Projections and scenario analysis for climate and nitrogen action planning

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Sustainability Institute

Elizabeth Dukes
University of Virginia
Outline

Part 1: Projections & scenarios

• SIMAP background
• Projection & scenario results
• Excel templates

Part 2: Integrated planning

• Integrated planning strategies
• Case study 1: University of Virginia and nitrogen
• Case study 2: University of New Hampshire and climate
SIMAP integrates two tools

6. **C**
   - UNH Sustainability Institute
   - Developed in 2001 at UNH
   - Excel and web version
   - Used by *thousands* of institutions

7. **N**
   - N-Print
   - Developed in 2009 at UVA
   - Excel-based
   - Used by 20 institutions
   - Completed pilot testing
Why a new tool?

1. Broader picture of environmental impacts

2. Single tracking tool

3. Integrate with other reporting platforms

4. Research about data trends

5. UNHSI’s ability to support the tool
How did we get here?

Carbon
How did we get here?

Nitrogen

- Leach senior thesis
- EPA grant
  - NFT v1 launched
  - NFT Network
- UVA N reduction goal
- Pilot testing by cohorts 1-3
- 2009
- 2013
- 2014
- 2014-2017
- 2017
- 2017
Challenge:

Optimize the use of nitrogen, while minimizing the negative impacts.

**Benefits**

Necessary for life
Synthetic fertilizer provides unlimited N supply for food

**Drawbacks**

Negative impacts to environmental & human health
What is a nitrogen footprint?

A **nitrogen footprint** is the amount of reactive nitrogen released to the environment as a result of an entity’s resource consumption.

1. **Food***

![Food consumption and production](image)

2. **Energy**

![Energy consumption](image)

*Food consumption and production
Carbon & nitrogen footprint of food

Consistent trends across C & N footprints

Leach et al. 2016
Heller & Keoleian 2014
SIMPLIFYING SUSTAINABILITY DECISIONS

SIMAP® is a carbon and nitrogen-accounting platform that can track, analyze, and improve your campus-wide sustainability. Our proven algorithms, based on nearly two decades of work supporting campus inventories with the Campus Carbon Calculator, CarbonMAP and Nitrogen Footprint Tool, will help you:

- Create a baseline
- Benchmark your performance
- Create reports
- Set goals
- Analyze your progress year over year

GET STARTED!

YOUR CAMPUS FOOTPRINT

CARBON

CO2 emissions from generating power, treating waste, daily commuting, and even the use of paper, contribute to a campus' carbon footprint. Reducing these greenhouse gas emissions will help slow the effects of climate change and global warming.

NITROGEN

Reactive nitrogen can result from everyday activities like food service, energy use, transportation, and ground fertilizer. Reducing your nitrogen footprint can provide benefits to air and water quality, while helping prevent climate change.

SUBSCRIPTION TIERS

While SIMAP offers basic functionality at no cost, we also offer two premium subscription levels that provide additional features at a nominal license fee. Our model allows UNH to cover the costs of continuing to offer and support this tool for the good of the entire campus-based sustainability community.

BASIC (FREE)

TIER 1 ($350):

TIER 2 (TBD):
3. Results

Footprints *
- Carbon
- Nitrogen

Report Type *
- Total footprint
- Scopes
- Categories
- Sources
- Gas/pollutant

Scope 2 Method *
- Market-Based
- Location-Based
- Custom Fuel Mix

Graph Type *
- Line
- Bar

Fiscal Year Range *
- 2014 - 2017

Normalization
- None

CALCULATE

Carbon
- Food
- T&D losses
- Paper purchasing
- Wastewater
- Solid waste
- Student travel to/from home
- Study abroad air travel
- Other directly financed travel
- Directly financed air travel
- Student commuting
- Staff commuting
- Faculty commuting
- Purchased steam/chilled water
- Purchased electricity
- Fertilizer & animals
- Refrigerants & chemicals
- Direct transportation
- Other on-campus stationary
- Co-gen steam
- Co-gen electricity

Nitrogen
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<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Scope</th>
<th>Source</th>
<th>CO2 (kg)</th>
<th>CO2 (MTCDE)</th>
<th>CH4 (kg)</th>
<th>CH4 (MTCDE)</th>
<th>N2O (kg)</th>
<th>N2O (MTCDE)</th>
<th>GHG MTCDE</th>
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Get help with graphs
Carbon and nitrogen footprint projections and scenarios
# What are projections and scenarios?

