Tufts UNIVERSITY | Gerald J. and Dorothy R. Friedman School of Nutrition Science and Policy

Updated: January 2024

NUTR 0342: Food Systems Modeling and Analysis
Spring 2024

Welcome to NUTR O342!

Welcome to Food Systems Modeling and Analysis. I'm looking forward to meeting you all and working together as we explore the use of quantitative models to understand food systems. Modeling is a passion of mine, and I love helping students to develop new skills for quantifying food systems, as well as having the opportunity to hear student perspectives during classroom discussions on the benefits and tradeoffs inherent to modeling approaches. This is my third time teaching the course, and I'm continually working to improve the format based on student feedback. This year's material should be very similar to the material covered in Spring 2023, with some minor revisions. The course utilizes a mix of qualitative discussion and quantitative analysis using spreadsheets, GIS, and other tools. The only prerequisite for the course is a solid foundation in geographic information systems (GIS), which is required for some of the assignments. If you're unsure of your GIS background, please reach out to me!

I enthusiastically welcome students of diverse backgrounds and life experiences, and particularly students from traditionally marginalized groups. Differences are the basis for rich conversations on any complicated topic, and food systems are no exception. To ensure the most productive classroom experience for all students, I hope we can all work together to develop a mutually supportive learning environment. If your require additional support, for example as a result of stressful life events, please know that I'm here to help, and that Tufts offers confidential resources to assist in managing these challenges: https://students.tufts.edu/health-wellness/mental-health/counseling-and-mental-health-service

If there is anything I can do to better support your learning, please don't hesitate to reach out to me.

Important Information:

Class Meetings: Tuesdays and Thursdays 9:00am-10:25am
Jaharis Room 156

Instructor: Alexandra Thorn (she/her/hers)
Email: alexandra.thorn@tufts.edu
Office: Jaharis 244

Semester Hour Units: 3

Prerequisites: NUTR 231 Fundamentals of GIS, an equivalent course, or other GIS training with instructor's consent

Course Communications:

If you need to contact the instructor, you may do so via e-mail, during office hours, or by making a personal appointment. Email and in-person office hours are her preferred modes of communication.

You are encouraged to meet with the instructor not only when you have questions or concerns about the material in class but also when you just need someone to brainstorm or have a conversation.

Dr. Thorn checks email Monday - Friday. It may take at least one workday for her to return an e-mail message. Please plan accordingly.

Office Hours:

Instructor: TBD
Location: Jaharis 244

The above are my in-person walk-in office hours to help answer any questions you might have about the topics or assignments for the course, and to talk through any thoughts or ideas students might have related to the course. I'd also be happy to discuss anything else that might be on your mind. My doors are open – just stop by.

I will also be providing links on the course Canvas page to signup spreadsheets for scheduled 1:1 meetings over Zoom. If none of the above work for you, or you wish to have a more private conversation, you can email me at alexandra.thorn@tufts.edu to set up an alternative time to meet.

Course Summary:

Agriculture and food industries are a subject of growing interest in terms of their resource requirements, ecological impacts, and sustainability. Food system modeling helps to illuminate these issues. Food systems are the interconnected systems through which food reaches consumers, including production, farming, processing, and global supply chains. Using examples focused on local and regional food systems in the United States, this course will provide a foundation in some of the methods of modeling and analysis used to study food systems. We will address several types of approaches, generally building in complexity. Using a systems dynamics framework, students will learn modeling tools to quantify and understand net balances of production and consumption, understanding the farm management, human carrying capacity of a region, foodshed analyses, supply chains, and integrated transdisciplinary modeling. Students will learn what types of questions are best addressed through different modeling approaches, the methods used to conduct food systems models, and the data required to complete the analyses. In addition, they will have opportunities to conduct simple analyses through in-class exercises. We will also discuss the relevance and use of models in the development of policy related to local and regional food systems or dietary changes to reduce environmental impact.

Course Goals:

Upon completion of this course, students will be able to describe the types of questions for which require food systems modeling and quantitative analysis to answer. They will be able to explain the methods used to conduct such models, including the data sources upon which the models are based. Students will be able to name the key lessons learned through food systems models to date and will be able to cite the principle limitations of these analyses. They will be able to succinctly describe the results of such analyses in lay language and explain the relevance of modeling or quantitative analysis to a policy issue.

Texts or Materials:

Each week's readings will be available through the course website on Canvas (https://canvas.tufts.edu). Readings for each week should be completed in advance of class, as familiarity with that material will be the basis for class lectures and discussions.

