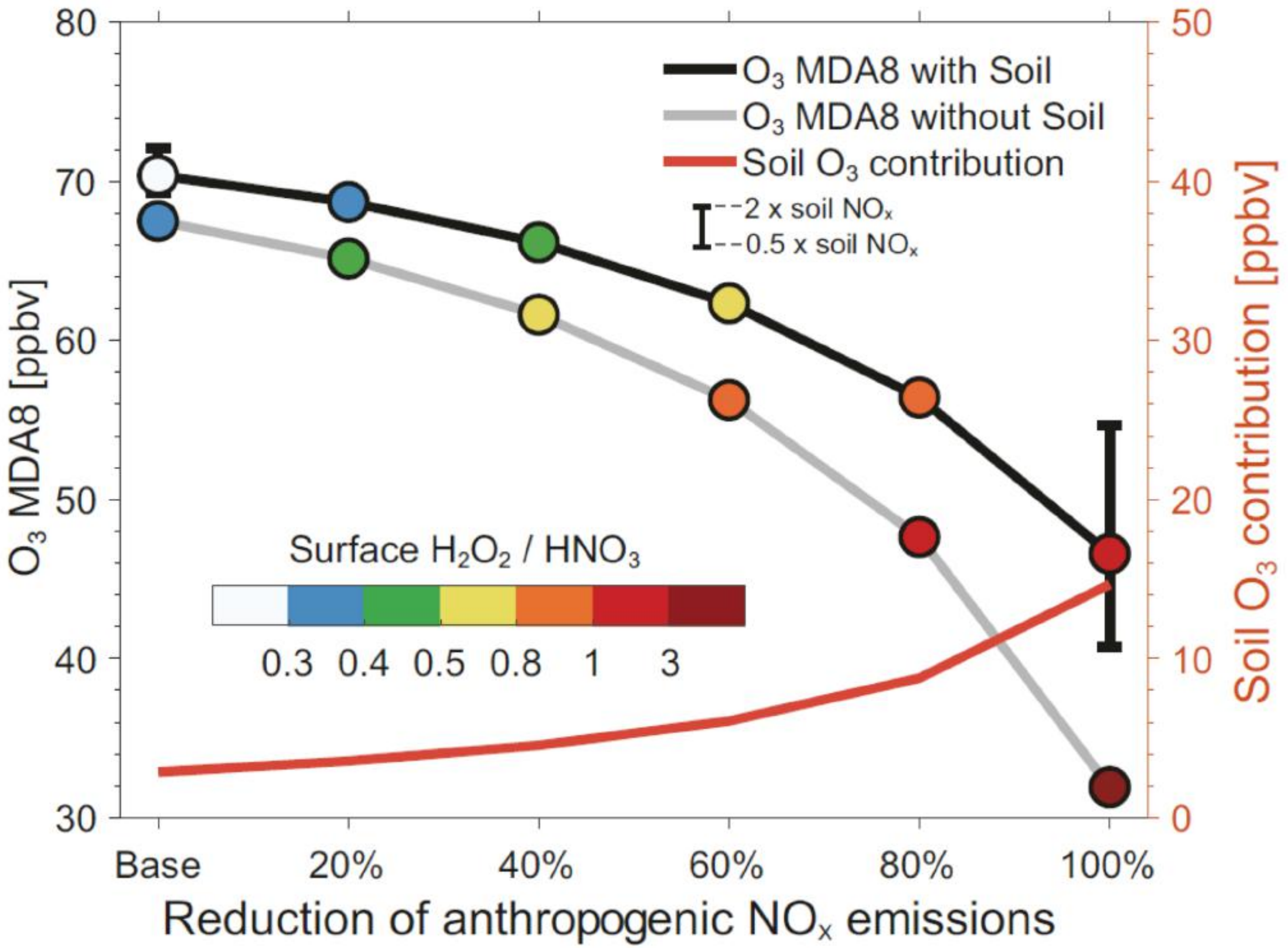


Maximum ozone air quality improvements in July 2017, as can be achieved by controlling all domestic anthropogenic emissions, decrease by 30% due to the presence of soil NOx.

[Lu et al., Nature Communications, 2021]

Stronger anthropogenic NO_x reduction are needed because of soil NO_x

Ozone changes with reduction of anthropogenic NOx emissions, with vs without soil NOx emissions



[Lu et al., Nature Communications, 2021]

Summary

- **Publications**

The nonlinear response of fine particulate matter pollution to ammonia emission reductions in North China, *Environ. Res. Lett.*, 16, 034014, 2021

The underappreciated role of agricultural soil nitrogen oxide emissions in ozone pollution regulation in North China, *Nature Communications*, 2021

Interannual variation of reactive nitrogen emissions and their impacts on $PM_{2.5}$ air pollution in China during 2005-2015, submitted to *Environ. Res. Lett.*

- **Next steps**

To refine the city-level NH_3 emission estimates

To set up atmospheric chemistry model simulations for Europe (Zehui Liu will visit IIASA for this work)

Work on deliverable 3.3

Thank you for your attention!

Datasets and statistics for constructing the inventory

☐ Fertilizer use

EarthStat global crop harvest areas and yields at 5 min × 5 min (~10 km) resolution for the base year of 2000

Soil pH and soil cation exchange capacity (CEC) – global datasets at 0.5° resolution

Fertilizer application rates from reports of farmers' practice

Fertilizer type (e.g., urea, ammonium bicarbonate (ABC), ammonium sulfate (AS))

Application mode (broadcast and injection) (national statistics or IFA)

Province-level statistics of fertilizer use amount from national reports

Surface air temperature and wind speed from GEOS-FP dataset (0.25° resolution)

☐ Livestock manure

Livestock distribution:

Distribution of cattle, buffaloes, sheep, goats, pigs, chickens and ducks in 2010 (5 min) according to the Gridded Livestock of the World database (GLW v3.1)

Province-level statistics of livestock numbers from national reports

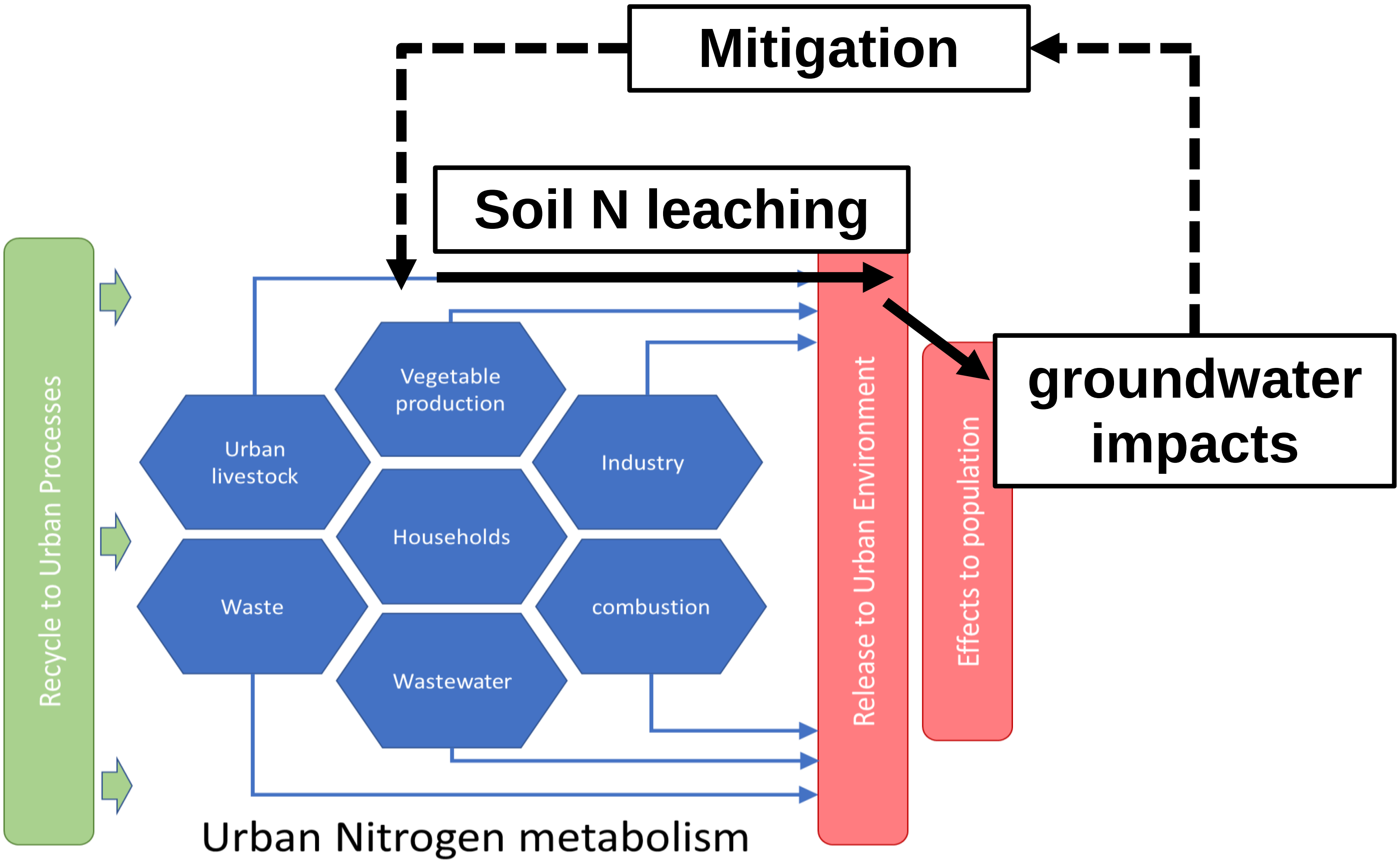
NSFC-EU Project – UNCNET annual meeting

WP4–Soil N leaching, impacts, & mitigations

Feng Zhou (PKU), Wenjun Jiang (PKU); Weichen Huang (PKU), Zhaohai Bai (CAS)

September 16-17, 2021, online

Role of WP4



Mitigation
Soil N leaching
groundwater impacts
Recycle to Urban Processes
Vegetable production
Urban livestock
Industry
Households
Waste
combustion
Wastewater
Release to Urban Environment
Effects to population
Urban Nitrogen metabolism

Objective and tasks of WP4

Objective—

We will quantify regional-scale N leaching from agricultural soils at high spatial resolution, as well as to optimize agricultural management practices to mitigate groundwater N pollution.

Key tasks—

Task 1. Development of high-resolution N inputs and irrigation datasets

Task 2. Land surface modeling simulation of N leaching and the associated N flow in aquifer groundwater under different agricultural management and climate change

Task 3. Optimization of urban agriculture management to mitigate groundwater N pollution under different climate changes

Deliverables and deadline of WP4

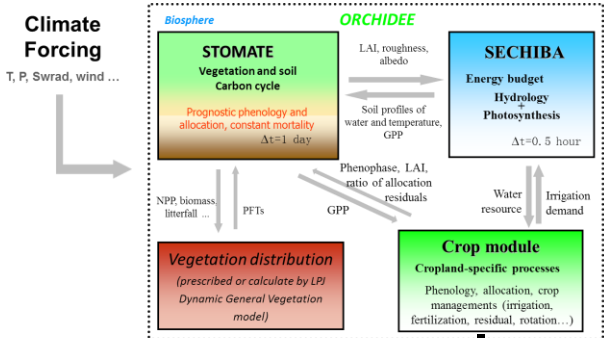
Deliverables	Deadline
D4/1: Development of high-resolution N inputs and irrigation datasets from agricultural soils (PKU+CAS)	**(Month 12)** ✓
D4/2: Land surface modeling simulation of N leaching (PKU)	**(Month 24)** ✓
D4/3: Optimization of urban agriculture management to mitigate groundwater N pollution under different climate changes (PKU)	**(Month 30)** ✓

Progress in 2020-2021

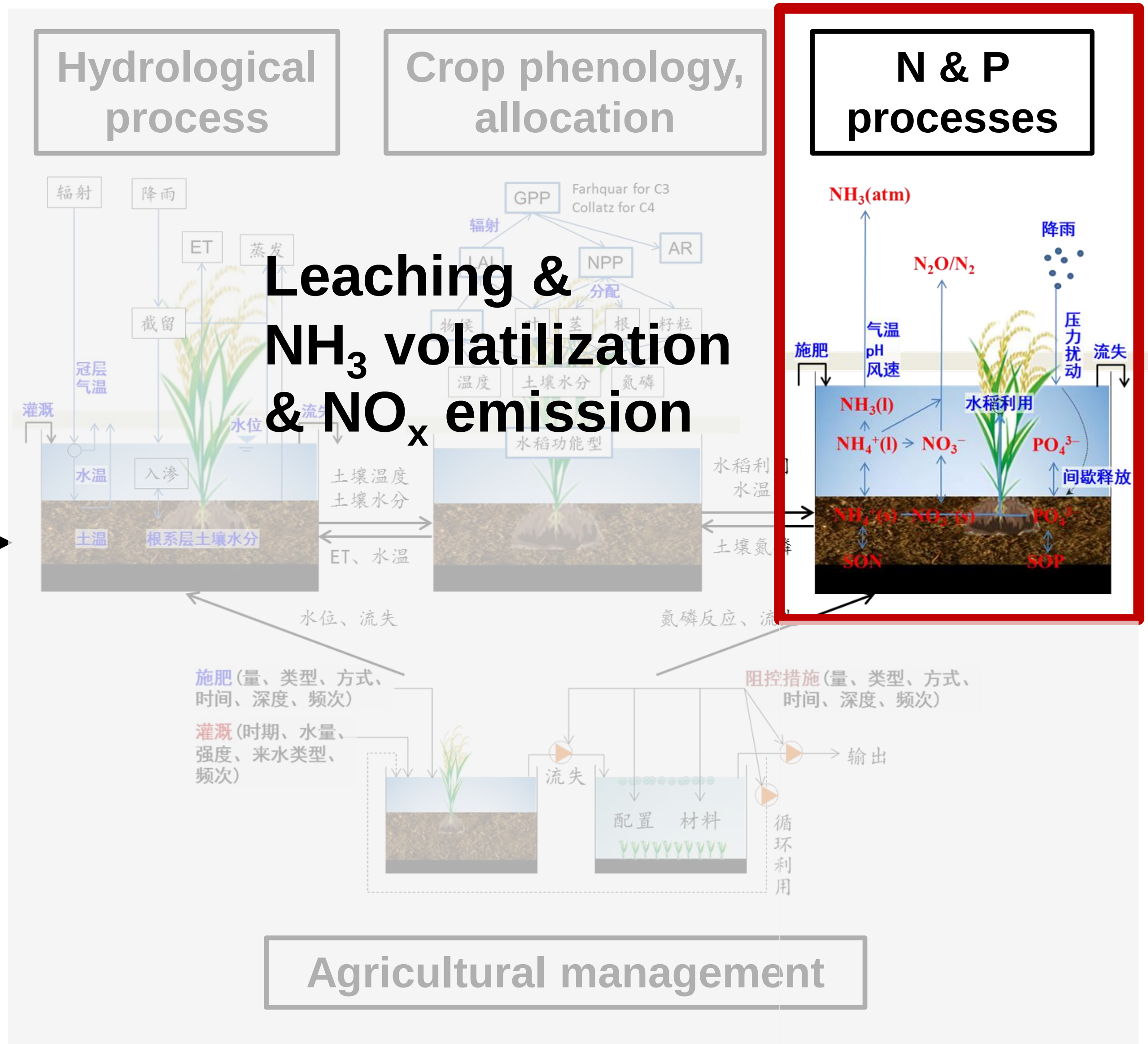
Deliverables and deadline of WP4

1. Cui, X. [#]; **Zhou, F.***; et al., Global mapping of crop-specific emission factors highlights hotspots of nitrous oxide mitigation. *Nature Food*. 2021, in press
2. Adalibieke, W. [#]; Zhan, X. [#]; ..., **Zhou, F.***, Decoupling between ammonia emission and crop production in China due to policy interventions. *Global Change Biology*. 2021, 27, doi: 10.1111/gcb.15847
3. Zhan, X.[#]; Adalibieke, W.[#]; …, **Zhou, F.***, Improved estimates of ammonia emissions from global croplands. *ES&T*. 2021, 55(2): 1329-1338.
4. Jiang, W. [#]; Huang, W. [#]; …, **Zhou, F.***, Is rice field a nitrogen source or sink for the environment? *Environmental Pollution*. 2021, 283: 117122.

WP4 Task 2 – Modeling



Rice paddies module

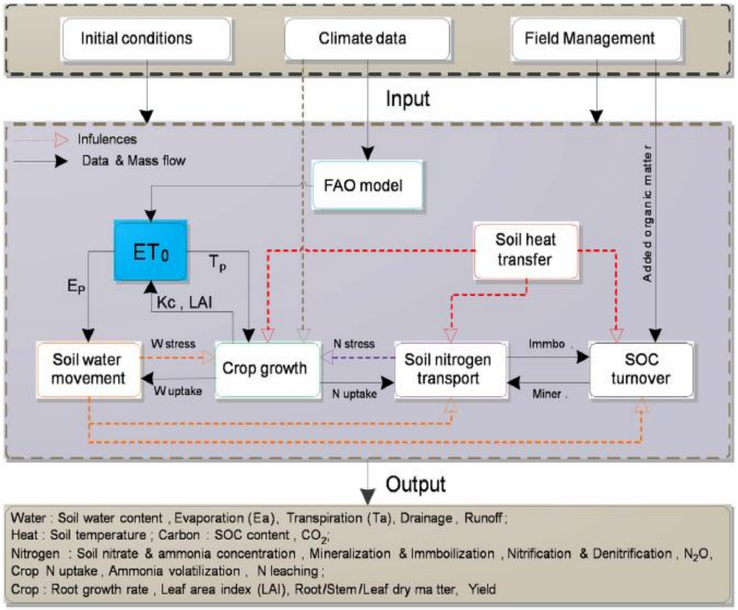


Leaching & NH_3 volatilization & NO_x emission

D4/2: Land surface modeling simulation of N leaching (PKU)

Jiang et al. 2021

WP4 Task 2 – Modeling



Jiang et al. 2021, Environ. Pollut.