<table>
<thead>
<tr>
<th>Projections</th>
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<tbody>
<tr>
<td>• Estimate future emissions based on:</td>
</tr>
<tr>
<td>– Population growth</td>
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<tr>
<td>– Planned construction</td>
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<tr>
<td>– More!</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Solutions/scenarios/projects</th>
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<tbody>
<tr>
<td>• Estimate effects of management strategies on current or projected footprint:</td>
</tr>
<tr>
<td>– Changes in emissions</td>
</tr>
<tr>
<td>– Cost of scenarios</td>
</tr>
</tbody>
</table>

Both are important for accurate and informed goal setting!
### What methods have been used?

<table>
<thead>
<tr>
<th>Projections</th>
<th>Solutions/scenarios/projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Methods for projecting in the CCC:</td>
<td>• Users entered detailed project* data in CCC</td>
</tr>
<tr>
<td>– Linear</td>
<td>– No “standard scenarios”</td>
</tr>
<tr>
<td>– Normalized by students</td>
<td>– Metrics to view results in the CCC:</td>
</tr>
<tr>
<td>– Normalized by square feet</td>
<td>– Impact on C footprint</td>
</tr>
<tr>
<td>– Custom trends</td>
<td>– Life-cycle cost of project</td>
</tr>
<tr>
<td>– Variable trends</td>
<td>– Payback time of the project</td>
</tr>
<tr>
<td></td>
<td>– Net present value (life-cycle cost/savings per ton of C)</td>
</tr>
</tbody>
</table>

CCC = Campus Carbon Calculator
In the CCC: Projections

Projected Greenhouse Gas Reductions 1990–2020
In the CCC: Weighing Solutions

A - Purchase high capacity buses
H - Co-fire biomass in steam plant
L - Purchase wind power
R – Natural Gas Blend in Steam Plant
S - Install solar electric system
In the CCC: Weighing Solutions

Net Present Value (2005 USD)

Emissions Reductions (t CO2e)
In the CCC: Wedge diagram

- EcoLine-Landfill Gas Pipeline
- LEED Silver-Equivalent Building Standards
- Geothermal Heating in Gables
- Replace Oil Boilers with Wood Pellets Produced on Campus
- Networked Computer Sleep Mode
- Replace Electric Heating Systems
- BAS Upgrades
- Lighting Upgrades
- Absorption Chillers
- Solar Hot Water for Parsons
- Improved Motors Efficiencies
- Heat Distribution Insulation
- Phillbrook Chiller Plant Conversion
- 20 Low Flow Fume Hoods
- 50 kW Wind Turbines
- 50 kW Solar Panels
- 1 Degree Temp Set-back
- Centralized Summer Scheduling
- EcoLiving Coordinator
- Real-time Energy Monitoring in Residence Halls
- ENERGY STAR Refrigerator Requirement
- Power Down Campaign
- One Credit Required Sustainability Course
- CFLs For Students
- Transition All Diesel Vehicles to B20
- Staff Telecommuting
- Clean Fleet
- RailCat
- Infrequent Parking Permits
- Cat Currier
- Emissions After Reductions
- 10% Below 1990 Emissions

Year

Emissions (t CO2e)
Example at UNH

Food is key sector for nitrogen

Energy sectors are key sector for carbon

- **N footprint (metric tons N)**
  - 141 MT N

- **C footprint (1,000 MT CO₂e)**
  - 67,000 MT CO₂e

- **Food is key sector for nitrogen**
- **Energy sectors are key sector for carbon**

- **Research**
- **Transport & commuting**
- **Utilities**
- **Food consumption**
- **Produce**
- **Dairy, eggs, & fish**
- **Meat**
PROJECTIONS: UNH’s C footprint in 2030

Assumes 2% growth rate for energy, linear population projection for food (0.7%)
PROJECTIONS: UNH’s N footprint in 2030

Assumes 2% growth rate for energy, linear population projection for food (0.7%)

Nitrogen footprint (MT N)