We will be reading a number of chapters from Donella Meadows 2008 book, *Thinking in Systems: a Primer*. A pdf of the book is provided on the Canvas website, but students may also wish to purchase their own copy: https://www.chelseagreen.com/product/thinking-in-systems/

Many class session will require computer activities using spreadsheets and other software. Please bring a laptop computer to all class sessions.

How to be Successful in this Course:

To succeed in the course, students should attend all in-person class meetings, complete all assignments and readings by the deadlines specified on Canvas, participate in small-group and whole-class discussions, contribute equitably and respectfully to class assignments, and respect the norms that will be established at the beginning of the semester. I work to promote a collaborative atmosphere in my courses. Students should be helpful to other students, while understanding that each student (or assigned group) should be responsible for completing assignments independently.

Assignments and Grading:

NUTR 0342 is structured around readings, discussion, and hands-on experience with modeling tools. During most weeks, students will be required to complete short **reflection pieces** on readings and course topics and/or short **hands-on homework** activities outside of class. Some weeks students will be required to submit larger more **formal writeups**, using style appropriate for scientific publications, and usually including a table, graph, or map illustrating their work. At some point during the semester, each student should also research and deliver a short **presentation** about uses of food systems models in policy or other real-world applications. These presentations should apply concepts learned in the course, and should include a independently developed diagram illustrating the model and/or its relationship to larger systems. Each student will also be required to submit a short **final project** documenting the application of tools from the course to answer an original research question. There will also be **participation** points awarded for attendance, class participation, and collaborative spirit displayed during in-class activities.

Grades will be based on the following distribution:

<u>Regular assignments</u>	
Reflection pieces	10%
Hands-on homework	10%
Exercises / formal writeups	50%
<u>Independent projects</u>	
Presentation	5%
Final project	15%
<u>Participation</u>	
In-class participation	10%

All in-class and out-of-class assignment should use formal academic language and be free of spelling errors and poor grammar. References must be cited properly. Please make your best effort to submit all assignments on time. Unless an extension is granted, late assignments will be penalized 5% per day of lateness. **The Final Project may <u>not</u> be submitted late without prior instructor permission.**

Reflection pieces and *hands-on homework* will be assessed for clarity and completeness. *Formal writeups* will be assessed for clarity, completeness, quality and correctness of analysis, and adherence to formatting guidelines.

The *presentation* will be assessed for clarity, completeness, and inclusion of one or more correctly formatted diagram or visual aid.

The *final project* will be assessed for clarity, completeness, quality and correctness of analysis, inclusion of appropriate graphs, tables, diagrams, or maps, and adherence to formatting guidelines.

Grading Range:

A passing grade in the course is B- or better. Course grades will be based on the below (subject to revision during the course):

A	> 94%
A-	90 - 93.95%
B+	87 - 89.95%
B	84 - 86.95%
B-	80 - 83.95%

Instructions for Submission of Assignments and Exams:

Unless specified otherwise, all assignments should be submitted via the course site on Canvas.

With the exception of emergencies, students must request an extension within 48-hours prior to the due date for an assignment. Unless a postponement is approved in advance by the instructors, half a letter grade (5%) for the assignment will be deducted for missed deadlines, with an additional 5% deducted for each full day of delay. The Final Project may **not** be submitted late.

Academic Conduct:

You are responsible for upholding the highest standards of academic integrity, as specified in the Friedman School's Policies and Procedures Handbook located at this web page: https://nutrition.tufts.edu/about/policies-and-procedures, as well as Tufts University's policies (https://students.tufts.edu/community-standards/support-resources/academic-integrity-resources). This includes understanding and avoiding plagiarism, which is defined as the unacknowledged use of someone else's published or unpublished work. It is the responsibility of each student to understand and comply with academic integrity standards, as violations will be sanctioned by penalties ranging from failure on an assignment and the course to dismissal from the school.

Because writing, analytical, and critical thinking skills are part of the learning outcomes of this course, all work students submit for this course should be their own. Additionally, students are not permitted to use any generative artificial intelligence tools (e.g. ChatGPT or Dall-E 2) at any stages of the work process, including preliminary ones. AI-generated submissions are not permitted and will be considered as plagiarism.

Accommodation of Disabilities:

I will do my best to ensure each of you has the resources you need to succeed.