Soil water infiltration

$$f = K_s\left(1 + \frac{h_f \triangle \theta}{F}\right)$$ Green-Ampt equation

$$\frac{\partial \theta}{\partial t} = \frac{\partial}{\partial z}\left[k(h)\left(\frac{\partial h}{\partial z} + 1\right)\right] - S_w$$ Richard's equation

Soil solute transport of NH_4^+-N and NO_3^--N

$$\frac{\partial C_1}{\partial t} = \mathrm{D}\frac{\partial^2 C_1}{\partial z^2} - v\frac{\partial C_1}{\partial z} + K_n C_2 - K_{den} C_1 - K_{bio}$$

The initial conditions:

$$C_1 = C_{10}(z), \qquad (0 \le z \le \infty,\ t = 0)$$
$$C_2 = C_{20}(z), \qquad (0 \le z \le \infty,\ t = 0)$$

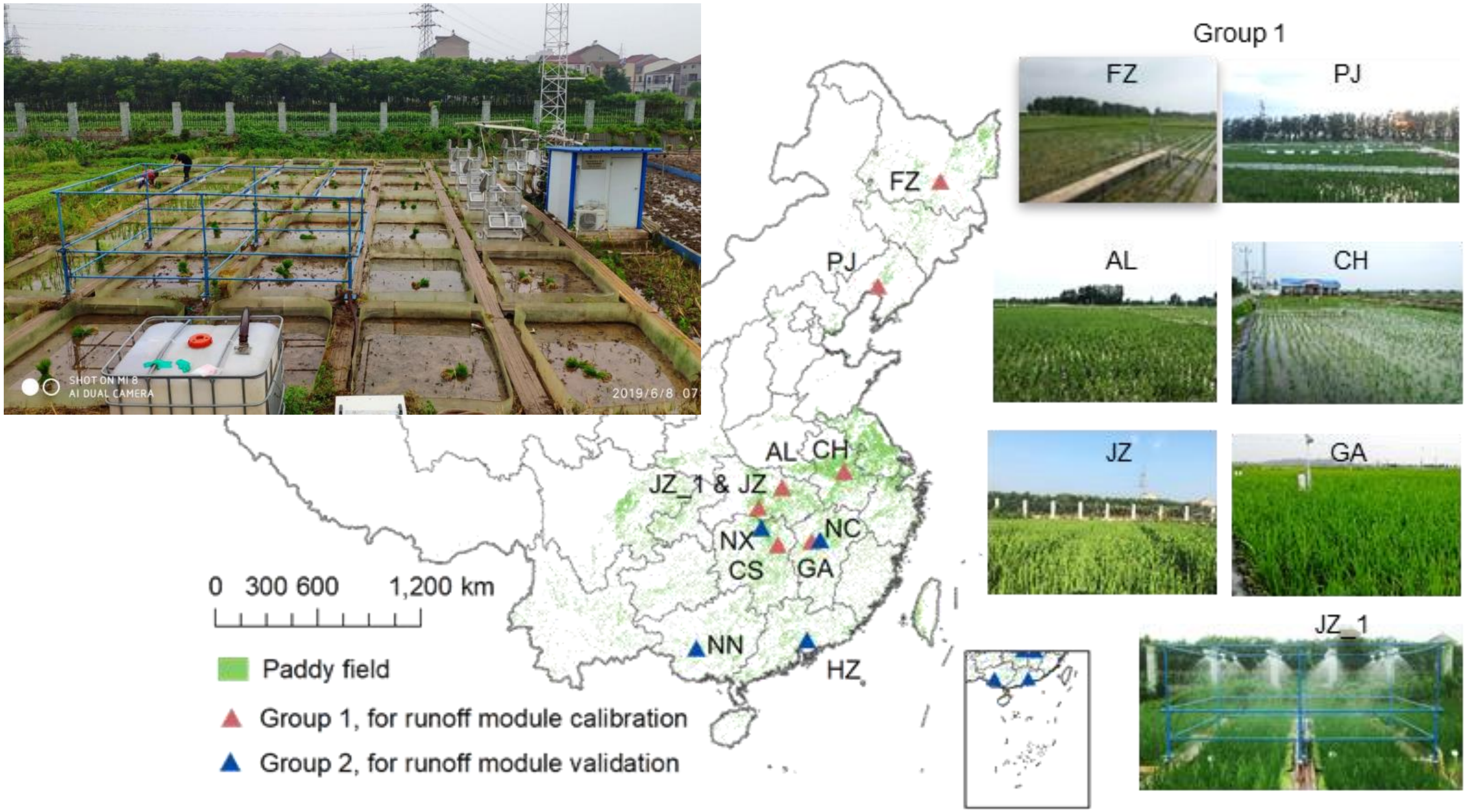
Boundary conditions:

$$D\frac{\partial C_{01}}{\partial z} = 0 \quad (z = 0, t \ge 0); \quad C_1 = C_{11}(t)\ (z \to \infty, t \ge 0)$$

$$\left(1 + \frac{\rho}{\theta}K_d\right)\frac{\partial C_2}{\partial t} = \mathrm{D}\frac{\partial^2 C_2}{\partial z^2} - v\frac{\partial C_2}{\partial z} + K_{min} - K_n C_2$$

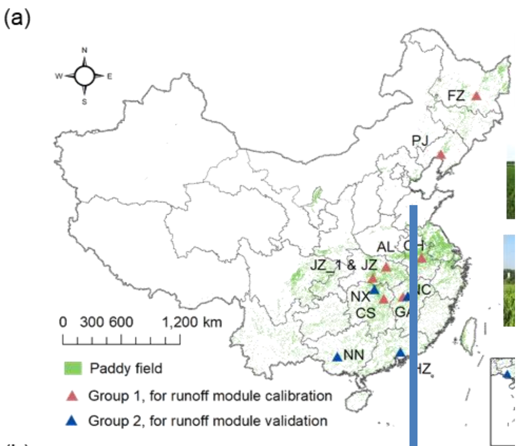
$$D\frac{\partial C_{02}}{\partial z} = 0 \quad (z = 0, t \ge 0); \quad C_2 = C_{12}(t)\ \ (z \to \infty, t \ge 0)$$

Field experiments (11 sites) for model validation

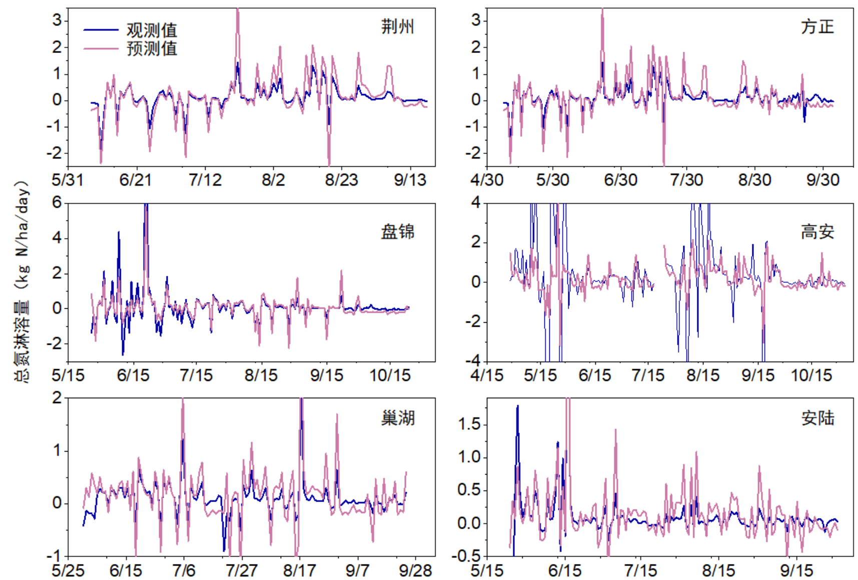


- running from May 2017 to Sept. 2019
- Indicators: climate, soil, crop growth, all budget fluxes of water and nitrogen (including N leaching)
- Resolution: daily

Calibration of N leaching across China



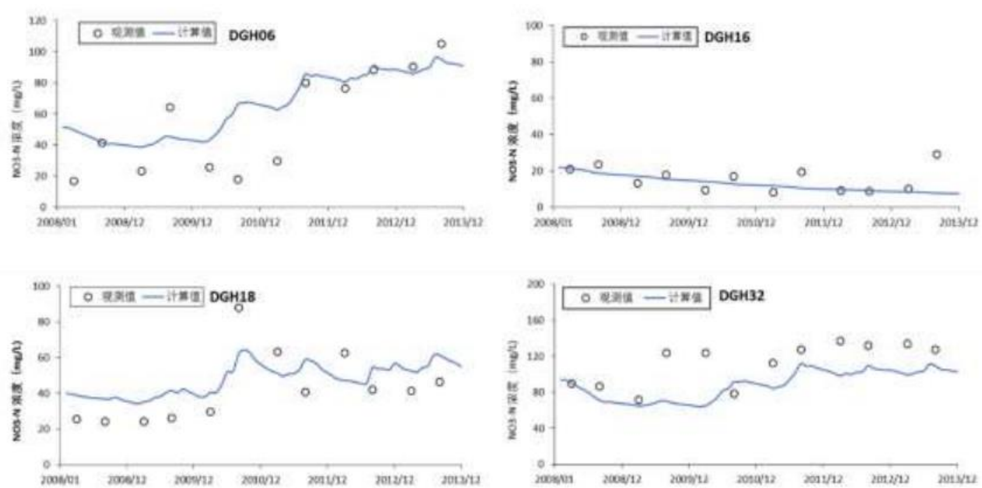
Daily N leaching flux



Observed

Simulated

Groundwater N dynamics



WP4 Task 2 – Modeling

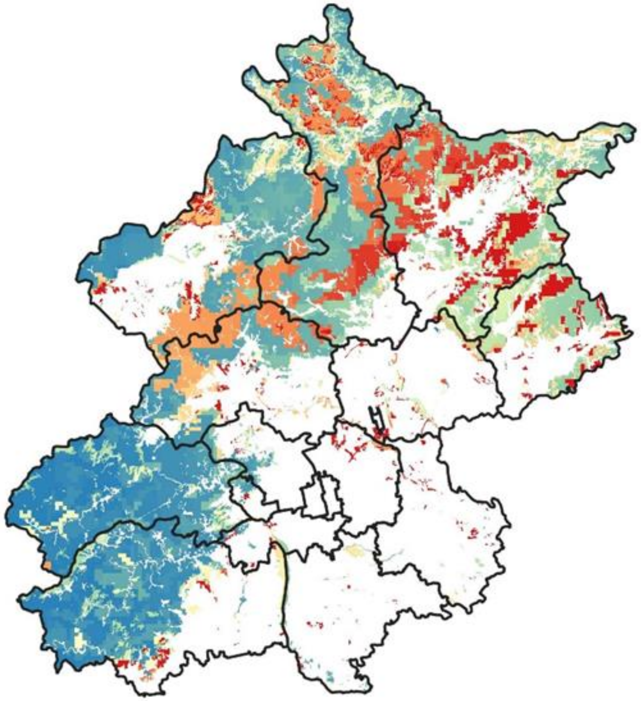
Main input data

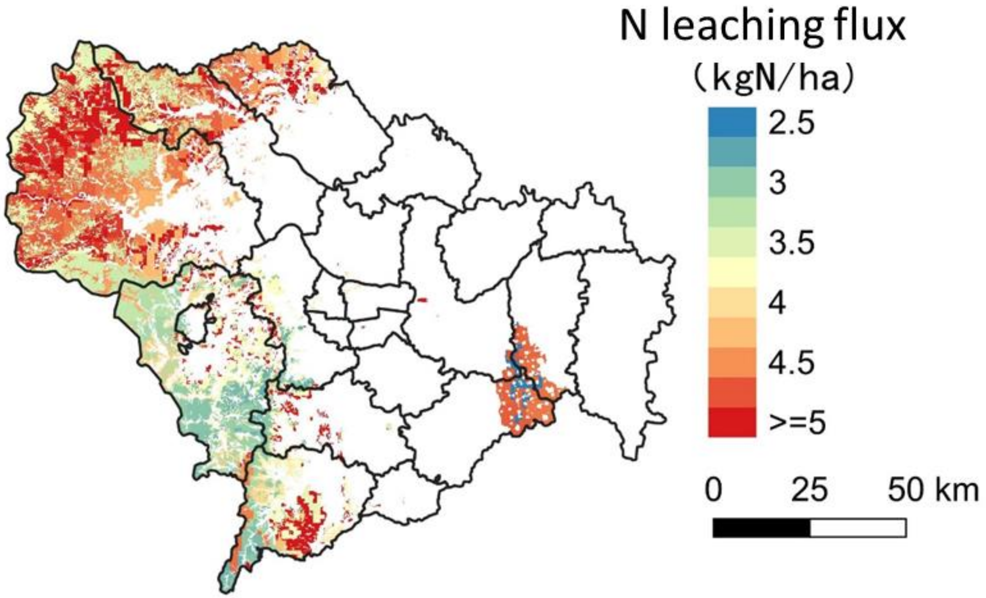
Name	Unit	Spatial resolution	Data source	Reference
Bulk density	g/dm3	1km×1km	HWSD_V1.2	Wieder, W.R., J. Boehnert, G.B. Bonan, and M. Langseth. 2014. Regridded Harmonized World Soil Database v1.2.
Clay content	%			
Total nitrogen in soil	%	0.083° ×0.083°	The Soil Database of China for Land Surface Modeling	Shangguan, W., Y. Dai, B. Liu, A. , et al (2013), A China Dataset of Soil Properties for Land Surface Modeling, Journal of Advances in Modeling Earth Systems, 5: 212-224.
Climatic variables	mm	0.1°×0.1°	China meteorological forcing dataset (1979-2018)	Yang, K., He, J. (2019). China meteorological forcing dataset (1979-2018). National Tibetan Plateau Data Center, DOI: 10.11888/AtmosphericPhysics.tpe.249369.file.
Rooting depth	m	-	FAO	www.fao.org/home/en/
Landuse	-	30m×30m	Geographic Data Sharing Infrastructure, College of Urban and Environmental Science, Peking University	http://geodata.pku.edu.cn
N application rate over urban grassland and forest	Kg N ha^{-1}	1km×1km	This study	
Groundwater levels and N concentrations	m	point		

WP4 Task 2 – Modeling

N leaching flux over forest and grassland in Beijing

N leaching flux over forest and grassland in Shijiazhuang





Mean: 3.4 kgN/ha

Mean: 4.4 kgN/ha

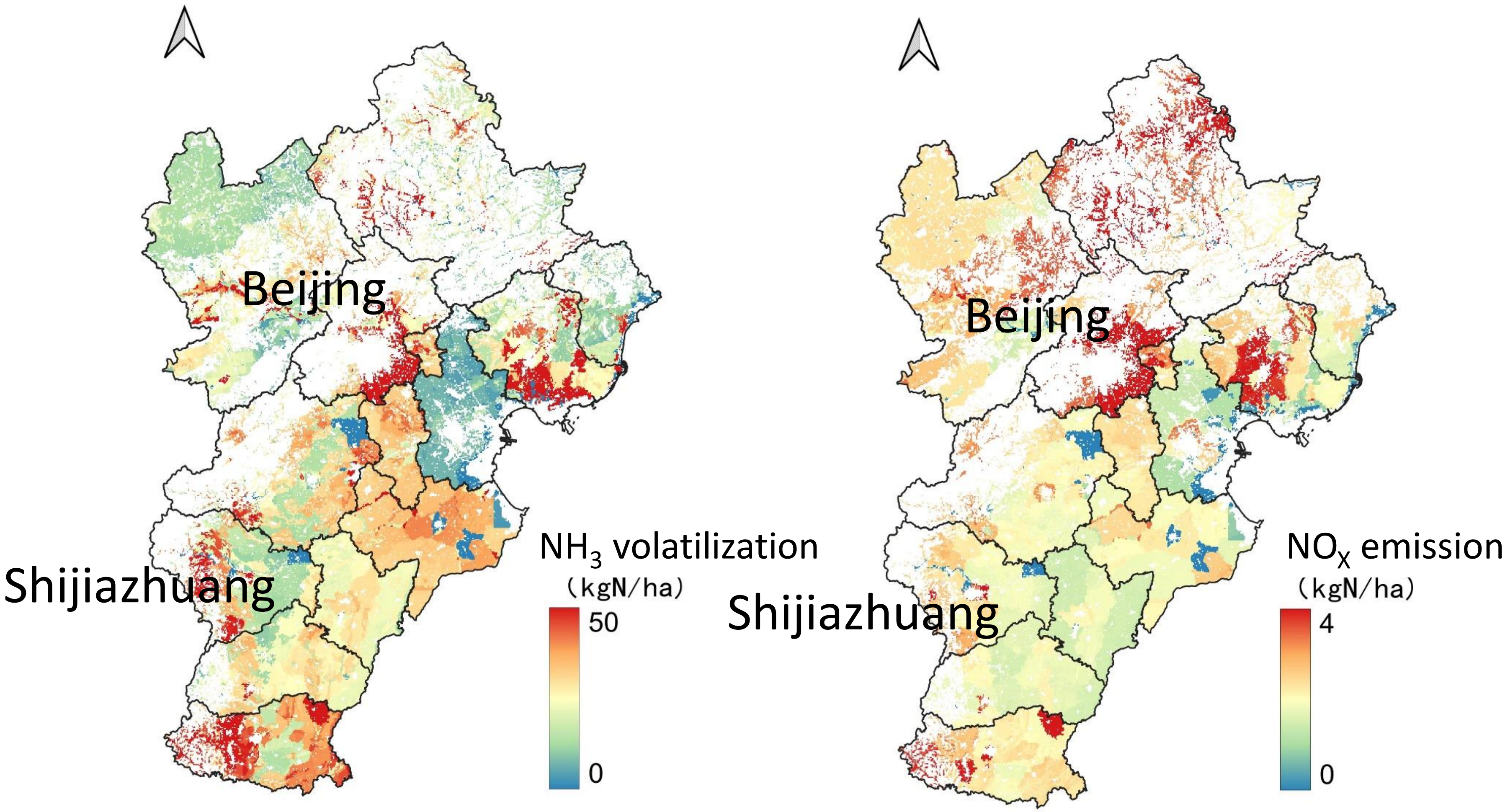
Threshold of N leaching: 22.6 kgN/ha (De Vries et al., 2013)