2014 baseline

2030 BAU

2030 scenarios

Research

Transport & commuting

Utilities

Food consumption

Produce

Dairy, eggs, & fish

Meat

PROJECTIONS: UNH’s N footprint in 2030

Assumes 2% growth rate for energy, linear population projection for food (0.7%)

Nitrogen footprint (MT N)

2014 baseline

2030 BAU

2030 scenarios

Research

Transport & commuting

Utilities

Food consumption

Produce

Dairy, eggs, & fish

Meat

*Relative to baseline (2014).
*C footprint goal + feasible food scenarios shown

BAU = Business As Usual
Next steps for projections and scenarios in SIMAP:

- Conducted survey in spring/summer
  - More feedback welcome!
- Beginning development
- Beta testing in early 2019

What can you do in the meantime?
Use our Excel scenario templates!
Food scenarios template

Food Projections & Solutions Template

Updated: 8 June 2018

What this template provides

You can use this template to project your SIMAP carbon and nitrogen footprint results to a projection year. You can then run the following food scenarios: vegetarian meal replacement, up to 4 food category replacements, custom food replacement, and local food replacement, and diverting food waste.

How to use this template

Enter SIMAP data tab

Copy-paste your exported data from SIMAP. This will be used for your baseline C and N footprint and food calculations. See the tab for detailed instructions.

Select projections and scenarios tab

Select how you would like to project your data. There are different selections for non-food data and food data. Select your scenario input data (e.g., % vegetarian meals, % replacement of food categories).

View projections and scenarios tab
Energy scenarios template

Energy Projections and Solutions Template
Prepared by: Andrew Pettit, Libby Milo, Izzy Castner, Allison Leach, Jim Galloway, and the UVA Office for Sustainability
University of Virginia

Introduction
This template is intended to help users make decisions on energy reduction strategies to minimize both GHG and N losses to the environment.

This template provides:
1) Inventory your organization’s Utility and Transportation reduction strategies.
2) Calculate the Nitrogen co-benefits from these reduction strategies.

Navigation
This color scheme is used throughout the template to indicate which cells to interact with.

<table>
<thead>
<tr>
<th>Do not enter data here</th>
<th>Enter copy and pasted data here</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Enter customized data here</td>
</tr>
</tbody>
</table>

Instructions Overview
Downloads from SIMAP:
1. Annual Report Carbon: Go to SIMAP "Reports" tab -> Chose "annual report"," carbon"-> Type in baseline year
2. Annual Report Nitrogen: Go to SIMAP "Reports" tab -> Chose "
Questions about projections and scenarios?
Part 2:
Integrated planning strategies

Alley Leach
University of New Hampshire
Sustainability Institute
Questions for proposing C+N goal

1. What other sustainability goals are in place or planned?

2. At what level should the goal be approved (e.g., governing body, university)?

3. How should the goal be framed (e.g., overall, scopes)?

4. What should the goal year be?

5. What should the % reduction goal be?
1. What other sustainability goals are in place or planned?

- Real Food Challenge
- Carbon & Climate Commitments
- Menus of Change
- Food Recovery Challenge (EPA)
- STARS (AASHE)
- Waste-Wise (EPA)
- Recycle-mania (PLAN)
- Zero Waste (PLAN)
- Buy Local

Barnes et al. 2017

Colorado College & University of New Hampshire
2. At what level should the goal be approved?

1. **Research exercise:** Internal stand-alone N footprint calculations and/or goal

2. **Grassroots action:** No goal, but working with stakeholders to push reduction strategies

3. **N benefits:** No goal, but N benefits mentioned in other plans

4. Goal based on existing plans

5. **New goal approved by governing body**
3. How should the goal be framed?

• **Overall goal**
  • A single reduction goal for the overall N footprint

• **Per capita/normalized goal**
  • Reduction goal(s) normalized to campus users

• **Scope goals**
  • Separate reduction goals for scope 1+2 (local) and scope 3 (not local)

• **Sector goals**
  • Separate goals for energy, transit, food, etc.
Other questions to consider:

4. What should the baseline year and goal year be?

5. What should the % reduction goal be?
The University of Virginia’s Nitrogen Action Plan

Elizabeth Dukes
From goal setting to action plans at UVA

Goal setting

5. And more!

Action plans

5. And more!
Sustainability Goals and Action Plans at the University of Virginia

- **Greenhouse Gas Action Plan**

- **Materials Action Plan**

- **Nitrogen (N) Action Plan**

- **Sustainable Food Action Plan**

  - 2015: 6.73%
  - 2034 Goal: 50%
  - Reduce reactive nitrogen emissions 25% below 2010 levels by 2025.
What’s Included in the N Action Plan?