Tufts University is committed to providing equal access and support to all students through the provision of reasonable accommodations so that each student may access their curricula and achieve their personal and academic potential. If you have a disability that requires reasonable accommodations, please contact the Friedman School Assistant Dean of Student Affairs at 617-636-6719 to make arrangements for determination of appropriate accommodations. Please be aware that accommodations cannot be enacted retroactively, making timeliness a critical aspect for their provision.

Tufts Zoom:

The audio and video for all sessions of NUTR 0342 will be recorded by Tufts Zoom (https://access.tufts.edu/zoom) and posted on the course's Canvas site (https://login.canvas.tufts.edu/) when completed. Class might also be run in a fully remote format on days when the Boston campus is closed due to pandemic, weather or a temporary cancellation issue, or when the instructor is traveling or ill but able to teach. Under these circumstances, students should expect to be notified by an announcement on the course Canvas page by 6am on the morning of class. The Zoom links for all class sessions will be available on the course Canvas site. If an on-campus Examination, Presentation, etc. was scheduled on a day when the Boston campus is closed due to weather or a temporary cancellation issue and cannot be conducted by Zoom, the exam/presentation will be rescheduled for an alternate on-campus class session date.

In-person attendance is required for all sessions unless prior permission is granted by the instructor (see guidelines below).

On-Campus and Remote Participation:

- This course will be delivered in the classroom. **Only students who have received approval from the Friedman School's Assistant Dean for Student Affairs will be permitted to participate remotely by Zoom on a regular basis.**
- If you are ill, please do **NOT** come to campus. Contact the instructor to let them know you would like to participate by Zoom.
- If you will need to participate remotely for a particular class session, please contact the instructor or TA in advance.
- In the event of inclement weather leading to campus closure the instructor may choose to conduct the class remotely by Zoom.
- Again, all class sessions will be recorded, and all students in the course will have access to these recordings. Massachusetts law states that students have the right to not have their voices recorded in the classroom; if this is your wish you may refrain from participating verbally in class when the session is being recorded.

Course Overview:

The course's Canvas site is organized by subject-matter modules (Net Balance, Carrying Capacity, Foodsheds, Systems Dynamics, Supply Chains, and Transdisciplinary Models). Within the modules, there is a Canvas page for each class session, displaying the learning objectives for the class and the readings due for that session. Assignments will be posted when you are ready to begin them, with detailed instructions for each assignment submission.

NOTE: Classes shown in yellow meet in a different classroom

DATE OF CLASS	COURSE TOPIC	ASSIGNMENTS DUE
January 18	Food systems and modeling	N/A
January 23	Tools and terminology	Reflection 1
January 25	Concept of net balance	Reflection 2 **Sign up for presentation slots**
January 30	Consumption: translating between intake and supply	Hands-on activity 1
February 1	Production: translating between agriculture and food commodities	Hands-on activity 2
February 6	A net-balance study of New England	**Reflection 3: Final Project ideas** Reflection 4: Limitations of public data
February 8	Carrying capacity and land requirements	Reflection 5
February 13	Scenario development and estimating consumption for hypothetical diets	**Exercise 1: Net Balance**
February 15	Estimating land availability and agricultural yields	Reflection 6
February 20	**Exercise 2:** Working with the U.S. foodprint model	Hands-on activity 3
February 27	**Exercise 2:** Working with the U.S. foodprint model (continued)	Reflection 7
February 29	Concept of a foodshed	Reflection 8
March 5	Spatial analysis of food production and consumption	**Exercise 2**
March 7 Meet in MedEd 510	Mapping foodsheds	Reflection 9
March 12 Meet in MedEd 510	**Exercise 3:** Mapping a potential foodshed	Reflection 10

March 14 Meet in MedEd 514	**Exercise 3:** Mapping a potential foodshed (continued 1)	N/A
March 26 Meet in MedEd 510	**Exercise 3:** Mapping a potential foodshed (continued 2)	Reflection 11
March 28	Introducing Systems Dynamics	Hands-on activity 4
April 2	Examples in systems modeling	Reflection 12
April 4	**Exercise 1:** Systems model of livestock production	Hands-on activity 5
April 9 Meets remotely	**Exercise 1:** Systems model of livestock production (continued)	Reflection 13
April 11	Modeling supply chains	Reflection 14
April 16	**Exercise 4:** Modeling supply chains	Hands-on activity 6
April 18	Foodshed & supply chain synthesis	**Exercise 3**
April 23	Transdisciplinary models & integrated assessment	Reflection 15
April 25	Evidence & policy; Course review	**Exercise 4**
May 9 (finals week)	N/A	**Final Project**

This schedule is subject to modification at the instructor's discretion.