WP4 Task 2 – Modeling

Beijing				Shijiazhuang			
County	N leaching(ton)	Ratio（%）	Flux(kg/ha)	County	N leaching(ton)	Ratio（%）	Flux(kg/ha)
东、西城区	0.0	0.0%	0.0	长安区	1.0	7.8%	3.9
朝阳区	15.2	11.8%	5.9	桥西区	0.1	7.1%	3.5
海淀区	22.3	6.1%	3.0	新华区	1.0	7.2%	3.6
丰台区	10.7	7.7%	3.9	裕华区	0.5	8.8%	4.4
石景山区	8.2	6.4%	3.2	藁城区	8.5	8.1%	4.0
门头沟区	326.3	5.4%	2.7	鹿泉区	40.6	7.5%	3.7
房山区	322.9	5.7%	2.8	栾城区	0.0	0.0%	0.0
通州区	17.1	11.8%	5.9	井陉县	288.9	7.1%	3.6
顺义区	44.2	9.5%	4.7	正定县	0.6	8.9%	4.4
昌平区	235.3	7.1%	3.6	行唐县	129.6	10.1%	5.0
大兴区	17.9	7.6%	3.8	灵寿县	206.2	9.2%	4.6
怀柔区	585.0	7.2%	3.6	高邑县	1.2	8.8%	4.4
平谷区	182.4	7.7%	3.9	赞皇县	167.3	8.0%	4.0
密云区	574.2	8.2%	4.1	平山县	846.8	9.5%	4.7
延庆区	426.4	6.7%	3.3	元氏县	42.6	8.0%	4.0
合计	2788.0	6.9%	3.4	赵县	56.5	8.7%	4.3
				晋州市	35.6	8.8%	4.4
				新乐市	0.0	6.7%	3.3
				合计	1827.1	8.7%	4.4

WP4 Task 2 – Modeling

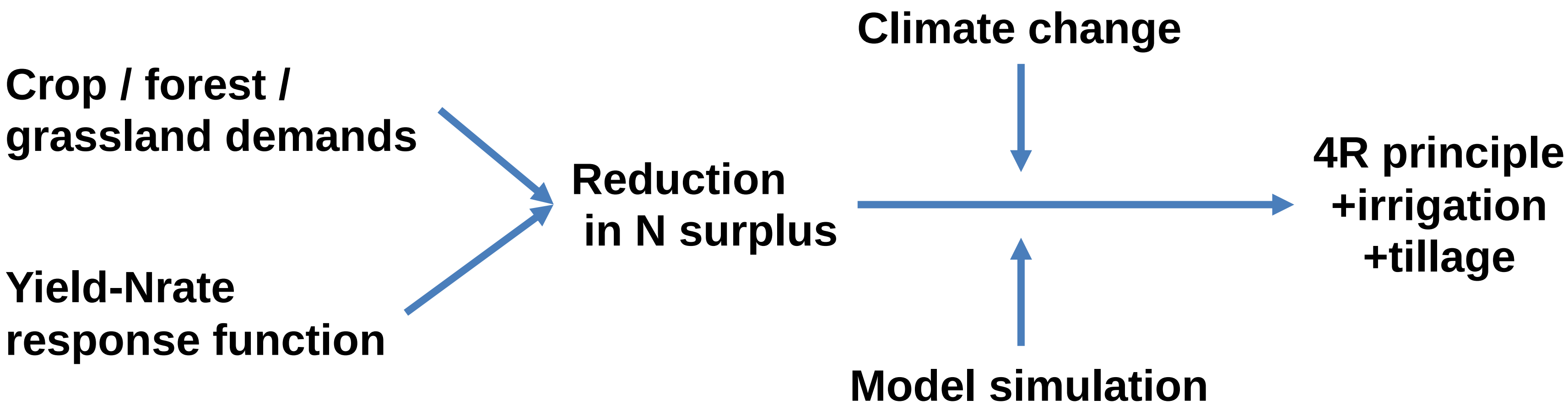
NH_3 volatilization | NO_X emission



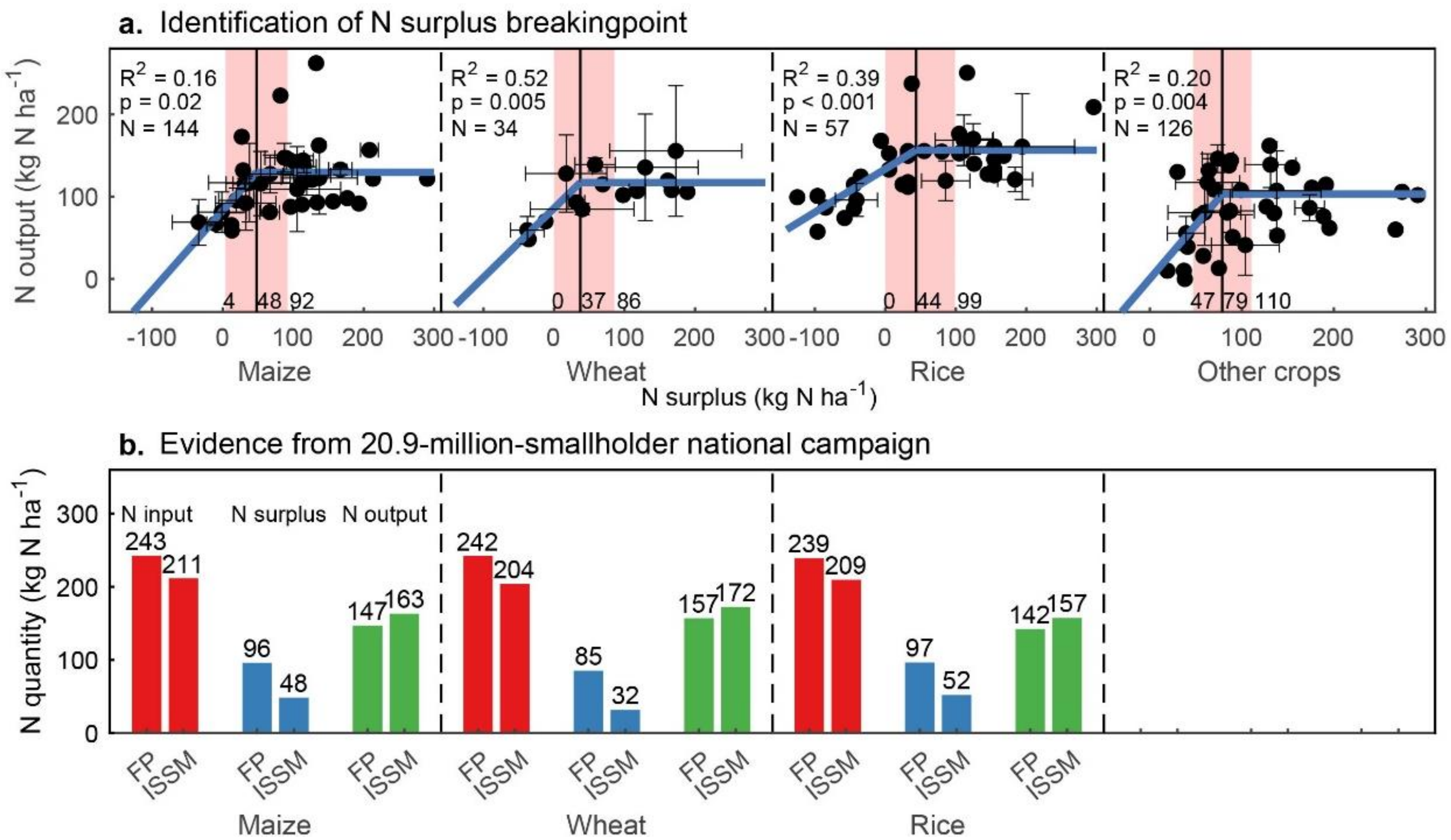
Data for Lin's Nature Communications paper

WP4 Task 3 – Optimization

D4/3: Optimization of urban agriculture management to mitigate groundwater N pollution under different climate changes (PKU) **(Month 30)**

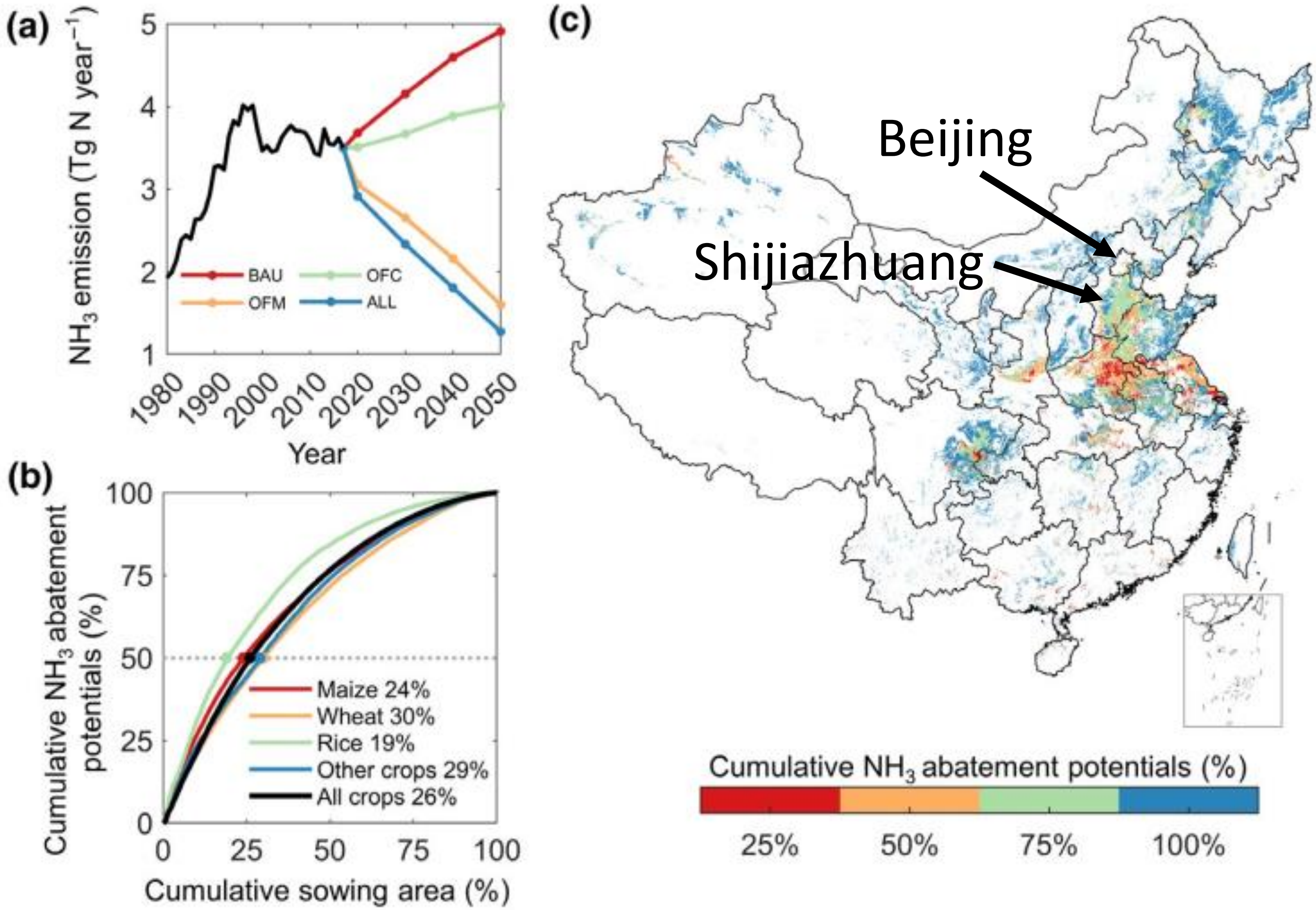


WP4 Task 3 – Optimization



Evidence for the consequences of N rate reduction on crop yield

WP4 Task 3 – Optimization



Future works 2021-2022

N leaching modeling and optimization of urban agri. management:

Mitigation assessments for soil N leaching

Region: Vienna, Zielona Gora.

Report preparation

Thanks, any question?

Feng Zhou
zhouf@pku.edu.cn
北京大學
PEKING UNIVERSITY

Urban nitrogen cycles: new economy thinking to master the challenges of climate change

Work Package 5: Urban Agricultural

Xiangwen Fan，Zhaohai Bai, Lin Ma

Center for Agricultural Resources Research, IGDB, CAS

2021-09-16

Content

- Research aims
- Overall progress
- Future plan

Objectives: Urban Agricultural

- Agriculture plays an important role in the urban N flow (Ma et al., 2014).
- The diverse flows of N will be investigated and guidance to assess them will be provided.
- In particular, the specific urban challenges will be treated: specific urban crops, urban livestock systems, and the prevalence of import and export of food and feed as a central element of urban metabolism.

Work package number	5	**Start date or starting event:**				Month 7	
Work package title	Urban agriculture						
Project partner number	3	2					
Project partner short name	CAS	UZG					
Person-months per applicant:	16	36					

Main task: Urban Agricultural

Task 1: Quantifying changes of N flow and losses from complicated urban livestock production chain (CAS): estimation the location and scale of different livestock production systems in the urban area, estimation of diet protein level and manure management situations in urban area especially focus on the manure treatment and application, estimation of livestock production systems changes and influences by policies;

Task 2: Understanding of N flow of external imported food or feed in the urban (CAS): quantifying the food and feed imported by cities, and estimation of N flow of external imported agricultural products

Task 3: Evaluating urban agricultural N flow N-circulation in a city and relationships with sustainable development goals (CAS, UZG): evaluate the coupling rate of crop and livestock production, estimation of agricultural N flow though the cities, and link the urban agricultural N flow with urban sustainable development goals.

Overall progress

Task	Status
1.Draft concept of urban agricultural nitrogen flows	**Completed；**
2.Clear concept of urban agricultural flows	**Completed ；**
3. .N flow characteristic in urban agriculture	**Completed；**
4. N flow characteristic in industry pool	**Completed；**
5. Comparison between the different test areas/city	**In progress；**
6.Evaluating urban agricultural N flow N –circulation in a city and relationships with sustainable development goals	**Find some sustainable goals related to N flow from SDG report (coupling rate of crop and livestock)；**

Achievement

UNCNET

Urban Europe and NSFC

URBAN EUROPE

Europe – China joint call on Sustainable Urbanisation in the Context of
Economic Transformation and Climate Change:
Sustainable and Liveable Cities and Urban Areas

Funded by
NCN (Poland), project UMO-2018/29 / Z / ST10 / 02986
NSFC (China), project 71961137011
FFG (Austria), project 870234

UNCNET

Urban nitrogen cycles:
new economy thinking to master the challenges of climate change

D5/1: Draft concept of urban agricultural nitrogen flows

Due date of deliverable: **31/01/2020** Actual submission date: **25/02/2020**

Start Date of Project: **01/04/2019** Duration: **35 months**

Organisation name responsible for this deliverable: **CAS**

Authors: Zhaohai Bai, Haodan Wang, Katrin Kaltenegger, Wilfried Winiwarter

Dissemination Level		
PU	Public	☒
PP	Restricted to other programme participants (including funding agencies)	☐
RE	Restricted to a group specified by the consortium (including funding agencies)	☐
CO	Confidential, only for members of the consortium (including funding agencies)	☐

UNCNET

Urban Europe and NSFC

URBAN EUROPE

Europe – China joint call on Sustainable Urbanisation in the Context of
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NSFC (China), project 71961137011
FFG (Austria), project 870234

UNCNET

Urban nitrogen cycles:
new economy thinking to master the challenges of climate change

D5/2: Clear concept of urban agricultural flows

Due date of deliverable: **30/11/2020** Actual submission date: **01/06/2021**

Start Date of Project: **01/04/2019** Duration: **35 months**

Organisation name of co-chairs for this deliverable: **CAS, UZG**

Authors: Zhaohai Bai, Xiangwen Fan, Katrin Kaltenegger, Wilfried Winiwarter

Dissemination Level		
PU	Public	☒
PP	Restricted to other programme participants (including funding agencies)	☐
RE	Restricted to a group specified by the consortium (including funding agencies)	☐
CO	Confidential, only for members of the consortium (including funding agencies)	☐

Deliverables

Future plan

	Sep. 2021				Oct. 2021				Nov.2021				Dec. 2021			
Calculation of N flow in combustion section			√	√												
Calculation of N flow in waste water section			√	√												
Comparison with other cities					√	√	√	√	√	√						
Link urban N flow with SDG											√	√	√	√	√	√

Thank you!

WP 8 – Urban Stakeholders

Meeting 17. 09. 2021
Minutes

Funded under the JPI Urban Europe / China pilot call

AGENDA

- Aims and status quo of WP8
- Approach in Austria
- Distribution of tasks
- Miro – interactive Session

WP8 Objectives

- information of stakeholders about the project
- feedback, involvement, interaction (affected parties, potential users etc.)
- discussion on project results
- development of practicable approaches and solutions to implement Urban Nitrogen Budgets in practice

Objectives

Select and approach candidates representing city authorities, city planners, NGO’s and the civil society, industry, educational institutions

Edit the scientific approaches and results developed in UNCNET for use with a lay audience (coordinate with WP9)

Allow stakeholders to “buy in” the project value. What are nitrogen budgets good for? Addressing the attention and the interest of stakeholder is key for this process

Think of strategies towards solution-based decision making, further projects and cooperations

WP8 Deliverables

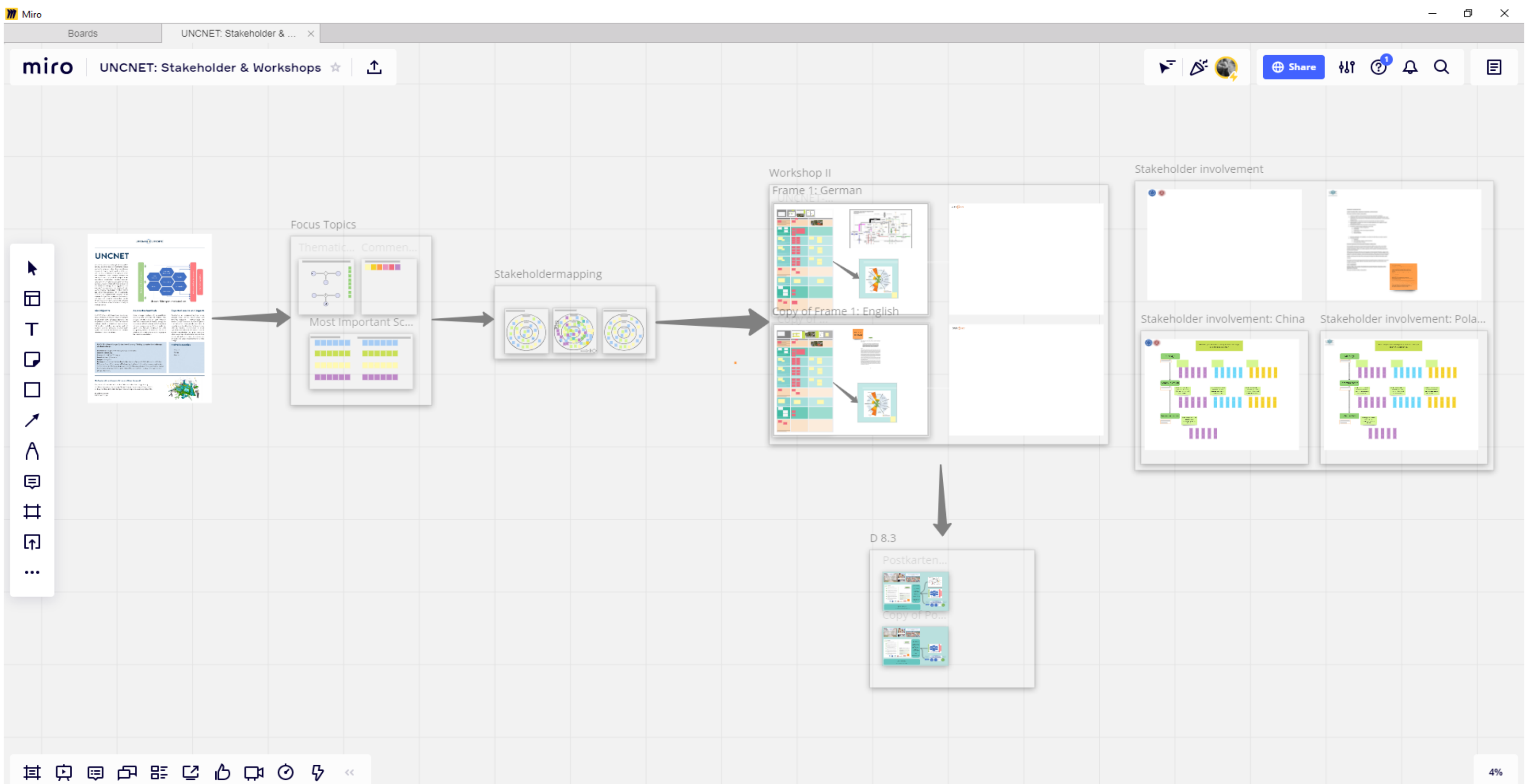
- D8/1: Reports from stakeholder workshops (Month 16 & 28)
- D8/2: Final workshop recommendations & report (Month 40)
- D8/3: N budgets for urban planning (Month 40)
- D8/4: Report on practitioner interaction (Month 40)
- D8/5: Report (meeting transcript) of experience obtained from the respective approaches (month 40)
- NEW D8/2/4/5: Combine to one single report with different chapters.

