

New Field Course Proposal:

# Regional and Global Chemical and Physical Effects of Agriculture: Organic vs. Industrial Farming

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## 1 Overview

We propose a new, mixed classroom/field course centered around the Hawthorne Valley cluster of biodynamic farms (HVF) in the Berkshire hills of east central New York. The HVF offers a unique setting of an intensive, large-scale, commercially thriving biodynamic family of farms. The farms employ nearly perfectly sustainable practices in an area with immediate access to an impressive array of natural and man-made environments. Those include old-growth and secondary growth natural forests, relatively unpolluted streams, creeks, rivers and lakes, geological richness and industrial and organic farms of various scales and levels of rigor. The Hudson River valley area also epitomizes many of the development pressures and dilemmas with which most of ex-urban rural America struggles, thereby providing an excellent case study of those struggles.

The foci of the proposed course are (1) the naturally occurring energy and mass cycles; (2) their alterations by agriculture; and (3) the qualitative and quantitative differences between the perturbations imposed by industrial agriculture and smaller-scale organic farming and its various variants. The course has been developed in close collaboration with the scientific, administrative and farm staff of the HVF, and is expressly designed to take full advantage of the important assets offered by this staff. From the University of Chicago, the course will be taught by Pamela Martin and Gidon Eshel (Department of Geophysics and the Environmental Studies program), thereby offering substantial expertise in both geochemistry and biogeochemical cycles (Martin) and mass and energy atmosphere–land transfer processes (Eshel). The course also draws on the experience gained by Eshel over the years of teaching *The Planetary Consequences of Human Diet* in the Environmental Studies program at Chicago. Finally, Eshel and Martin have just authored a paper, to appear in *Earth Interactions*, on the global energy consequences of plant-based vs. animal-based human diets, from

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which the proposed course stems intellectually.

In designing the course, we set out to tackle two problems we identify in current geophysical education. First, while in general technically advanced and thorough, existing geophysical curricula are often phenomenologically extremely focused and disciplinarily narrowly defined. At the same time, they tend to lack a Central element that can make geophysics more societally useful, the multidisciplinary regional context. Yet many of today's most pressing environmental issues are regional and multidisciplinary in nature. For example, water scarcity and pollution—ubiquitous worldwide and at times centrally detrimental to further development—reflect not only physical variables such as local meteorology, hydrology or botany, but also societal parameters such as farming and water use practices. Air pollution, also a major affliction of the developed and developing world, represents not only local boundary layer meteorology and geography of principal polluters, but also political realities governing legislative mitigation measures or the availability of pollution reducing technologies. Addressing such complex, multi-faceted problems requires deep understanding of the specific region in question, and clearly transcends traditional disciplinary barriers, involving several of the social and physical sciences. In designing this course, we strive to provide an academic, intellectual home for such region-focused, trans-disciplinary thinking that has been the philosophical foundation of the HVF for decades.

## 2 Rough Outline of Proposed Curriculum

The course will have two elements. The first, a classroom component held in Chicago, will comprise lectures and exercises, and will meet four to six times (as needed) during the semester prior to the field component. The second, field component to be held at the HVF, will include 10-14 days of day hikes, road trips and on-site lectures as well as activities and supervised work on the farm.

### 1. The geophysical foundation

- the geophysics of agriculture
  - the idea of natural cycles
  - the global energy, water and nutrient cycles
  - regional and local cycles, residuals and open budgets
  - anthropogenic alterations and perturbations of global and local cycles
  - perturbations due to food production

field component: Hiking from the parking lot at Mount Everett to the lower parking lot at Bash Bish falls, demonstrating the above processes in the nearly pristine setting of the Bash Bish/Wright Brooks of southwestern MA. Water sample collection and nutrient content, turbidity, sediment load and pH analyses.

- the geological setting

- geological structure
- geomorphic features
- spatial heterogeneity

field component: a road trip across the main features from Hudson, NY to Northampton, MA with multiple short hikes to road cuts and principal off-road features.

- the climate and weather of southern New England
  - climatological seasonality
  - climate and weather extremes
  - seasonal, annual, interannual and longer variability

hands-on component: Supervised analysis of historical data from long-reporting stations in the region such as Pittsfield, Great Barrington and Amherst.

- the meteorology, precipitation and hydrology of the region
  - precipitation generating processes
  - percolation and runoff in various settings
  - hydrological timescales and response time
  - anthropogenic alterations of the hydrologic cycle on global and local scales
- the evolution, development, and maintenance of local flora and soils
  - chemical and physical erosion
  - soil evolution and strata
  - soil fauna and flora
  - sustainable soil regeneration

field component: a north-south road trip complementing the earlier east-west one, across the main features from Millbrook, southern Columbia county, to central VT with multiple short hikes to road cuts and principal off-road features, emphasizing geology, weather, climate, hydrology and soils. A hike through Bartholomew Cobble with emphasis on the interactions of the hill slopes with the Housatonic and their effects on vegetation succession and development. Comparison of the meandering part of the river with its naturally straight or anthropogenically straightened parts near the towns of Stockbridge and Housatonic with respect to flow patterns, erosion, soil retention.

## 2. agriculture and food production: at the HVF and environs

- an introductory survey of the farm
  - a thorough examination of the dairy farm including detailed analysis of the full spectrum of the technicalities of milk and dairy product production

- a similar examination of the greenhouse and the (dormant at that time of year) vegetable plots
- an experiential analysis of CSA in action and the direct sales facilitated by the farm store

field component: a hike through the farm fields and streams, the (seasonally active or not) pastures. Sampling water from the stream behind the farm and analyzing it for nutrient content, turbidity, sediment load and pH. Comparison with the results from the relatively pristine Bash Bash/Wright Brooks.

- comparison of the HVF with neighboring industrial farms. Each visit comprises collection of water and soil samples for later chemical analysis, as well as gathering as much information about use by the farm of energy (such as diesel, electricity, gasoline) and other inputs (such as synthetic fertilizers, herbicides and pesticides)
  - a guided comparative visit to Odyssey Farm in Copake Falls, NY, a large-scale, privately owned and operated dairy farm
  - a guided comparative visit to the Old Chatham Shepherding Co. farm in Old Chatham, NY and to the nearby Chatham Alpacas farm in Chatham Center, NY

hands-on component: a two-group-based comparative analysis of the all the information gathered during the field trips, augmented by web-based data gathering. The final objective is for the groups to orally present a thorough planetary footprint analysis and comparison of industrial vs. biodynamic farming in terms of all inputs, all brought to a common denominator of energy requirements.

3. development: a meeting with—and a road trip guided by—Patty Rohrlich, Planning Board chairwoman of Hillsdale, NY (a small hamlet near HVF now struggling to maintain its rural character in the face of enormous second-home development pressures)

We envision a course with open enrollment and no prerequisites. We wish to welcome students of the social-, physical- and biological-sciences, and the humanities. The course will build on those diverse strengths and contributions the variable backgrounds will afford, and will integrate those narrow contributions into a single, synthetic, framework that is inherently regional, squarely at the interface of science and societal needs. While disciplinarily diverse, the course will be quantitatively rigorous because, in the context of matter and energy budgets, rigor is often simply book-keeping requiring no more than division and multiplication, addition and subtraction. The course approach will serve as a prototype, equipping students with skills needed for the construction of a simple yet complete, accurate quantitative argument that can be readily applied to almost any environmental problem.