Topics, Assignments, and Learning Objectives for Each Class Session:

Class 1:
Date of Class: Jan 18
Topic: Food systems and modeling
Learning Objectives:

- Understand why models are used in science
- Explain how modeling differs from controlled experimentation and observation
- Identify types of questions that models are well-suited to answer

Readings Due:
1. Canham, C.D., Cole, J.J., and Lauenroth, W.K. 2003. Models in ecosystem science. *In* C.D. Canham, J.J. Cole, and W.K. Lauenroth (Eds.) Models in Ecosystem Science. Princeton University Press, Princeton, New Jersey.
2. Oreskes, N. 2003. The role of quantitative models in science. *In* C.D. Canham, J.J. Cole, and W.K. Lauenroth (Eds.) Models in Ecosystem Science. Princeton University Press, Princeton, New Jersey.
Assignments Due: N/A

Class 2:
Date of Class: Jan 23
Topic: Tools and terminology
Learning Objectives:
Upon completion of this class, students will be able to describe and discuss:

- What a model is
- Several types of models used in food systems
- The difference between systems dynamics and other types of models
- How to think about the limitations of a model, including the simplifications inherent to all forms of modeling

Readings due:
"Chapter One: The Basics" from Meadows, D.H. 2008. Thinking in Systems: A Primer. Chelsea Green Publishing, White River Junction, VT. (available on course Canvas site)
Assignments Due:
Reflection 1: Think about how systems dynamics might be used to help understand food systems, and submit of one or more examples of parts of the food system that might be better understood through systems thinking.

Class 3:
Date of Class: Jan 25
Topic: Concept of net balance
Learning Objectives:
Upon completion of this class, students will be able to:

- Explain the contexts in which net-balance studies have been used in the literature on food systems.
- Interpret the results of a net-balance study of a food system
- Explain how net balance would be understood through a systems thinking framework
- List common errors in understanding net-balance studies and describe the limits of the net-balance approach

Readings Due:
1. Griffin, T., Conrad, Z., Peters, C. Ridberg, R., and Tyler, E.P. 2015. Regional self-reliance of the Northeast Food System. Renewable Agriculture and Food Systems 30(4): 349-363.
2. Dorward, C., Smuckler, S.M., and Mullinix, K. 2017. A novel methodology to assess land-based food self-reliance in the Southwest British Columbia bioregion. Renewable Agriculture and Food Systems 32(2): 112-130.
3. Wood et al. 2018. Trade and the equitability of global food nutrient distribution. Nature Sustainability 1: 34-37.
Assignments Due:

- Sign up for presentation slots
- Reflection 2: Net balance discussion

Class 4:

Date of Class: Jan 30

Topic:: Consumption: translating between intake and supply

Learning Objectives:

Upon completion of this class, students will be able to describe, discuss and critique:

- Challenges of converting food intake into the required food supply
- Challenges of converting food supply into estimated intake
- Strengths and weaknesses of intake and food supply data for estimating consumption

Readings Due:

Spend some time exploring the model documentation links below

Web-based data documentation:

1. USDA ERS (2021) Food Availability documentation

2. USDA ERS (2020) Loss-Adjusted Food Availability documentation

3. USDA ARS (2021) WWEIA (food intake) overview page

4. USDA ARS (2021) FICRCD overview page

Reports on methodology for LAFA and FICRCD

5. Kantor et al. (1998) A Dietary Assessment of the U.S. Food Supply: Comparing Per Capita Food Consumption with Food Guide Pyramid Serving Recommendations. Kantor (1998)

7. Bowman et al. (2013) Food Intakes Converted to Retail Commodities Databases 2003-2008: Methodology and User Guide Bowman et al. (2013)

Assignments Due:

- Hands-on activity 1 – LAFA spreadsheets (https://www.ers.usda.gov/data-products/food-availability-per-capita-data-system/)

Class 5:

Date of Class: Feb 1

Topic: Production: translating between agriculture and food commodities

Learning Objectives:

Upon completion of this class, students will be able to describe, discuss and critique:

- The differences in how Census and Survey data are collected
- The value of these data for estimating production
- How to convert estimates of agricultural production into equivalent amounts of edible food

Readings Due:

1. Review this information provided on data for analysis:

2. USDA NASS (2018) Foundation of NASS survey estimates

3. USDA NASS (2007) Census of Agriculture, Appendix A - Methodology

4. USDA NASS (2007) Census of Agriculture, Appendix B - Report Form

5. UN FAO (Accessed 2021) FAO on agricultural censuses

Assignments Due:

Hands-on activity 2 – exploring Census of Agriculture database

Class 6:

Date of Class: Feb 6

Topic: A net-balance study of New England (Exercise 1)

Learning Objectives:

Access data from the Loss-Adjusted Food Supply database, the Census of Agriculture, and the NASS annual surveys
Assemble the requisite data to produce a carefully documented spreadsheet analysis that can readily be followed by someone unfamiliar with the work
Complete a net-balance analysis of a food commodity and accurately calculate self-sufficiency ratios
Report your findings in a journal-quality table or figure containing sufficient documentation such that the exhibit stands alone.
Explain the work in a concise, multi-part abstract that clearly interprets the meaning of the results.

Readings Due: None

Assignments Due:

Reflection 3: Final Project ideas
Reflection 4: Limitations of using published data to connect production to consumption & alternative approaches

Class 7:

Date of Class: Feb 8

Topic: Carrying capacity and land requirements

Learning Objectives:

Upon completion of this class, students will be able to describe, discuss and critique:

- How studies of human carrying capacity fit into a systems thinking framework
- The relationship between human carrying capacity and the ecological carrying capacity for biomass or wildlife populations
- The definition of carrying capacity and its relevance to sustainability
- The definition and classification of agricultural land
- The relevance of dietary land requirements to food security and environmental impact

Readings Due:

1. Peters et al. 2016. Carrying capacity of U.S. agricultural land: Ten diet scenarios. *Elementa: Science of the Anthropocene*. 4: 000116
2. Van Zanten *et al.* 2018. Defining a land boundary for sustainable livestock consumption. *Global Change Biology* **24**(9): 4185-4194.
3. Shepon *et al. 2018.* The opportunity cost of animal based diets exceeds all food losses. *Proceedings of the National Academy of Sciences* **115**(15): 3804-3809.
4. Bringezu, S. *et al*. 2021. Environmental and socioeconomic footprints of the German bioeconomy. *Nature Sustainability* **4**(9):775–783.

Assignments Due: Reflection 5 – Carrying capacity discussion

Class 8:

Date of Class: Feb 13

Topic: Scenario development and estimating consumption for hypothetical diets

Learning Objectives:

Upon completion of this class, students will be able to describe, discuss and critique:

- The definitions and relationships between area, yield, and production
- Sources of crop yield data
- Sources of livestock feed requirement data

Readings Due:

1. Bigelow & Borchers. 2012. Major Uses of Land in the U.S., 2012 USDA-ERS.

Assignments Due: Exercise 1: A net-balance study of New England

Class 9:

Date of Class: Feb 15

Topic: Estimating land availability and agricultural yields

Learning Objectives:

Upon completion of this class, students will be able to describe, discuss and critique:

- The differences between scenarios and forecasts
- How to develop engaging scenarios that are informative for planning
- Examples of scenarios used in food system studies
- How relevant are past consumption patterns to the creation of hypothetical scenarios?
- How do analysts transform abstract ideas about a hypothetical diet into a concrete list of individual food commodities?

Readings Due:

Recommended readings:

1. Reilly and Willenbockel (2010) Managing uncertainty: a review of food system scenario analysis and modelling. Philosophical Transactions of the Royal Society B 365: 3049-3063

Reilly and Willenbockel (2010)

2. Mouel and Forslund (2017) How can we feed the world in 2050? A review of the responses from global scenario studies. European Review of Agricultural Economics 44(4) Mouel and Forslund (2017)

Assignments Due: Reflection 6: Foodprints, sustainability, and diet

Class 10:

Date of Class: Feb 20

Topic: Working with the U.S. foodprint model (Exercise 2)

Learning Objectives (classes 14 & 15):

Upon completion of this class, students will be able to:

- Trace the relationships between the component worksheets in the model for an individual commodity
- Access additional data sources not used in the previous unit, such as population data from the U.S. Census Bureau or nutrient composition data from the Nutrient Database for Standard reference
- Use the foodprint model in a systematic fashion to assess different scenarios of dietary intake.
- Add a food to the model, including all requisite data and formulae needed to integrate that food commodity into the model
- Explain how working directly with a model influences their perceptions of land use, diet, and carrying capacity

Readings Due:

Review instructions for Exercise 2.