Status quo WP8 (September 2021)

- Two workshops
  - First one: November 13, 2020 in Klagenfurt (Pilot WS, online) and November 17, 2020 in Vienna (online)
  - Second one: October 12 (Klagenfurt) and [14 (Vienna)]
- 12 – 20 people (round tables, stations)
- Duration: 3h

Miro

https://miro.com/app/board/o9J_lIwPC6k=/



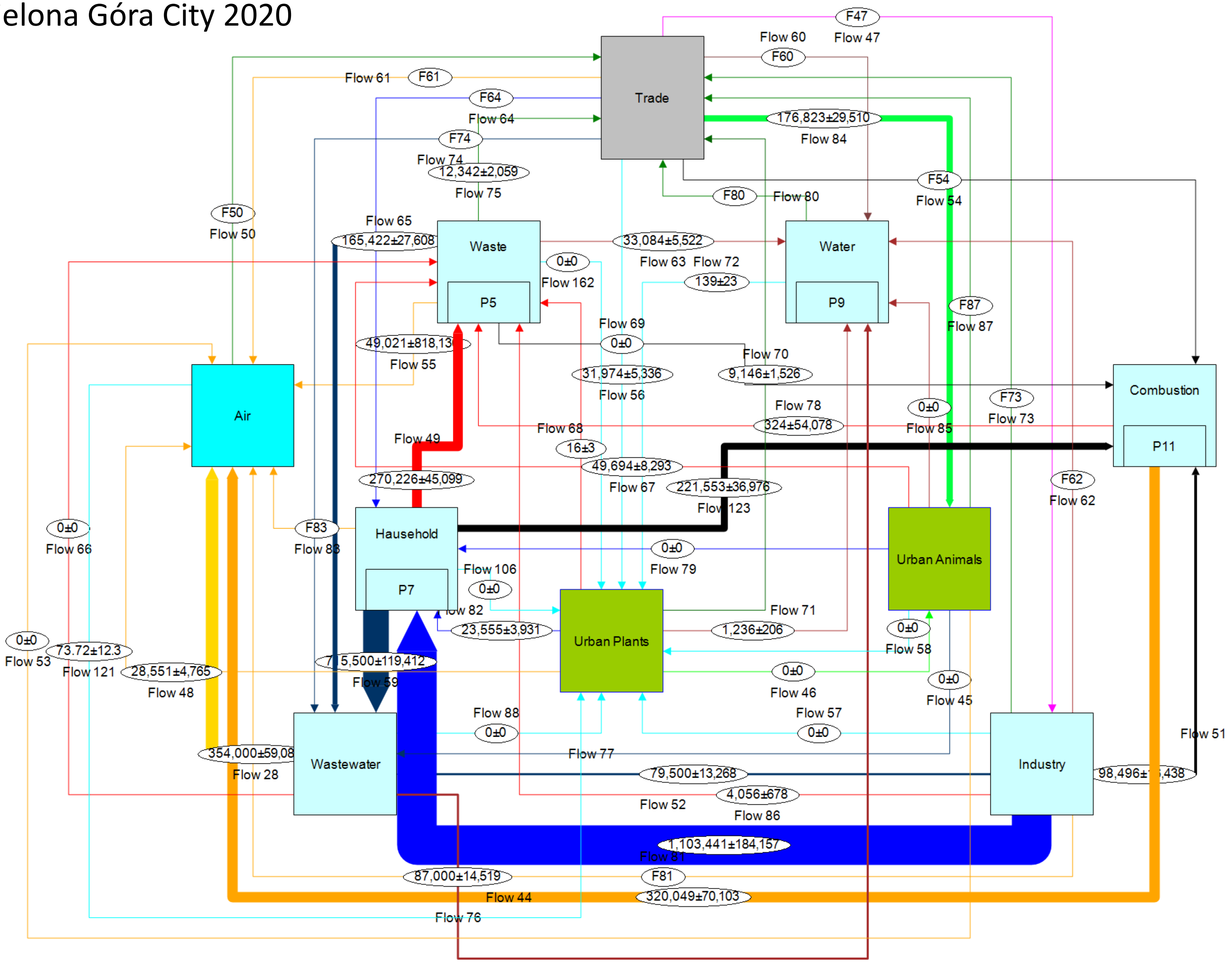
brainbows informationsmanagement gmbh
Köllnerhofgasse 6/3/10
1010 Wien
tel: +43 1 796 54 44 – 00
fax: +43 1 796 54 44 – 85
www.brainbows.com

E.C.O. Institut für Ökologie
Lakeside B07 b
9020 Klagenfurt
+43 463 504 144
www.e-c-o.at

Project meeting 16-09-2021

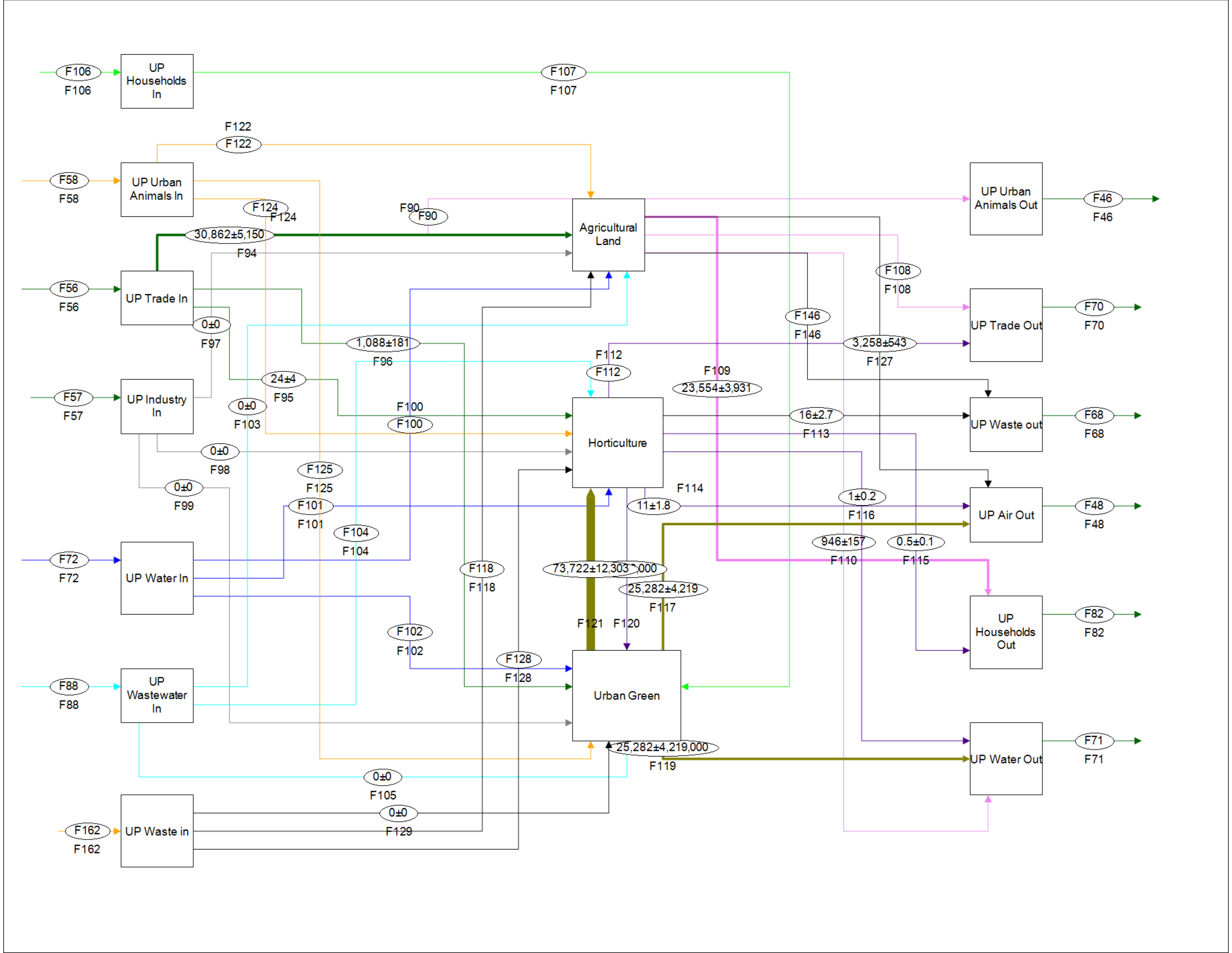
Urban Nitrogen Cycles: New Economic Thinking to master the challenges of climate change

Zielona Góra City 2020

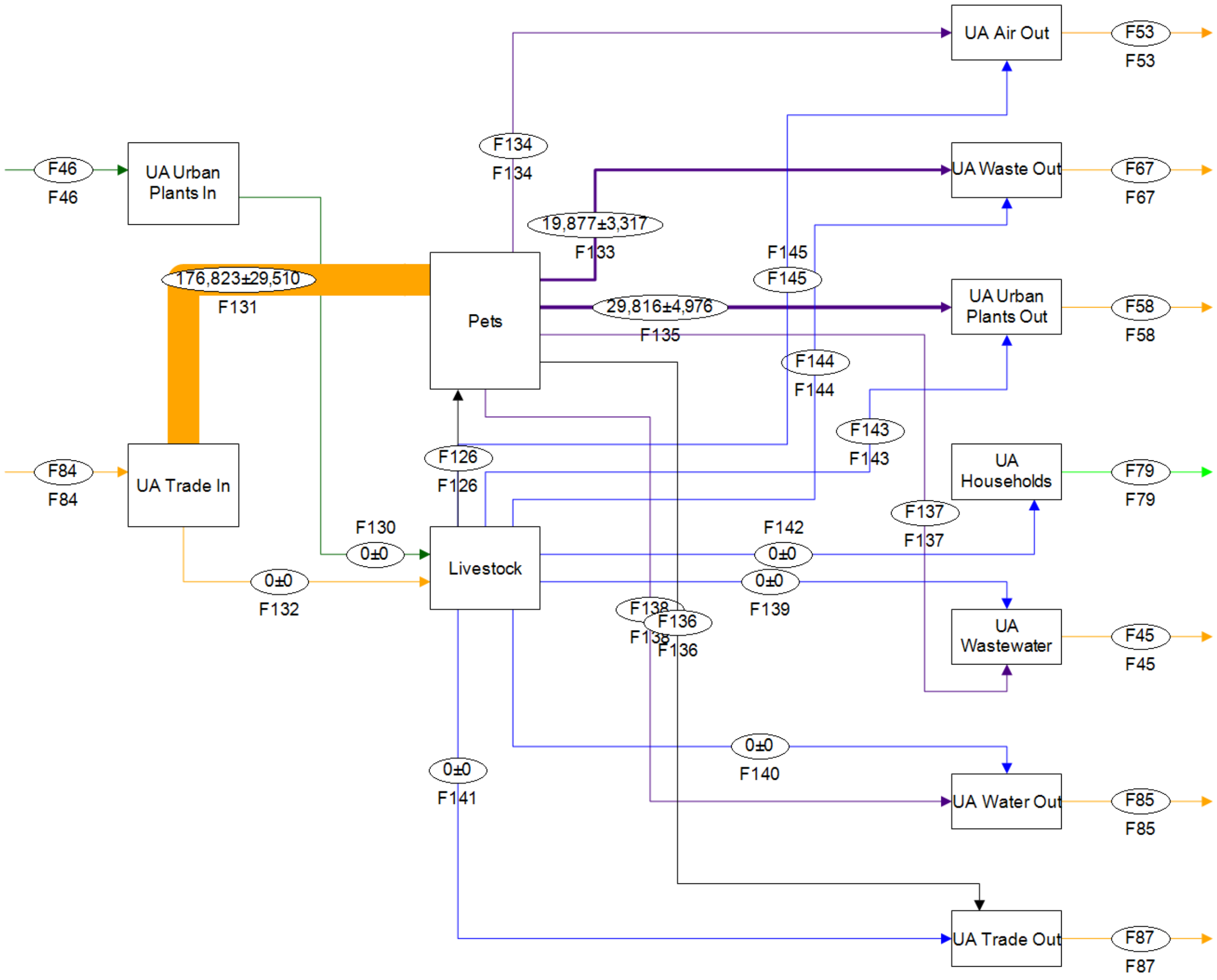


	A	B	C	D	E	F	G	H	I	J	K
73	2015	N,Nitrogen	F115	Flow 115		0,5			5	Amount of N from horticulture to households	products to eat
74	2015	N,Nitrogen	F116	Flow 116		1			82	Amount of N from horticulture to water	
75	2015	N,Nitrogen	F117	Flow 117		25282			104850	Amount of N from urban green to air	including forest
76	2015	N,Nitrogen	F118	Flow 118	0		0			Amount of N from waste to agricultural land	manure or compost - manure is not a
77	2015	N,Nitrogen	F119	Flow 119		289			445	Amount of N from urban green to water	
78	2015	N,Nitrogen	F120	Flow 120		159			150	Amount of N from horticulture to urban green	
79	2015	N,Nitrogen	F121	Flow 121	73722	0	309237		0	Amount of N from air to urban plants (sum of F147 and F148)	
80	2015	N,Nitrogen	F122	Flow 122	0		0			Amount of N from urban animals to agricultural lanc	not possible to estimate
81	2015	N,Nitrogen	F123	Flow 123						Amount of N from household to combustion	
82	2015	N,Nitrogen	F124	Flow 124	0		0			Amount of N from urban animals to horticulture	not possible to estimate
83	2015	N,Nitrogen	F125	Flow 125	0		0			Amount of N from urban animals to urban green	not possible to estimate
84	2015	N,Nitrogen	F126	Flow 126		0			0	Amount of N from livestock to pets	not possible to estimate
85	2015	N,Nitrogen	F127	Flow 127		3258			35076	Amount of N from agricultural land to air	from soil and manure (excretion outdo
86	2015	N,Nitrogen	F128	Flow 128	0		0			Amount of N from waste to horticulture	not presented in ZG
87	2015	N,Nitrogen	F129	Flow 129	0		0			Amount of N from waste to urban greens	not presented in ZG
88	2015	N,Nitrogen	F130	Flow 130	0		0			Amount of N from urban plants to livestock	not presented in ZG
89	2015	N,Nitrogen	F131	Flow 131	176823		44922			Amount of N from trade/industry to pets	pet food
90	2015	N,Nitrogen	F132	Flow 132	0		244045			Amount of N from trade/industry to livestock	fodder
91	2015	N,Nitrogen	F133	Flow 133		49694			11822	Amount of N from pets to waste	
92	2015	N,Nitrogen	F134	Flow 134						Amount of N from pets to air	not possible to estimate
93	2015	N,Nitrogen	F135	Flow 135		49694			11822	Amount of N from pets to urban plants	the proposed division between the city
94	2015	N,Nitrogen	F136	Flow 136		0			0	Amount of N from pets to trade	not possible to estimate
95	2015	N,Nitrogen	F137	Flow 137		0			0	Amount of N from pets to wastewater	not possible to estimate
96	2015	N,Nitrogen	F138	Flow 138		0			0	Amount of N from pets to water	not possible to estimate
97	2015	N,Nitrogen	F139	Flow 139		0			0	Amount of N from livestock to wastewater	not presented in ZG
98	2015	N,Nitrogen	F140	Flow 140		0			0	Amount of N from livestock to water	not possible to estimate
99	2015	N,Nitrogen	F141	Flow 141		0			120341	Amount of N from livestock to trade	products for trade
100	2015	N,Nitrogen	F142	Flow 142		0			43609	Amount of N from livestock to households	products for self-use
101	2015	N,Nitrogen	F143	Flow 143		0			231839	Amount of N from livestock to urban plants	direct relation not presented in ZGC
102	2015	N,Nitrogen	F144	Flow 144		0			0	Amount of N from livestock to waste	
103	2015	N,Nitrogen	F145	Flow 145		0			26904	Amount of N from livestock to air	exhaust and wastes indoors
104	2015	N,Nitrogen	F147	Flow147	43952		201715			Amount of N from air to urban greens	contamination