1. **Reductions from GHG Action Plan**
   a) Purchased Electricity
   b) On-site utilities
   c) Transportation

2. **Reductions from Sustainable Food Action Plan**
   a) Increase vegetarian meals
   b) Increase local purchasing
   c) Opening plant-based café

3. **Reductions from Materials Action Plan**
   a) Composting waste

4. **Other specific N scenarios**
   a) Higher reductions in utilities sectors
   b) More stringent meat reduction strategies in food sectors
   c) Offsets for N
UVA’s Nitrogen Footprint: Action Plans Combined

-12% -17% -2% -16% -11% -25%

M T N
0 50 100 150 200 250 300


Food T&D Losses Wastewater Student Commuting Staff Commuting Faculty Commuting Purchased Electricity Fertilizer & Animals Direct Transport On-Campus Stationary

University of Virginia
Take-aways for UVA’s Nitrogen Action Plan

1. Current action plans strategies will allow UVA to reach 25% reduction goal.

2. Collaboration with multiple sectors at the university (dining, facilities, health system, etc.) will reduce N footprint and meet other goals!
A climate resilience plan at the University of New Hampshire

Jennifer Andrews
University of New Hampshire
Sustainability Institute
Framing Resilience: “Five Capitals” Model

Natural:
- is any stock or flow of energy and material that produces goods and services. It includes:
  - Resources - renewable and non-renewable materials
  - Sinks - that absorb, neutralize or recycle wastes
  - Processes - such as climate regulation

Financial:
- plays an important role in our economy, enabling the other types of Capital to be owned and traded. Unlike the other types, it has no real value itself but is representative of natural, human, social or manufactured capital.

Physical:
- comprises material goods or fixed assets which contribute to the production process rather than being the output itself.

Human:
- consists of people’s health, knowledge, skills and motivation. All these things are needed for productive work.

Social:
- concerns the institutions that help us maintain and develop human capital in partnership with others; e.g. Institutes, task forces, student orgs., committees.

Source: https://www.forumforthefuture.org/project/five-capitals/overview
Findings: Priority Opportunities

- Use improved understanding of needs to improve social capital/systems to drive change in other capitals, primarily by working to break down silos and ensure collaborative, inclusive, transparent and effective processes
- Better communication and outreach
- Continue/enhance student engagement
- Add community representatives to Task Forces
- Water conservation – demand/summer, $
- Promote active transportation
- Update WildCAP to meet/exceed GHG reduction goals
- Land conservation policies in light of development pressure
- Updated and implement Landscape Master Plan
- Accelerate sustainable food initiatives
- Provide more interpersonal resilience skills training for students, staff, faculty
- Research: groundwater mapping
- Research: supply chains
- Focus on indicator data collection
The Five Capitals: Connected to Every Aspect of Sustainability

**Physical**
- Energy and GHG planning
- Buildings, deferred maintenance, and codes and zoning;
- Greening of fleets, streets (i.e. storm water) and TDM;
- Supply chains for food, water, waste disposal

**Natural/Ecological**
- Landscape master plan update
- Nitrogen footprint reduction
- Land policy committee: zoning, land use planning

**Social**
- Coordination and planning
- Social justice and racial equity

**Human**
- “Healthy UNH”—including Menus of Change
- Learning outcomes
- Research and engaged scholarship
- “Campus climate”
- Sustainable food systems
- Inclusion and diversity

**Financial**
- Move to life-cycle cost accounting in planning
- Housing affordability
- Living wages
- Staffing and employment
- Corporate social responsibility, social innovation
- Sustainable investment
# Summary

## Projections and scenarios

- Important for informed and accurate goal setting
- Excel templates available now
- Beta testing in early 2019

## Goal setting

- Lots of options for integrated carbon and nitrogen goals
- Integrated goal setting is win-win for sustainability initiatives

unhsimap.org