Assignments Due: Hands-on activity 3: Understanding the tabs of the U.S. Foodprint spreadsheet + what questions do you have?

Class 11:

Date of Class: Feb 27

Topic: Working with the U.S. foodprint model (Exercise 2)

Learning Objectives (classes 14 & 15):

Upon completion of this class, students will be able to:

- Trace the relationships between the component worksheets in the model for an individual commodity
- Access additional data sources not used in the previous unit, such as population data from the U.S. Census Bureau or nutrient composition data from the Nutrient Database for Standard reference
- Use the foodprint model in a systematic fashion to assess different scenarios of dietary intake.
- Add a food to the model, including all requisite data and formulae needed to integrate that food commodity into the model
- Explain how working directly with a model influences their perceptions of land use, diet, and carrying capacity

Readings Due: Review instructions for Exercise 2.

Assignments Due: Reflection 7 – Foodprint model vs. systems dynamics vs. empirical studies

Class 12:
Date of Class: Feb 29
Topic: Concept of a foodshed
Learning Objectives:
Upon completion of this class, students will be able to describe, discuss and critique:
- The origin of the term foodshed
- Meaning of the concept and variations in definition
- How the concept is relevant to sustainability
- How studies of foodsheds fit into a systems thinking framework

Readings Due:
1. Hedden, W. 1929. Watersheds, Milksheds, and Foodsheds. Chapter II *in* How Great Cities Are Fed. D.C. Heath and Company, New York, NY.
2. Horst, M. and Gaolach, B. 2015. The potential of local food systems in North America: A review of foodshed analyses. *Renewable Agriculture and Food Systems* **30**(5): 399–407. Horst and Gaolach (2015)
3. Nixon, P.A. and Ramaswami, A. 2018. Assessing Current Local Capacity for Agrifood Production To Meet Household Demand: Analyzing Select Food Commodities across 377 U.S. Metropolitan Areas. *Environ. Sci. Technol.* **52**: 10511−10521. Nixon and Ramaswami (2018)

Assignments Due: Reflection 8 – Foodshed discussion

Class 13:
Date of Class: Mar 5
Topic: Spatial analysis of production and consumption
Learning Objectives:
Upon completion of this class, students will be able to describe, discuss and critique:
- Variation in the approaches used to map foodsheds
- Interpretation of food analysis results
- Strengths and weaknesses of various approaches

Readings Due:
1. Zumkehr and Campbell. 2015. The potential for local croplands to meet US food demand Frontiers in Ecology and the Environment, 13(5) 2015. 244-248.
2. Peters et al. 2009. Mapping potential foodsheds in New York State: A spatial model for evaluating the capacity to localize food production Renewable Agriculture and Food Systems, 24(1). 72-84.

Assignments Due: Exercise 2: Foodprint

Class 14:
Date of Class: Mar 7
Topic: Mapping foodsheds
Learning Objectives:
Upon completion of this class, students will be able to describe, discuss and critique:
- Differences and similarities between land cover and land use
- Sources of spatial data on land cover
- Methods for assessing productivity of soils and climate
- Concept of an urbanized area
- How to define the point of consumption in a foodshed analysis in both urban and rural contexts

Readings Due: Review ArcGIS Pro tutorials on Raster and Vector analysis; documentation on ArcGIS Pro Zonal toolbox
Optional: View NUTR 231 recorded lectures on raster and vector analysis
Assignments Due: Reflection 9: Questions on GIS tools

Classes 15:

Date of Class: Mar 12

Topic: Mapping a potential foodshed (Exercise 3)

Learning Objectives:

Upon completion of this class, students will be able to:

- Access the raw spatial data required for conducting a basic foodshed analysis, such as land cover data and urban area delineations
- Process the raw spatial data to create the layers of spatial information on production potential and food requirements used in the foodshed model
- Perform a basic foodshed analysis using tools available within ArcGIS and integration of data from previous exercises
- Troubleshoot solutions to address gaps in data availability
- Explain the assumptions inherent in a foodshed analysis and correctly interpret a map of a potential, local foodshed

Readings Due: None

Assignments Due: Reflection 10: Plan for GIS foodshed analysis

Class 16:

Date of Class: Mar 14

Topic: Mapping a potential foodshed (Exercise 3) [continued 1]

Learning Objectives:

Upon completion of this three-part class, students will be able to:

- Access the raw spatial data required for conducting a basic foodshed analysis, such as land cover data and urban area delineations
- Process the raw spatial data to create the layers of spatial information on production potential and food requirements used in the foodshed model
- Perform a basic foodshed analysis using tools available within ArcGIS and integration of data from previous exercises
- Troubleshoot solutions to address gaps in data availability
- Explain the assumptions inherent in a foodshed analysis and correctly interpret a map of a potential, local foodshed

Readings Due: None

Assignments Due: None

Class 17:

Date of Class: Mar 26

Topic: Mapping a potential foodshed (Exercise 3) [continued 2]

Learning Objectives:

Upon completion of this three-part class, students will be able to:

- Access the raw spatial data required for conducting a basic foodshed analysis, such as land cover data and urban area delineations
- Process the raw spatial data to create the layers of spatial information on production potential and food requirements used in the foodshed model
- Perform a basic foodshed analysis using tools available within ArcGIS and integration of data from previous exercises
- Troubleshoot solutions to address gaps in data availability
- Explain the assumptions inherent in a foodshed analysis and correctly interpret a map of a potential, local foodshed

Readings Due: None

Assignments Due: Reflection 11: Plan for second stage of GIS foodshed analysis

Class 18:

Date of Class: Mar 28

Topic: Introducing Systems Dynamics Modeling

Learning Objectives:

Upon completion of this class, students will be able to describe and discuss:

- The roles of stocks, flows, and auxiliary variables in systems models
- How to translate between the equations used to define a systems dynamics model and the graphical depictions of the same model
- Time series line graphs of stocks and flows.
- Examples of where systems thinking will help to understand food systems

Readings due:

StochSD User's Manual Part 1: https://stochsd.sourceforge.io/manuals/StochSD_User_Manual.pdf

Assignments due:

Hands-on activity 4: StochSD interface basics

Class 19:

Date of Class: Apr 2

Topic: Examples in Systems Modeling

Learning Objectives:

Upon completion of this class, students will be able to use StochSD to build systems dynamics model based on the description and equations, and make basic modifications to independently run simulated experiments. Student should also be able to describe, discuss and critique:

- How the concepts of stocks, flows, feedback loops, and equilibrium states describe real world phenomena, like population growth.
- Why modeling change over time is important to food systems analysis
- How to recognize classic systems problems
- How systems thinking compares with predominant conventional wisdom
- Apply simple systems thinking to help understand pandemic-related disruptions to the supply chain

Readings due:

"Chapter Two: A Brief Visit to the Systems Zoo" from Meadows, D.H. 2008. Thinking in Systems: A Primer. Chelsea Green Publishing, White River Junction, VT. (available on course Canvas site)

Assignments due:

Reflection 12: Thoughts & questions on systems dynamics

Class 20:

Date of Class: Apr 4

Topic: Working with a systems model of livestock production

Learning Objectives:

Upon completion of this class, students will be able to:

- Define and illustrate central concepts in systems thinking: inflection points, equilibrium states, and lag times in observing a change in a system
- Use a system model to identify the sensitivity of a system to changes in key parameters to identify leverage points
- Construct and analyze a simple systems-model using Excel

Readings Due:

1. Peters, C. J. 2014. Feed conversions, ration compositions, and land use efficiencies of major livestock products in the U.S. agricultural systems. *Agricultural Systems*. **130**: 35-43

2. Excel tutorials (TBD)

Assignments Due: Hands-on activity 5 – practice with Excel

Class 21:

Date of Class: Apr 9 [MEETS REMOTELY]

Topic: Working with a systems model of livestock production (continued)

Learning Objectives:

Upon completion of this class, students will be able to:

- Explain reasons when systems dynamics models are useful and what information they provide
- Identify limitations of a systems dynamics model
- Describe alternative approaches to answering questions answered by systems dynamics models
- Discuss trade-offs between systems dynamics models and empirical studies

Supplemental readings:

1. Remaining chapters of: Meadows, D.H. 2008. Thinking in Systems: A Primer. Chelsea Green Publishing, White River Junction, VT. (available on course Canvas site)
2. Meadows, D.H. 2007. History and Conclusions of the Limits to Growth. System Dynamics Review, 23(2/3): 191-197.