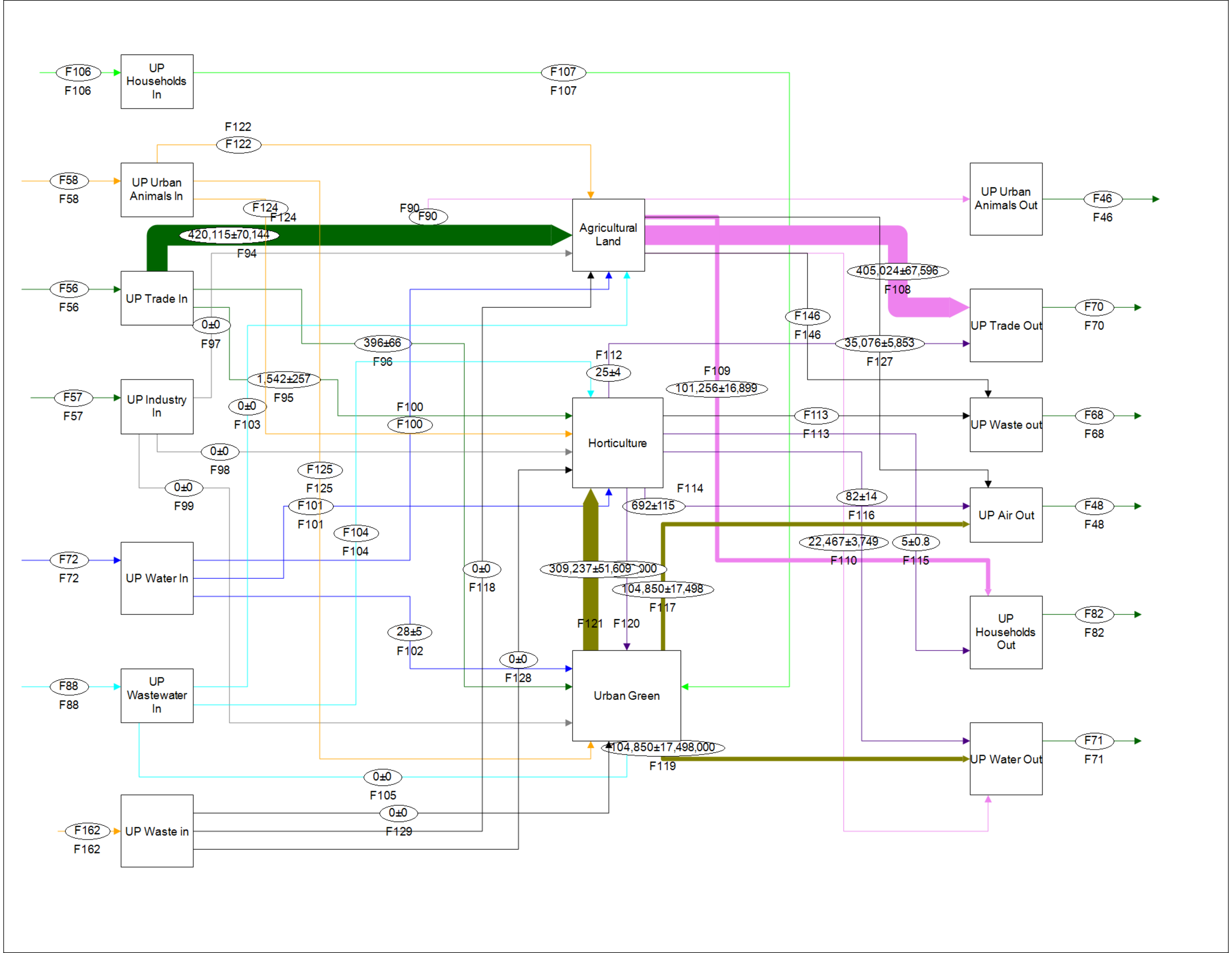
Zielona Góra City 2020
Urban plants



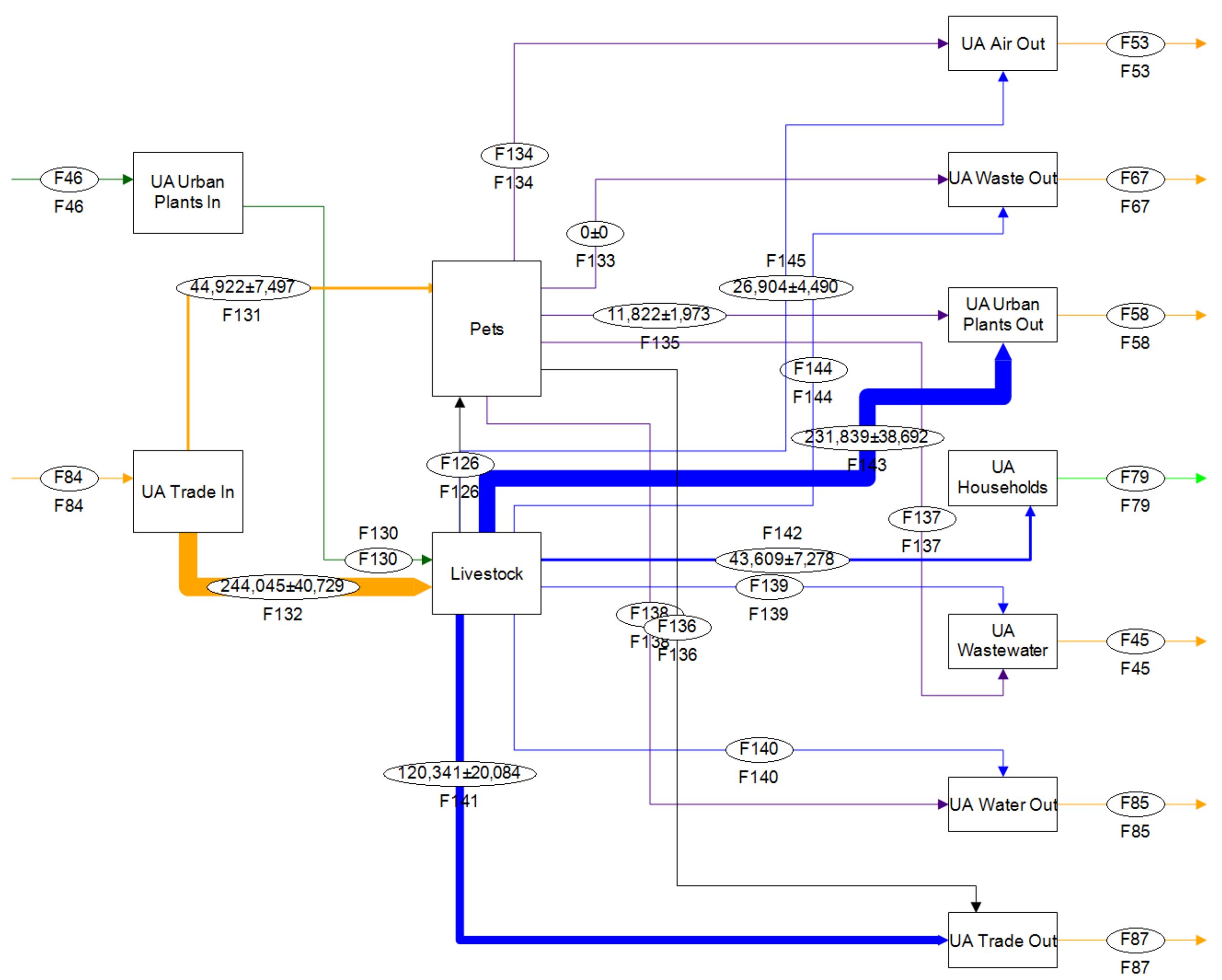
Zielona Góra City 2020
Urban animals



Zielona Góra New district
2020
Urban plants



Zielona Góra New District
2020
Urban animals



agronomy

Article

Nitrogen and Phosphorus Accumulation in Horizontal Subsurface Flow Constructed Wetland

Anita Jakubaszek

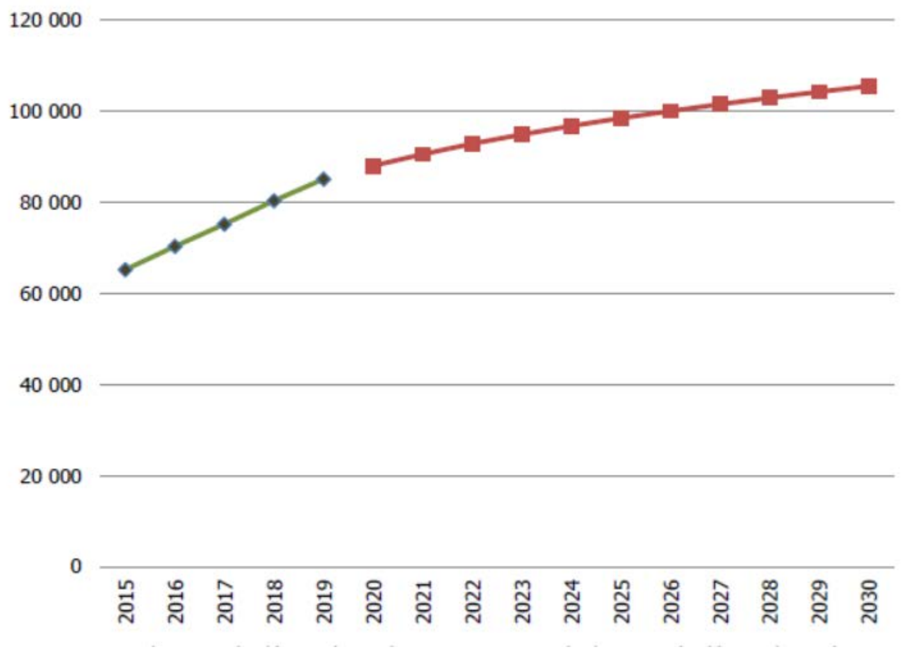
scientific reports

DOI : 10.1038/s41598-021-97536-5

Title : Influence of storms on the emission of pollutants from sewage into waters

Monika Suchowska-Kisielwicz, Ireneusz Nowogoński

D6/2	Uncertainty guidance document	6	30.09.2021 (30 month)



Forecast of the number of cars in Zielona Góra

Area	Population									
	1995	2000	2004	2005	2010	2014	2015	2020	2025	2030
Zielona Góra New District	13 167	14 728	15 834	16 128	18 434	19 592	19736	**20451**	21094	21610
Zielona Góra City	-	-	-	-	-	-	138711	**141388**	141756	141612

Status of N industrial pool in Shijiazhuang and Beijing

Xiangwen Fan, Zhaohai Bai, Lin Ma

Center for Agricultural Resources Research,
IGDB, CAS

Content

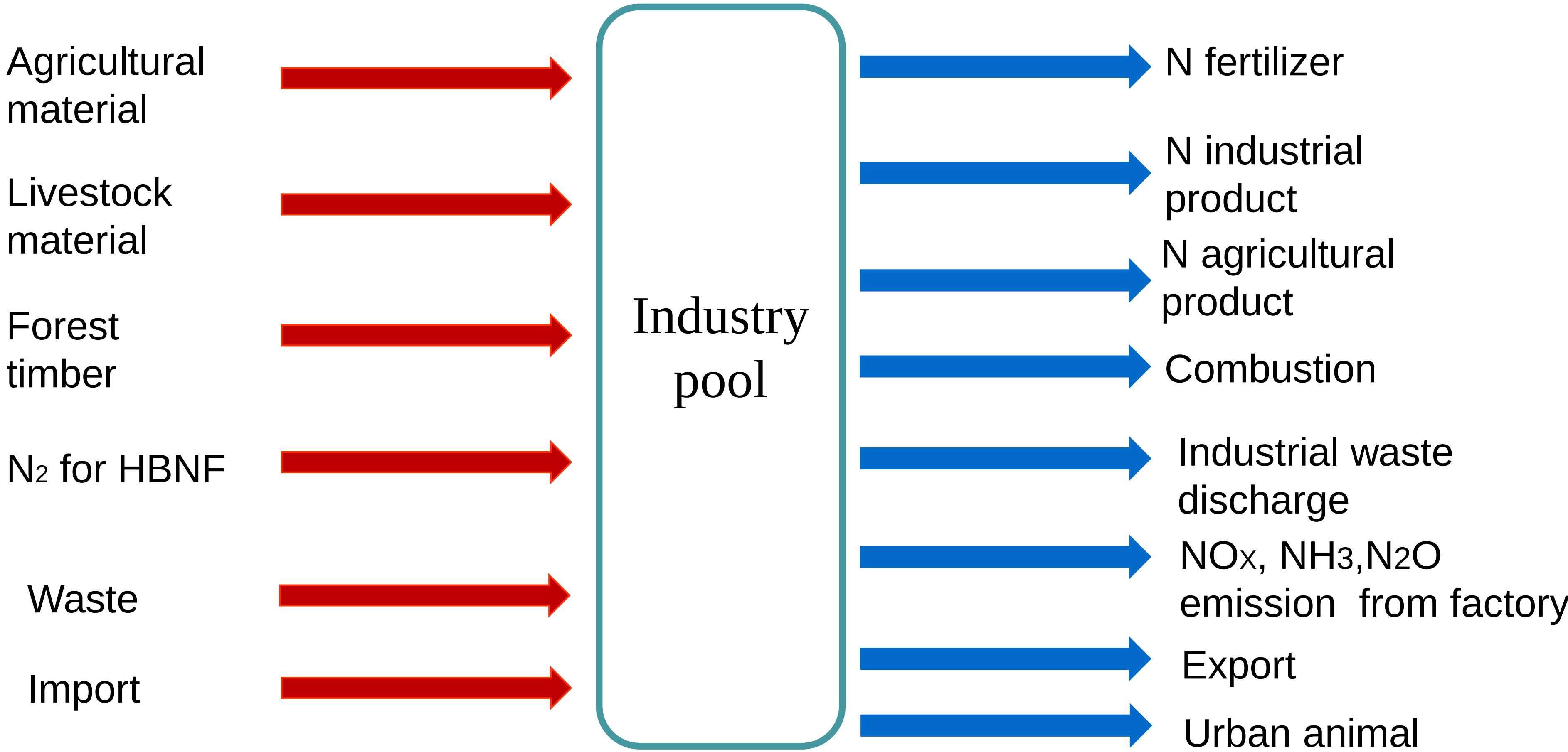
1. Industry pool progress

2. Total industrial N flux for Shijiazhuang and Beijing

3. Overall progress and Ongoing work

Work progress-Industry pool

Methodology-CHANS model



We extended CHANS model to include waste, import, urban animal, export and combustion.

Work progress-Industry pool

Calculation process-input

Agricultural material= straw(kg)* proportion of straw transfer to industrial material(%)

Livestock material= Livestock skin(or cotton)kg* N content(%)

Forest timber= commercial timber production(kg)* commercial timber density (kg/m^3)*wood N content(%)

HBNF=Haber-Bosch process for production of ammonia in factory

Waste= Amount of N from waste to factory (landfill)#

Import=raw material imported to factory(food, pet, fertilizer)#

Data source : statistical year book; country-specific data from Chinese national data center; China environmental status bulletin. # represent data collected from public website and interview

Work progress-Industry pool

Calculation process-output

N fertilizer = fertilizer produced in local factory#

N industry product= industry product* N containing industrial products(included leather, wool)

N agricultural product=agricultural product* N containing agricultural products (included cotton, hemp,beer)

Industrial wastewater discharge= nitrogen content after the removal of nitrogen through denitrification, N2O discharge, sewage reuse and other processes#

Nox,NH_3 and N_2O= industry production*emission factor during industrial production(electricity, construction refining)

Water recycle = amount water recycled from water treatment factory

Work progress-Industry pool

Calculation process-output

Urban animal= feed produced in local factory and direct N flow from agricultural land

waste= (N industrial product + agricultural product) * average waste rate

Household= (N industrial product agricultural product) * (1-waste rate)-urban animal

Export = amount of industrial product and agricultural product exported #

Combustion= Waste to combustion + domestic fossil fuel

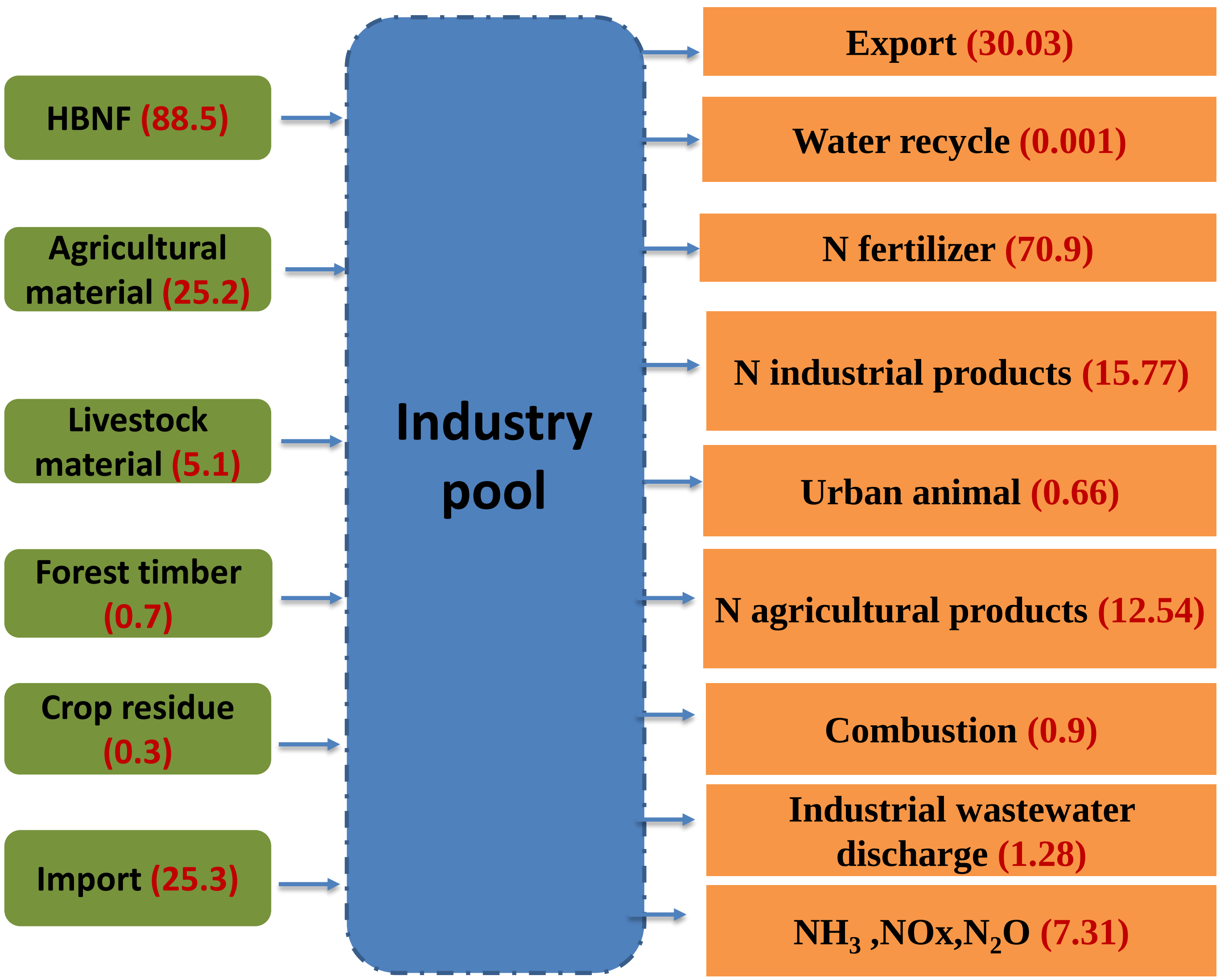
Work progress-Connected with Stan

N flow input in Stan	N flow input in extended CHANS
Waste	waste
Urban animal	Livestock material
Urban plant	Agricultural material + forest timber +crop residue + HBNF
trade	Import

Work progress-Connected with Stan

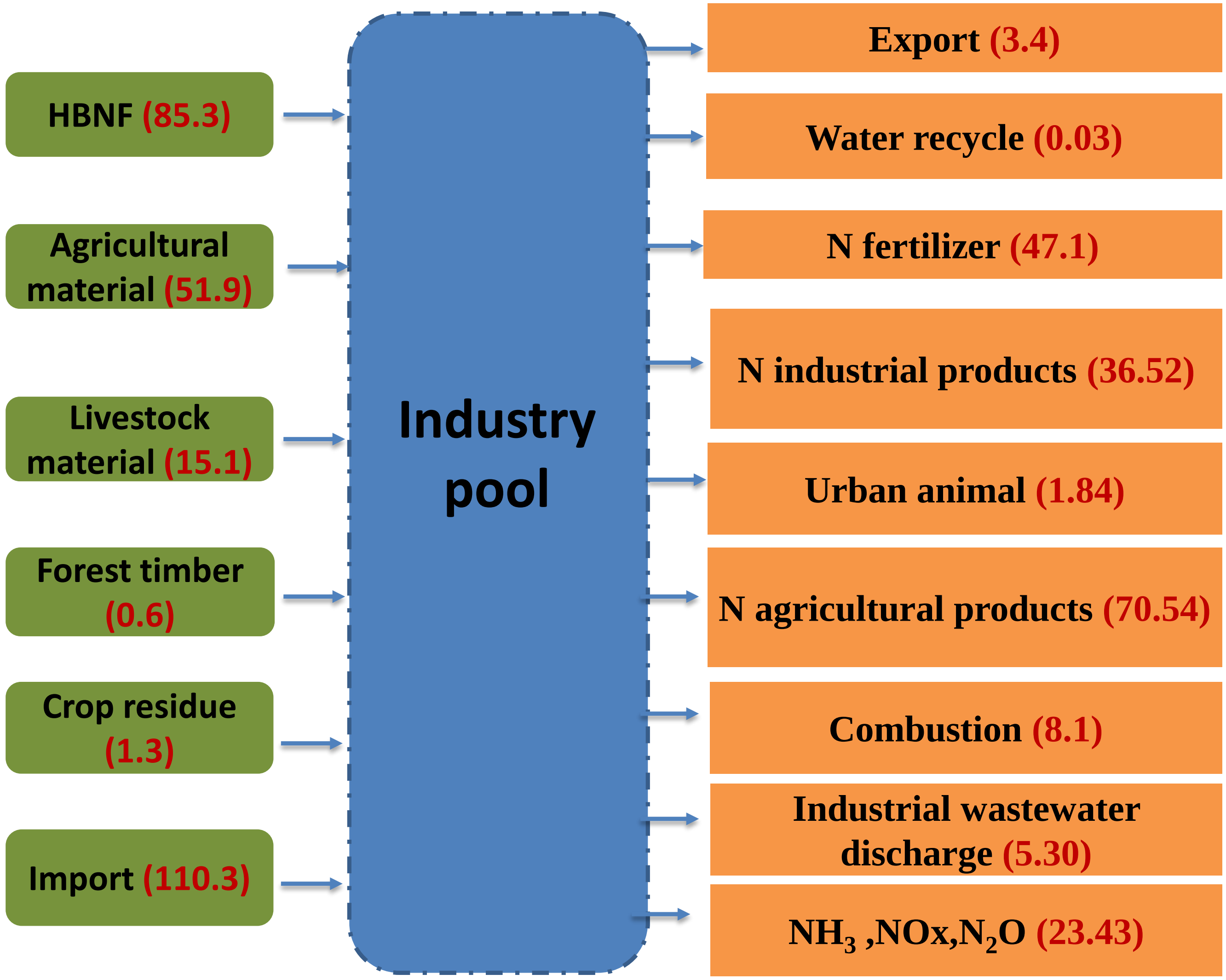
N flow output in Stan	N flow output in extended CHANS
Water	Water recycle
Urban plant	N fertilizer
Trade	export
Waste water	Industrial wastewater discharge
Waste	Waste
Household	Household
Urban animal	Urban animal
Air	NOx emission, NH_3(not included traffic source), N_2O emission
Combustion	Combustion

Work progress-Result-Shijiazhuang



N flows among industry pool in Shijiazhuang. Units are in Gg N

Work progress-Result-Beijing



N flows among industry pool in Beijing. Units are in Gg N year^{-1}

Work progress- Status of urban N budget

Sectors	**Status**
Agricultural land	**Completed**
Horticulture	**Completed**
Urban green	**Completed**
Livestock	**Completed**
Pets	**Completed**
Industry	**Completed**
Air	**Completed**
Water	**Completed**
Waste	**Completed**
Household	**In progress**
Wastewater	**In progress**

Ongoing work

1. STAN implementation (include uncertainty calculation);

2. Comparison with other cities (N flow per ha; N flow per person; total N flow in urban and peri-urban);

3. Evaluating urban agricultural N flow N-circulation in a city and relationships with sustainable development goal.

Thank you!

Scenarios

EAT-Lancet diet

- Diets as link between human health & environmental sustainability
  - Human diet needs + planetary boundaries
- 37 leading scientists from 16 countries
- Goal year: 2050

EAT Lancet diet

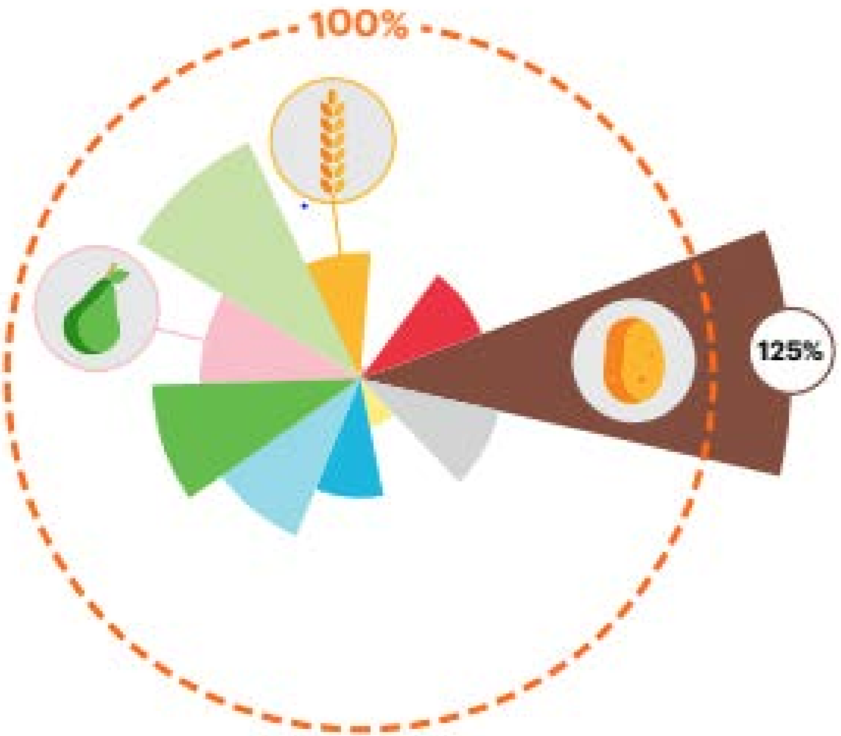
	Macronutrient intake grams per day (possible range)	Caloric intake kcal per day
Whole grains		
Rice, wheat, corn and other	232	811
Tubers or starchy vegetables		
Potatoes and cassava	50 (0–100)	39
Vegetables		
All vegetables	300 (200–600)	78
Fruits		
All fruits	200 (100–300)	126
Dairy foods		
Whole milk or equivalents	250 (0–500)	153
Protein sources		
Beef, lamb and pork	14 (0–28)	30
Chicken and other poultry	29 (0–58)	62
Eggs	13 (0–25)	19
Fish	28 (0–100)	40
Legumes	75 (0–100)	284
Nuts	50 (0–75)	291
Added fats		
Unsaturated oils	40 (20–80)	354
Saturated oils	11.8 (0-11.8)	96
Added sugars		
All sugars	31 (0–31)	120

EAT-Lancet Commission, Summary report

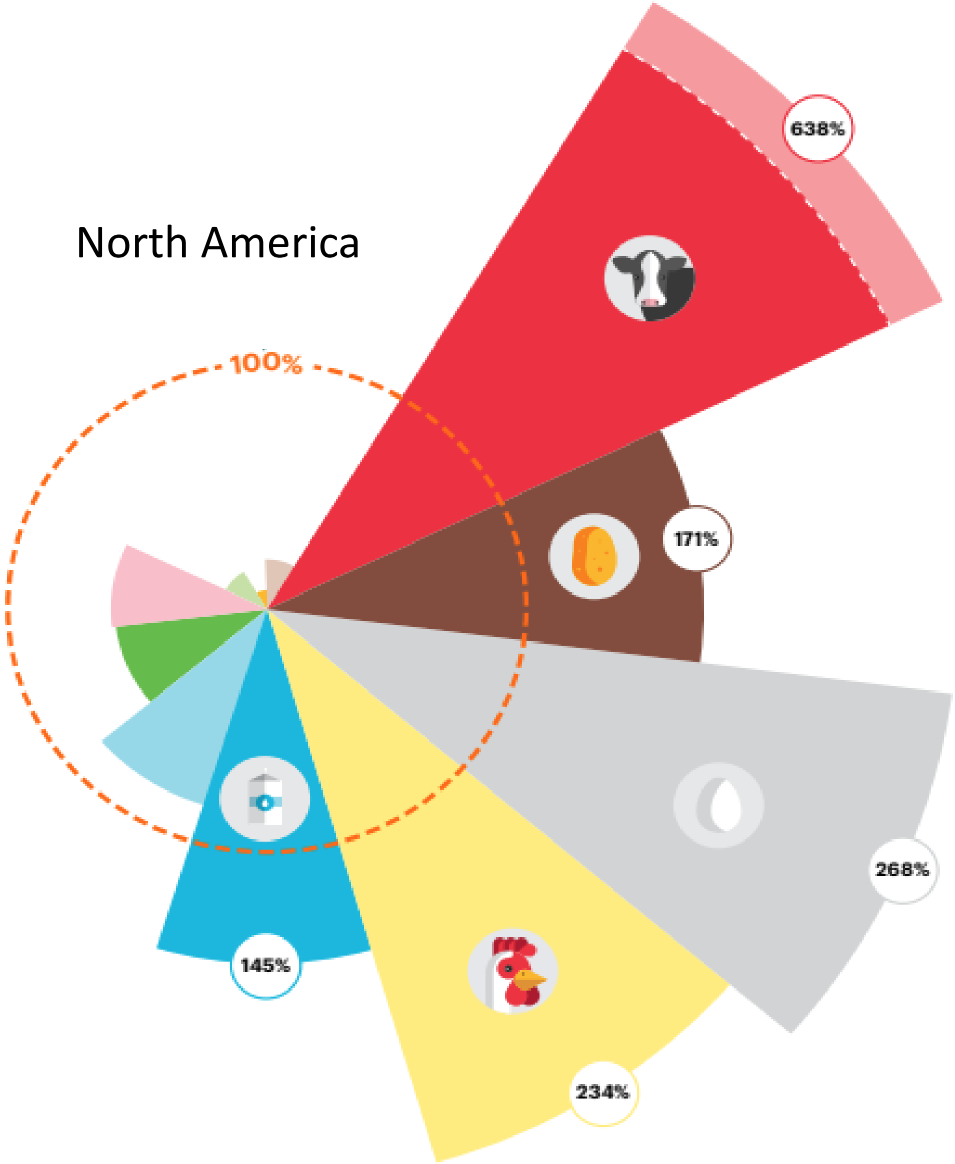
	EAT Lancet [g/day]			Austria 2015 [g/day]	Conversion Factor
	Minimum	*Average*	*Maximum*		
Beef, lamb, pork	0	14	28	142.03	0.10
Poultry	0	29	58	34.29	0.85
Eggs	0	13	25	39.71	0.33
Fish	0	28	100	21.76	1.29
Legumes	0	75	100	2.03	37.00
Nuts	0	50	75		
Rice, wheat, corn etc	0	232		257.06	0.90
Potatoes	0	50	100	133.40	0.37
Vegetables	200	300	600	305.88	0.98
Fruit	100	200	300	216.74	0.92
Whole milk	0	250	500	330.90	0.76
unsaturated oils	20	40	80		
saturated oils	0	11.8	11.8		
Sugars	0	31	31		

Globally different effects

South Asia



North America



Additionally

- Reducing food losses & waste by half
- Closing yield gaps to 75-90%
- Increasing NUE by 30%

Table 1

Narratives of N abatement by sector. N policy ambition levels range from high to low, the former reflecting the frontier of technical feasibility and the latter no improvement or a continuation of current trends. Countries are split into three groups based on economic wellbeing and N-use intensity. Different ambition level targets for livestock manure excretion, manure recycling, air pollution and wastewater are taken from previous published studies (UNEP, 2013, Rao et al., 2017, van Puijenbroek et al., 2019). Additional interventions on bioenergy and dietary change are described in Section 5 and listed in Table 3.

Sector & country group		N policy ambition levels: High	Medium	Low	Indicators
Crop (Zhang et al., 2015)	*OECD*	Target NUE by 2030	Target NUE by 2050	Current NUE remains constant	Crop NUE (%) N surplus (kg N ha^{-1})
	Non-OECD/High N	Target NUE in 10 years after catch-up with OECD countries	Target NUE in 30 years after catch-up with OECD countries	NUE trends from past 10 years continue if negative until 2030, otherwise NUE remains constant	
	Non-OECD/Low N	Target NUE in 30 years after catch-up by avoiding historical trajectory	NUE follows historical trajectory towards high N/low NUE over 30 years, before improving	Current decreasing NUE trends continue akin to countries with similar socioeconomic status	
Livestock manure excretion (UNEP, 2013)	*OECD*	10% reduction by 2030, 30% reduction by 2050	10% reduction by 2050, 30% reduction by 2070	Current rates remain constant to 2050	N excretion per unit animal (kg N/LSU/yr) N excretion per unit animal product (kg N/kg meat, milk, eggs)
	Non-OECD/High N	N excretion rates same as OECD in 10 years after catch-up	N excretion rates same as OECD in 30 years after catch-up	Current trends continue if negative until 2030, otherwise remain constant	
	Non-OECD/Low N	30% reduction for new livestock production after 2030	30% reduction for new livestock production after 2050	Current trends continue or remains constant	
Manure recycling (UNEP, 2013)	*OECD*	90% recycling by 2030	90% recycling by 2050	Current rates remain constant to 2050	Excreted manure collected, properly stored and recycled (%)
	Non-OECD/High N	50% increase in recycling by 2030; 100% increase by 2050, or until 90% recycling reached	50% increase in recycling by 2050; 100% increase by 2070, or until 90% recycling reached	Current trends continue if negative until 2030, otherwise remain constant	
	Non-OECD/Low N	90% recycling in new systems by 2030	90% recycling in new systems by 2050	Current trends continue or remain constant	
Air Pollution (Rao et al., 2017)	*OECD*	70% of technically feasible measures by 2030, all measures by 2050	Current legislation (CLE) by 2030, 70% of technically feasible in 2050 increasing to all measures by 2100	CLE reached by 2040, further improvements slow	NO_x emissions (t N yr^{-1}) NH_3 emissions (t N yr^{-1})
	Non-OECD/High-Med income	Same as OECD in 10 years after catch-up	Delayed catch-up with OECD (CLE achieved by 2050), 70% of technical feasible reductions achieved by 2100	CLE reached by 2040, further improvements slow	
	Non-OECD/Low income	CLE by 2030, OECD CLE by 2050, gradual improvement towards 70% technical feasible measures	OECD CLE achieved by 2100	CLE reached 2050, further improvements negligible	
Wastewater (van Puijenbroek et al., 2019)	*OECD*	>99% wastewater treated; 100% N and P recycling from new installations from 2020	>95% wastewater treated 100% N and P recycling from new installations from 2030	>90% wastewater treated	Tertiary treatment rate (%) Secondary treatment rate (%) Sludge recycling (%) Organic recycling (%)
	Non-OECD/High N	>80% wastewater treated; Recycling same as OECD in 10 years after catch-up	>70% wastewater treated Recycling same as OECD in 30 years after catch-up	>60% wastewater treated	
	Non-OECD/Low N	>70% wastewater treated	>50% wastewater treated	>30% wastewater treated	

Kanter et al. (2019)