Assignments Due: Reflection 13: systems dynamics vs. empirical studies

Class 22:

Date of Class: Apr 11

Topic: Modeling supply chains

Learning Objectives:

Upon completion of this class, students should be able to:

- Define what a supply chain is
- Describe the parts of a supply chain model and how they interact
- Discuss approaches to supply chain modeling
- Discuss how systems thinking can help to understand supply chains

Readings Due:

1. Kumar, S., and A. Nigmatullin. 2011. A system dynamics analysis of food supply chains – Case study with non-perishable products. *Simulation Modelling Practice and Theory* 19(10):2151–2168. Available: https://www.sciencedirect.com/science/article/pii/S1569190X11001213
2. Zhang, Y., Y. Chai, and L. Ma. 2021. Research on Multi-Echelon Inventory Optimization for Fresh Products in Supply Chains. *Sustainability* 13(11):6309. Available: https://www.mdpi.com/2071-1050/13/11/6309
3. Peña, J. A. D., this link will open in a new window Link to external site, Á. O. Bas, and N. M. R. Maldonado. 2021. Impact of Bullwhip Effect in Quality and Waste in Perishable Supply Chain. *Processes* 9(7):1232. Available: https://www.proquest.com/docview/2554723884/abstract/3EF67C5859654EE1PQ/1

Assignments Due: Reflection 14: Final Project analysis plan

Class 23:

Date of Class: Apr 16

Topic: Modeling supply chains (Exercise 4)

Learning Objectives:

Upon completion of this class, students should be able to:

- Construct a several-level supply chain model using StochSD
- Use a supply chain model to illustrate the bullwhip effect
- Discuss the challenges of identifying parameterizing supply chain models

Readings Due: None

Assignments Due: Hands-on 6: Exploring SochSD supply chain models Exercise 3

Class 24:

Date of Class: Apr 18

Topic: Localization of supply chains

Learning Objectives:

Upon completion of this class, students should be able to:

- Compare the frameworks for understanding supply chain and foodshed models
- Identify the limitations of different modeling approaches
- Critique supply chain and foodshed models using a systems thinking lens

Readings Due:

1. Atallah, S.S., Gomez, M.I, and Bjorkman, T. 2014. Localization effects for a fresh vegetable product supply chain: Broccoli in the eastern United States. Food Policy 49: 151-159.
2. King et al. 2010. Comparing the Structure, Size, and Performance of Local and Mainstream Food Supply Chains. Economic Research Report No. 99, USDA Economic Research Service.)
3. Ge, H., M. Gómez, and C. Peters. 2022. Modeling and optimizing the beef supply chain in the Northeastern U.S. Agricultural Economics 53(5):702–718. https://onlinelibrary-wiley-com.ezproxy.library.tufts.edu/doi/pdf/10.1111/agec.12708

Assignments Due: Exercise 3: Foodshed mapping

Class 25:

Date of Class: Apr 23

Topic: Transdisciplinary models & integrated assessment

Learning Objectives:

Upon completion of this class, students will be able to:

- List examples of transdisciplinary research and participatory assessment that incorporate models
- Understand the challenges of translating stakeholder ideas and goals into quantitative models
- Describe challenges of usefully describing quantitative modeling processes and outputs to stakeholders with diverse backgrounds
- Identify ways that topics from the course can be applied to answering transdisciplinary questions about food systems and supply chains
- Synthesize concepts from different types of models
- Critique evidence-based recommendations for global diets

Readings Due:

1. Salter J et al. 2010. Participatory methods of integrated assessment - a review. WIREs Climate Change, 1. 697-717. Salter_2010.pdf
2. Willet et al. (2019) Food in the Anthropocene: the EAT---Lancet Commission on healthy diets from sustainable food. The Lancet 393 (10170) EAT-Lancet Commission Report (2019)
3. Springmann, M., et al. 2021. The global and regional costs of healthy and sustainable dietary patterns: a modelling study. *The Lancet Planetary Health*:S2542519621002515.

Assignments Due: Reflection 15: Integrated & Transdisciplinary modeling

Class 26:
Date of Class: Apr 25
Topic: Evidence and policy
Learning Objectives:

Upon completion of this class, students should be able to:

- Discuss the role of science-based evidence in values-driven processes
- Discuss the level of evidence required for concrete policy decisions
- Critique approaches to translating model results into policy applications
- Review course content
- Identify ways that different kinds of models contribute to ongoing debates about diets, food security, and sustainability

Readings Due:
1. Bryce, E. (30 March 2018). What if we treated meat consumption like food waste? http://www.anthropocenemagazine.org/2018/03/what-if-we-treated-meat-consumption-like-food-waste/
Assignments Due: Exercise 4

Finals Week:
Date: May 9
NO CLASS
Assignments Due: Final project

The above schedule is subject to modification at the instructor's discretion.