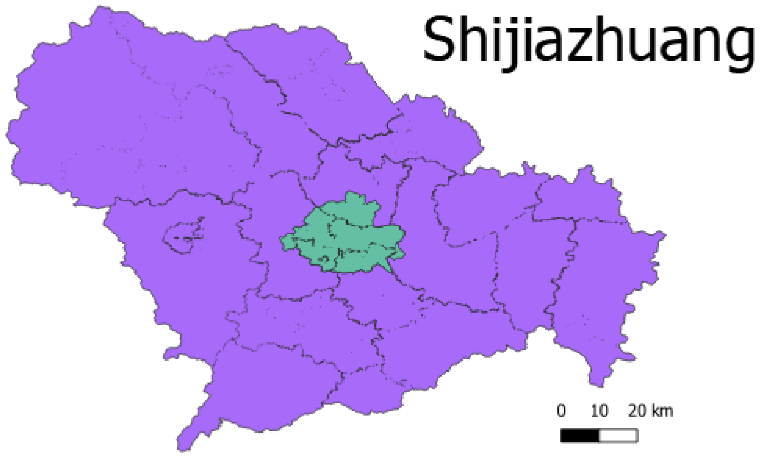
Climate Strategy Vienna

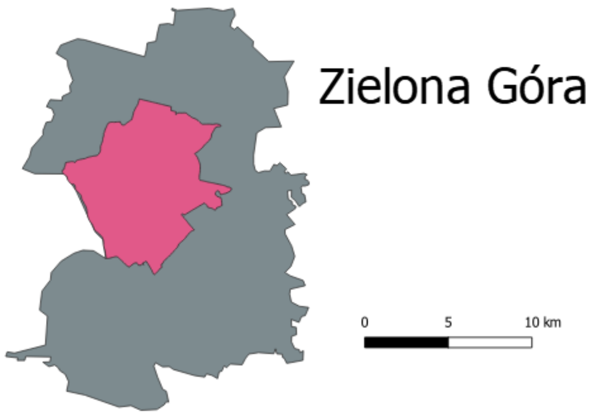
- Climate neutral by 2040
- -50% CO_2 emissions from traffic per capita by 2030
- Adding urban greens of minimum 6 mio m^2 (Prater)
- -25% food losses by 2030 & -50% food losses by 2050
  - Development of a nutrition strategy
- Zero Waste by 2050 & increasing recycling rate (60% by 2030 - EU)
- -20% fertilizer by 2030
- Increasing organic farming by 25%

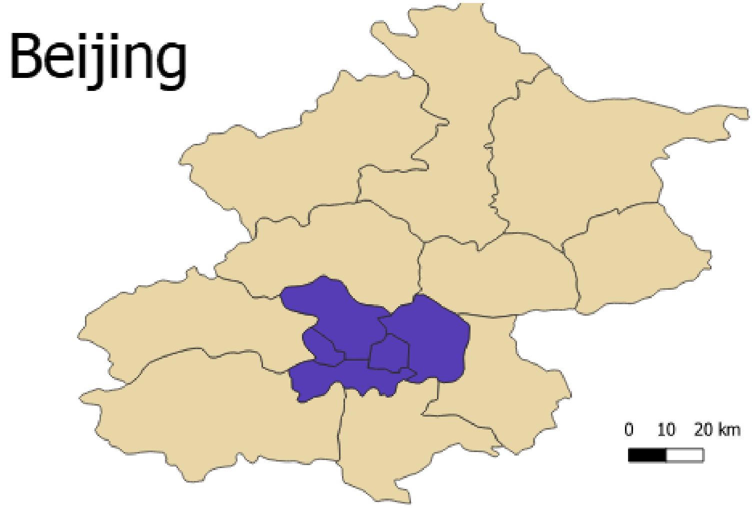
- 4R scenario – Feng
- Combination of scenarios

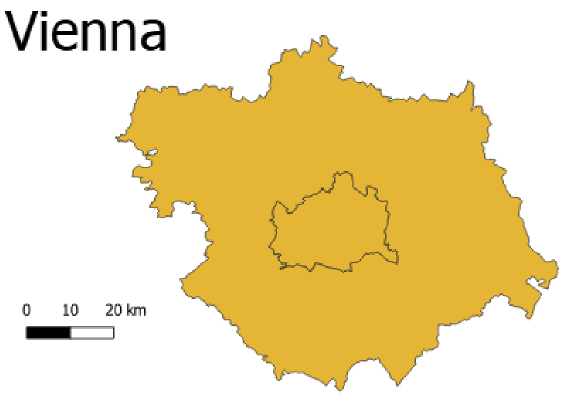
Urban N Budget Vienna – A comparison

UNCNET test areas

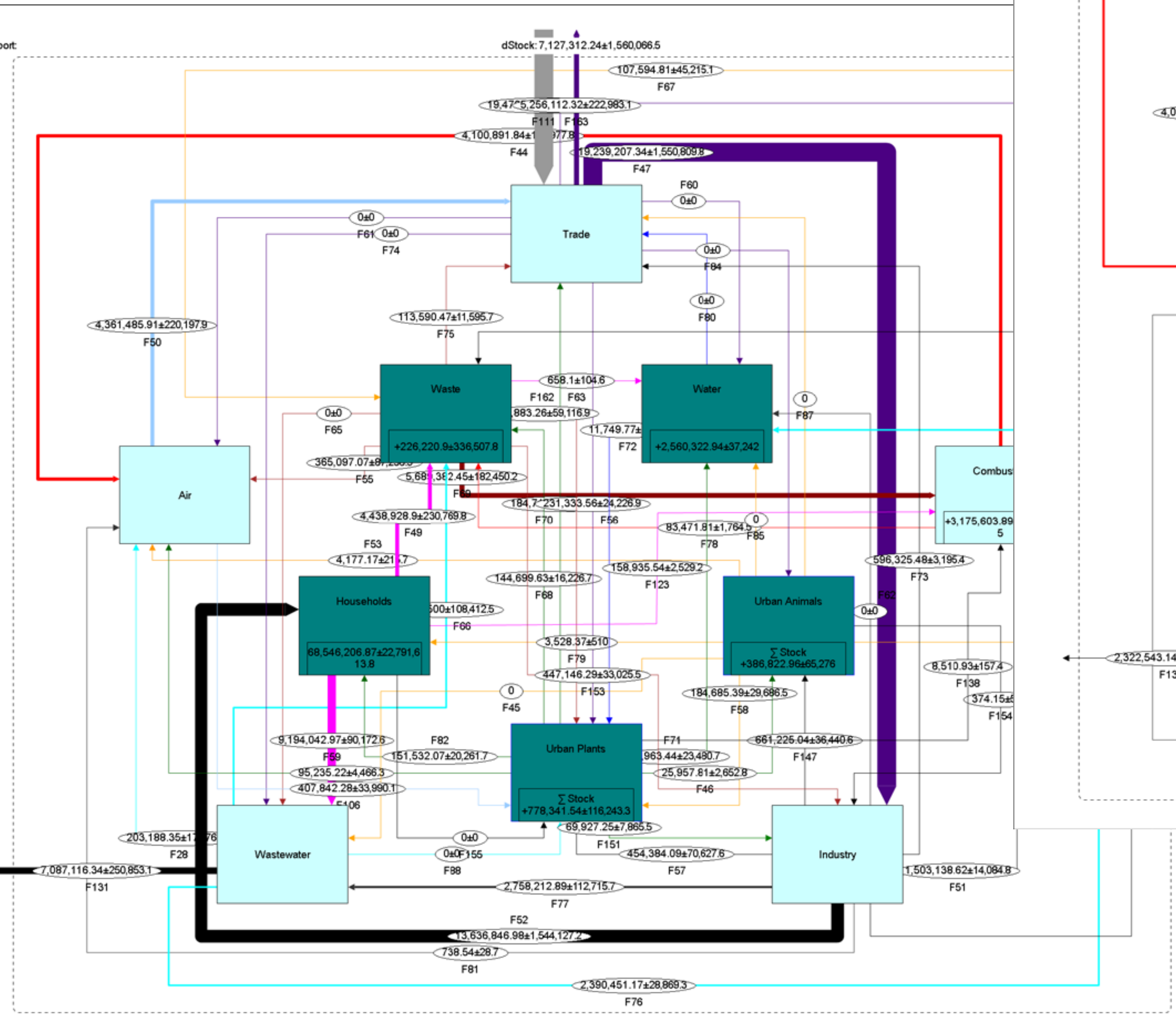


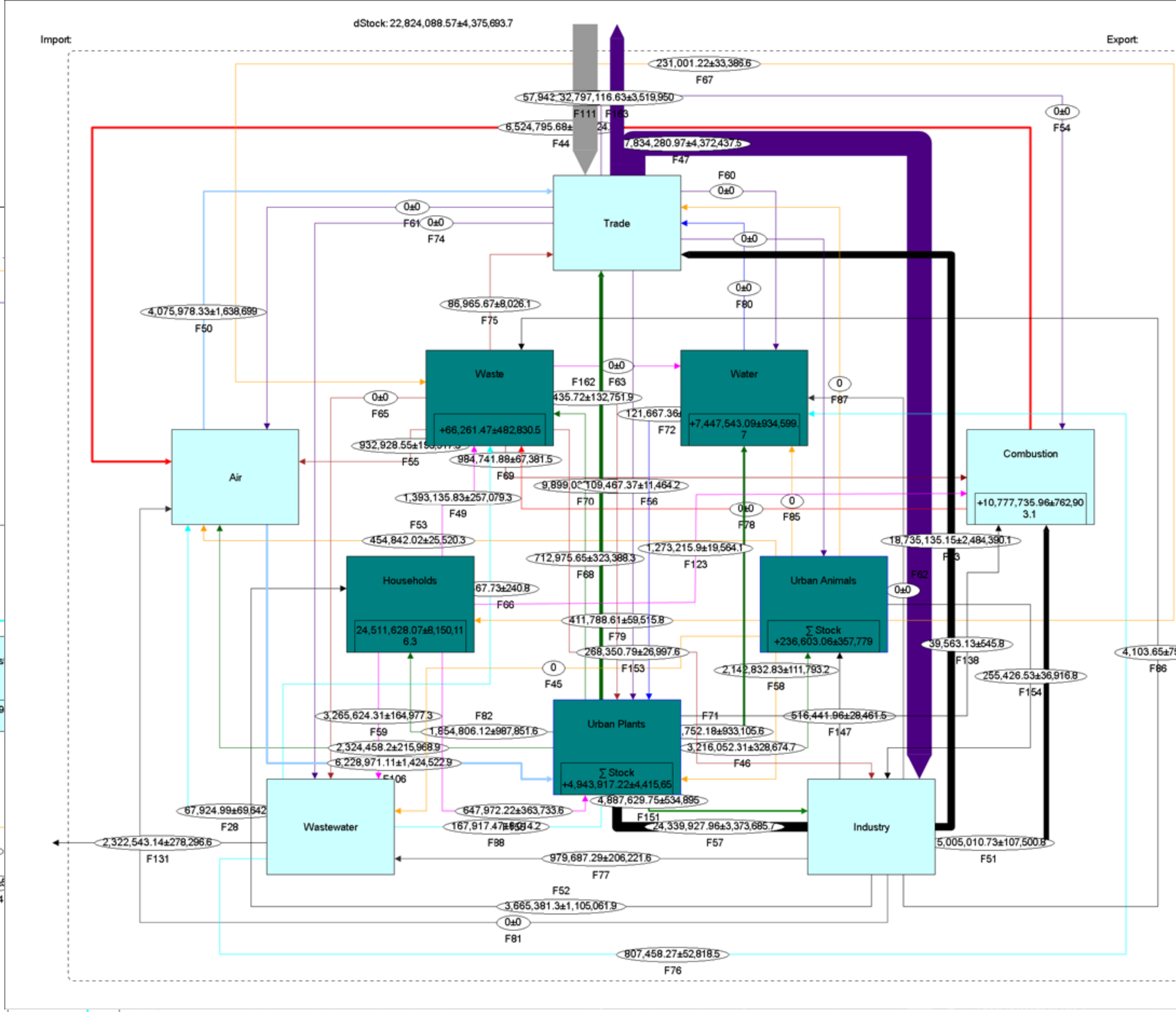




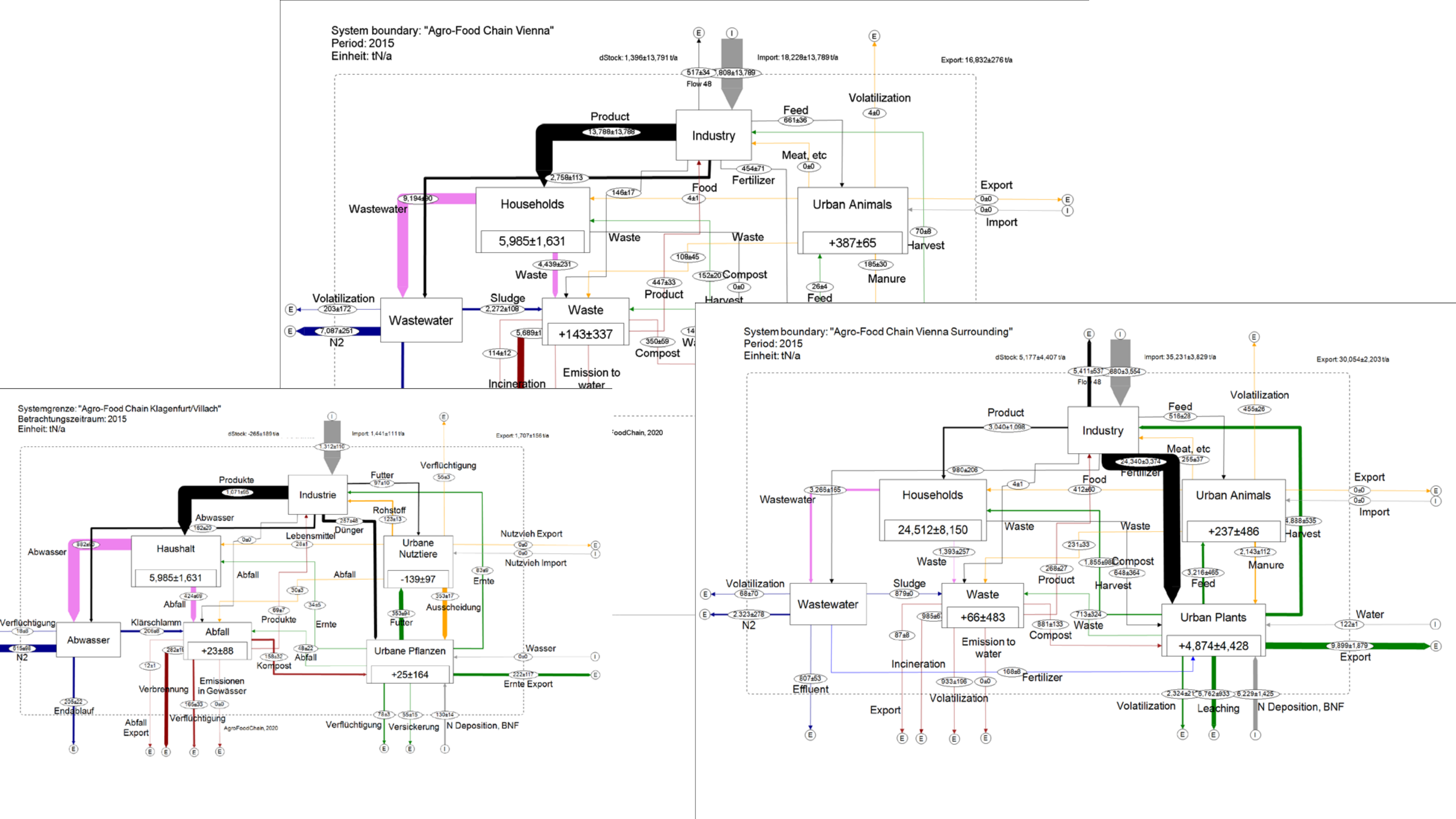


Vienna





Vienna Surrounding

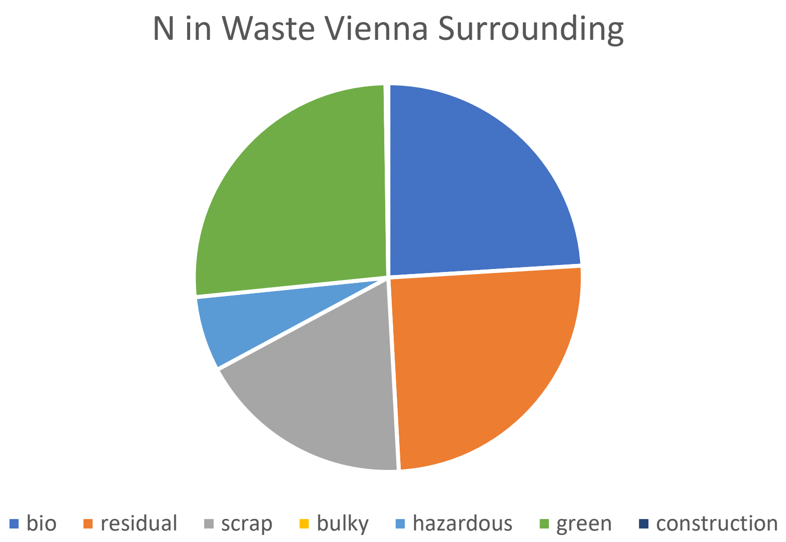


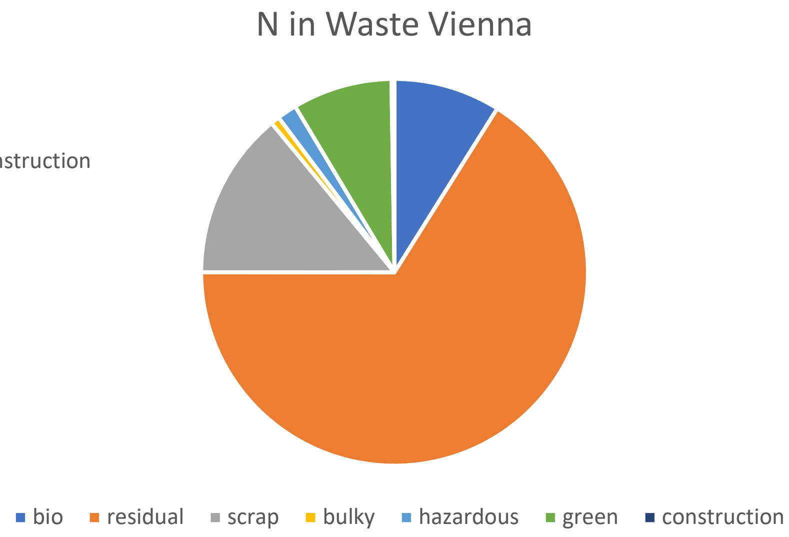
System boundary: "Agro-Food Chain Vienna"
Period: 2015
Einheit: tN/a
dStock: 1,396±13,791 t/a
Import: 18,228±13,789 t/a
Export: 16,832±276 t/a
Industry
Households
5,985±1,631
Urban Animals
+387±65
Wastewater
Waste
+143±337
Product
Feed
Volatilization
Meat, etc
Fertilizer
Food
Wastewater
Waste
Export
Import
Harvest
Manure
Compost
Sludge
N2
Incineration
Emission to water
Systemgrenze: "Agro-Food Chain Klagenfurt/Villach"
Betrachtungszeitraum: 2015
Einheit: tN/a
dStock: -265±189 t/a
Import: 1,441±111 t/a
Export: 1,707±156 t/a
Industrie
Haushalt
5,985±1,631
Urbane Nutztiere
-139±97
Abwasser
Abfall
+23±88
Urbane Pflanzen
+25±164
Produkte
Futter
Verflüchtigung
Rohstoff
Dünger
Lebensmittel
Nutzvieh Export
Nutzvieh Import
Ernte
Ausscheidung
Klärschlamm
Kompost
Wasser
Ernte Export
Verbrennung
Emissionen in Gewässer
Endablauf
Abfall Export
Versickerung
N Deposition, BNF
AgroFoodChain, 2020
System boundary: "Agro-Food Chain Vienna Surrounding"
Period: 2015
Einheit: tN/a
dStock: 5,177±4,407 t/a
Import: 35,231±3,829 t/a
Export: 30,054±2,203 t/a
Industry
Households
24,512±8,150
Urban Animals
+237±486
Wastewater
Waste
+66±483
Urban Plants
+4,874±4,428
Product
Feed
Volatilization
Meat, etc
Fertilizer
Food
Harvest
Manure
Compost
Sludge
N2
Water
Export
Import
Effluent
Incineration
Emission to water
Leaching
N Deposition, BNF

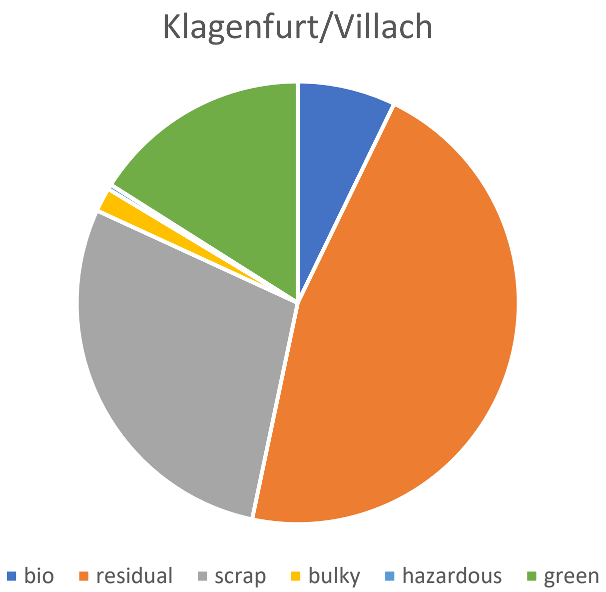
Per Capita Comparison

	Vienna		Vienna Surrounding		Villach/Klagenfurt		Zielona Gora	
	[kgN]	*[kgN/cap]*	*[kgN]*	*[kgN/cap]*	*[kgN]*	*[kgN/cap]*	*[kgN]*	*[kgN/cap]*
Waste to Air	365,097.07	0.20	932,928.55	1.43	88,838.51	0.56	101,909.50	0.54
Waste to Combustion	5,689,382.45	3.11	984,741.88	1.51	276,990.81	1.74		
Household to Waste	4,438,928.90	2.43	1,393,135.83	2.13	271,897.83	1.70	570,049.71	5.14
Wastewater to Water	2,390,451.17	1.31	807,458.27	1.24	227,633.14	1.43	135,855.33	1.22
Wastewater to Waste	2,271,500.00	1.24	879,467.73	1.35	206,098.15	1.29	341,000.00	3.07

Waste


N in Waste Vienna Surrounding
bio
residual
scrap
bulky
hazardous
green
construction

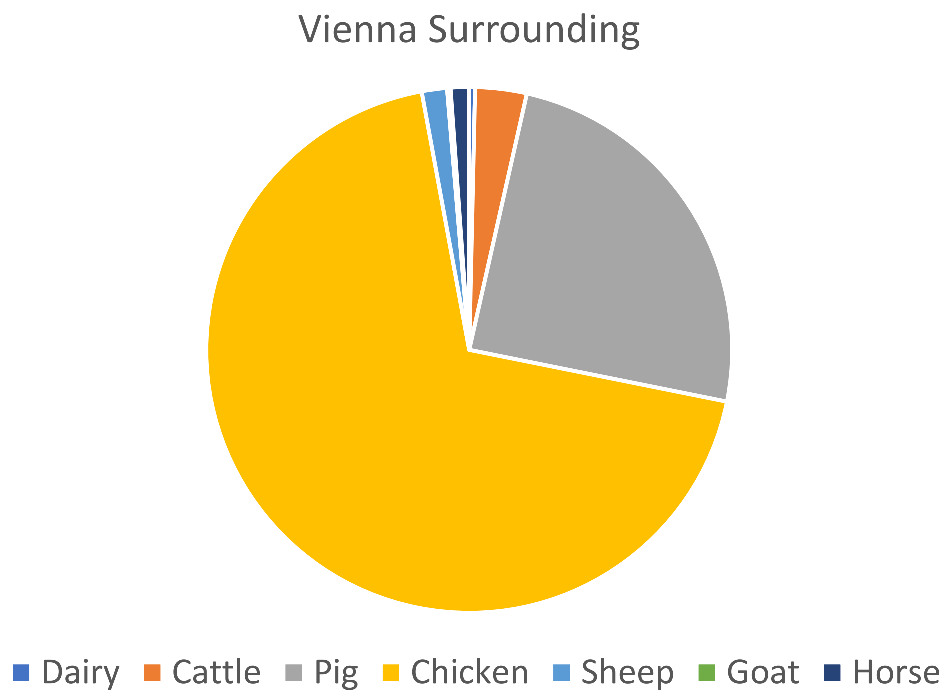

N in Waste Vienna
bio
residual
scrap
bulky
hazardous
green
construction

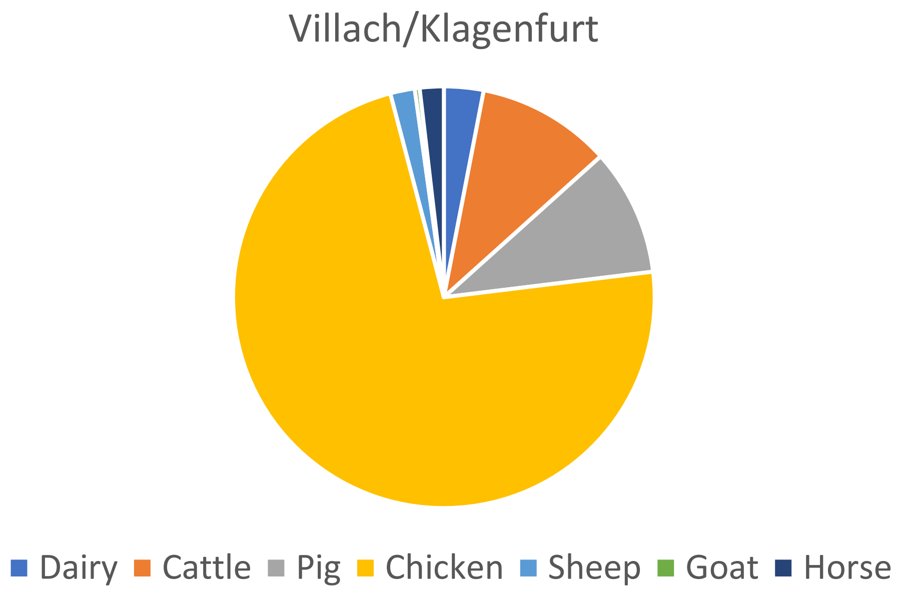

Klagenfurt/Villach
bio
residual
scrap
bulky
hazardous
green

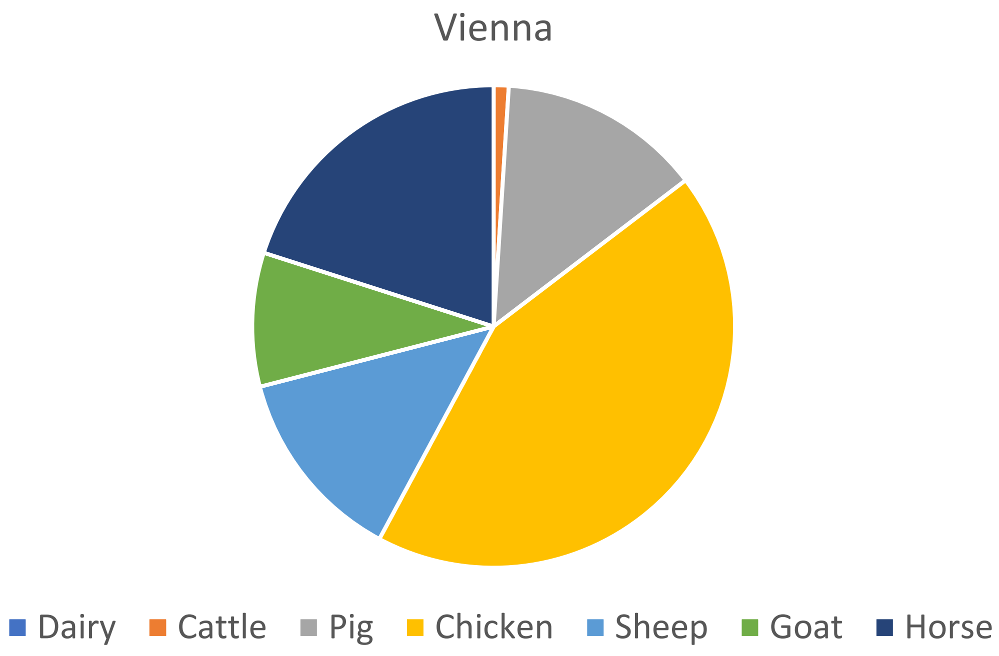
	Population [cap]	Total Area [ha]	Agricultural Area [ha]	Horticultural Area [ha]	Urban Green area [ha]	Livestock [head]	Pets [heads]
Vienna	1,828,127.00	41,482.42	5,547.85	213.50	11,600.00	1,461.10	177,940.00
Vienna Surrounding	653,725.00	419,789.35	210,949.32	43.54	13,613.92	442,877.42	140,253.64
Villach/Klagenfurt	159,626.00	25,510.56	6,009.64	10.13	534.98	32,007.78	28,324.32

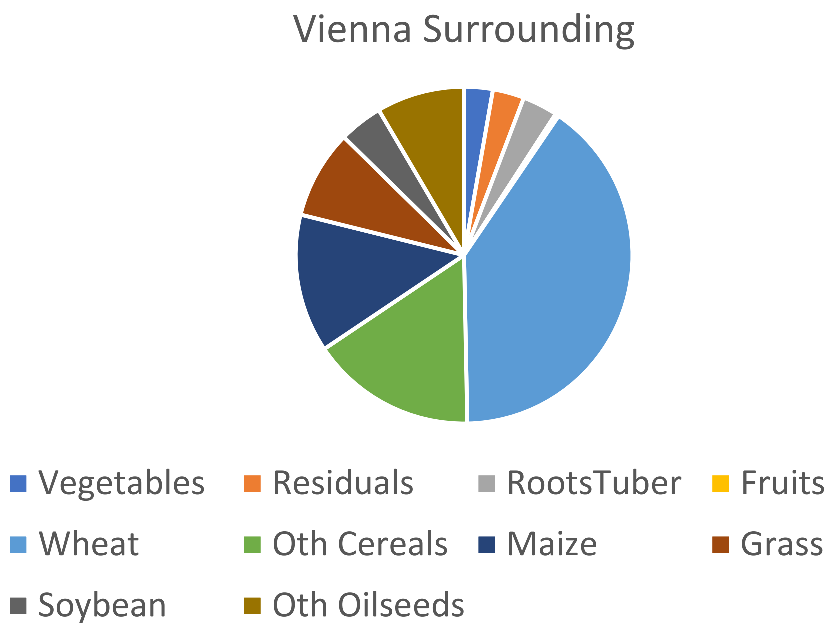
	Share Agricultural Area	Share Horticultural Area	Share Urban Green Area	Agricultural Area / Capita	Pet Share
Vienna	0.13	0.01	0.28	0.00	0.99
Vienna Surrounding	0.50	0.00	0.03	0.32	0.24
Villach/Klagenfurt	0.24	0.00	0.02	0.04	0.47

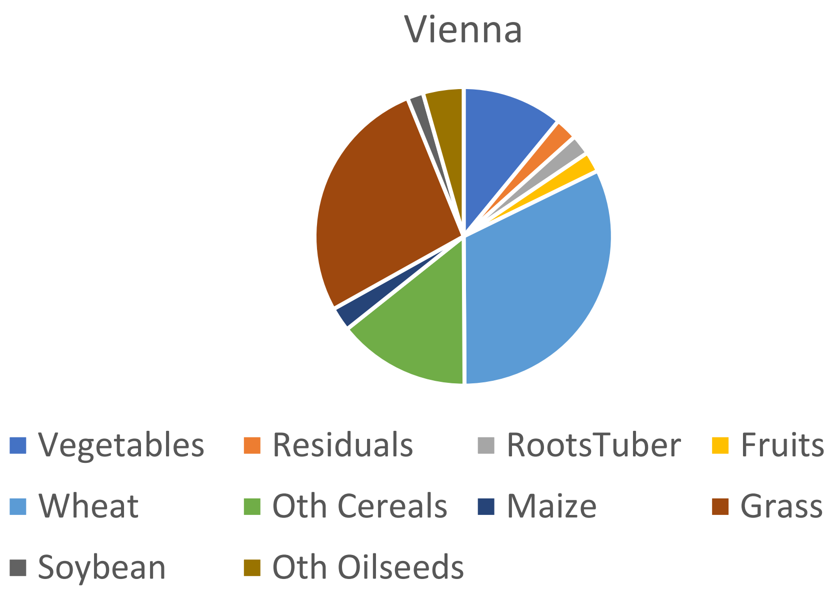
	Vienna		Vienna Surrounding		Villach/Klagenfurt	
	[kgN]	[kgN/ha or head]	[kgN]	[kgN/ha or head]	[kgN]	[kgN/ha or head]
Urban animals to household	3,528.37	2.41	411,788.61	0.93	27,682.70	0.86
Urban Animals to Air	4,177.17	2.86	454,842.02	1.03	55,440.65	1.73
Urban Plants to Households	151,532.07	8.73	1,854,806.12	8.26	33,777.19	5.15
Industry to Urban Plants	454,384.09	26.17	24,339,927.96	108.37	266,994.24	40.73


Vienna Surrounding
Dairy
Cattle
Pig
Chicken
Sheep
Goat
Horse

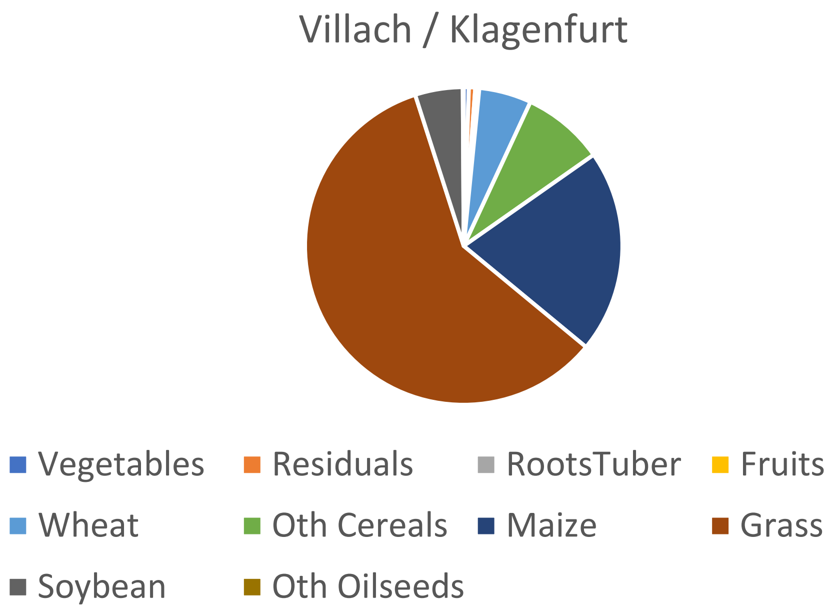

Villach/Klagenfurt
Dairy
Cattle
Pig
Chicken
Sheep
Goat
Horse


Vienna
Dairy
Cattle
Pig
Chicken
Sheep
Goat
Horse





	AUT [kgN/ha]	EU-27 IFA [kgN/ha]
Vegetables	173.95	170.79
Residuals	34.47	78.71
RootsTuber	129.57	84.13
Fruits		82.53
Wheat	120.00	115.80
Oth Cereals	98.03	80.70
Maize	130.00	107.09
Grass	58.34	138.41
Soybean	30.00	2.51
Oth Oilseeds	50.00	67.60



Comparison

- General Checks
  - More detailed information will be needed (documentation)
    - Crop share (IFA category)
    - Area share in total area
    - Fertilizer per crop
    - Waste types
    - Pet & Livestock units
- Identify largest flows or cluster / flows of interest
  - Mitigation or recovery potential – wastewater & sewage sludge
  - Agrofood chain & diets
- Decision on indicators
  - NUE
  - N surplus
  - N recycling

IIASA UNIWERSYTET ZIELONOGÓRSKI E.C.O. Institut für Ökologie brainbows

Sources

- Kanter, D. R., Winiwarter, W., Bodirsky, B. L., Bouwman, L., Boyer, E., Buckle, S., Compton, J. E., Dalgaard, T., de Vries, W., Leclère, D., Leip, A., Müller, C., Popp, A., Raghuram, N., Rao, S., Sutton, M. A., Tian, H., Westhoek, H., Zhang, X., & Zurek, M. (2020). A framework for nitrogen futures in the shared socioeconomic pathways. *Global Environmental Change*, *61*(December 2019), 102029. https://doi.org/10.1016/j.gloenvcha.2019.102029
- Rao, S., Klimont, Z., Smith, S. J., Van Dingenen, R., Dentener, F., Bouwman, L., Riahi, K., Amann, M., Bodirsky, B. L., van Vuuren, D. P., Aleluia Reis, L., Calvin, K., Drouet, L., Fricko, O., Fujimori, S., Gernaat, D., Havlik, P., Harmsen, M., Hasegawa, T., … Tavoni, M. (2017). Future air pollution in the Shared Socio-economic Pathways. *Global Environmental Change*, *42*, 346–358. https://doi.org/10.1016/j.gloenvcha.2016.05.012
- Zhang, X., Davidson, E. A., Mauzerall, D. L., Searchinger, T. D., Dumas, P., & Shen, Y. (2015). Managing nitrogen for sustainable development. *Nature*, *528*(7580), 51–59. https://doi.org/10.1038/nature15743