Ecology of Agricultural Systems
AGRO 5321
2014 Landscape Design/AEA Project

Working in groups, we will do a case study of landscape design for sustainable development of agriculture in the US 'Corn Belt' region. As Atwell et al. (2011) discuss, the Corn Belt is a globally significant resource because of soils, climate, water and infrastructure that create an enormous productive capacity. Yet, from some points of view, there are problems related to a variety of drivers, stressors, ecological effects, and resulting impacts on a wide range of valued attributes, as we have discussed in class. The purpose of this case study is to give you an initial experience with a social process of landscape design following the process that we have broadly outlined in class, in which a systemic assessment of the biophysical aspects of an agroecosystem is followed by a process of restructuring of the spatial pattern of plant communities across a landscape, guided by spatial modeling to assess the impact of this restructuring on a set of valued attributes. We will use the PE/WI model (Donahey et al. 2008) for this purpose. This model (Fig. 1) provides a flexible platform for exploring the biophysical consequences of 'what if' scenarios of landscape restructuring. PE/WI simulates the biophysical functioning of a small watershed in a landscape typical of certain parts of the state of Iowa. It provides a reasonable model of the watershed of Elm Creek in south-central Minnesota, which we have discussed in our class meeting on agroecosystem analysis (2/26/14).

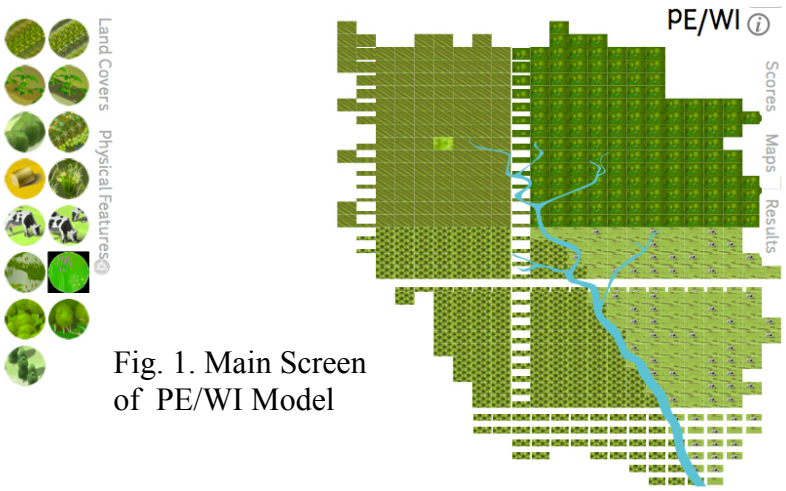

Fig. 1. Main Screen of PE/WI Model

Here is the process we will follow in this project:

1) For background, please read Atwell, R. C., L. A. Schulte, and L. M. Westphal. 2011. Tweak, Adapt, or Transform: Policy Scenarios in Response to Emerging Bioenergy Markets in the US Corn Belt. Ecology and Society **16**, which is available from the moodle site. The article reports on the outcomes of landscape design workshops that were done in 2010 in Iowa by a multi-stakeholder group composed of sectors and groups that represented a wide range of interests in agriculture, food, water, biodiversity and other resources. The group identified three broad scenarios for change in the Corn Belt agriculture of Iowa, driven by demand for bioenergy from agriculture as well as other ecosystem services. These scenarios are termed 'Tweak', 'Adapt' and 'Transform'. Each is identified in terms of certain changes in landscape design and functioning, and related to particular pathways for change in a system model that is closely related to the agroecosystem conceptual models we have considered.

An important feature of our case study is the challenge of addressing the concerns of multiple stakeholder groups. As Atwell et al. discuss, many different stakeholder groups are interested in

restructuring Corn Belt landscapes to pursue their particular interests. These groups include environmental and agriculture agencies and NGOs, among others. The question is how to create an adequately multifunctional landscape that is acceptable to farmers, landowners, influential stakeholder groups, and the general public. PE/WI allows us to work with this landscape as a 'gameboard'. We can use a wide range of plant communities as 'pieces' to deploy on the gameboard, to explore how pieces could be arranged in space to provide particular 'bundles' of ecosystem goods and services, ranging from production of various commodities to effects on a range of other valued attributes.

We will focus on the 'Adapt' and 'Transform'scenarios of Atwell et al. (2011). The Adapt and Transform scenarios differ in the degree of land-use change, which is modest in the Adapt scenario and major in the case of Transform. In essence, the Adapt scenario envisions that corn/soybean agriculture will continue to be the dominant form of agricultural production, but that demand for other ecosystem services will increase, so that farmers and landowners will adapt their landscapes by targeted conversation of a small fraction of land to other plant communities, in an attempt to respond to demand for additional ecosystem services. The Transform scenario envisions major changes in land-use, in which corn and soybeans are replaced on a substantial fraction of the landscape, replaced by extensive areas devoted to a wide range of other production systems and land use.

Working with your group, please use the PE/WI model as a tool to develop and describe ***two alternative designs*** for restructuring the model watershed watershed along the general outlines suggested in the 'Adapt' scenario, and ***two alternative designs*** for restructuring according to the 'Transform' scenario. By "design", I mean a particular pattern of land use and land cover that is altered somehow from the landscape depicted in PE/WI. The PE/WI model is available at http://www.nrem.iastate.edu/landscape/pewi/. Here are some details to guide your work:

1) In your landscape designs for the Adapt scenario, your guideline is to change land use on roughly 10% of the parcels (30 m by 30 m units) of the landscape, which represents a 5900 acre (2400 hectare) watershed. There are about 600 parcels in the PE/WI landscape, so you have 60 parcels available to change. You may change these parcels to any land-use type, located anywhere you wish within the watershed. In your designs for the Transform scenario, you may change land use on roughly 50% of parcels in the watershed; again, you have complete license to change these as you see fit.

2) Your two designs for each scenario should ***each have some particular merit***; i.e., each should improve the multifunctionality of the watershed, as measured by the 'bundle' of goods and services provided by the watershed. In describing what your watershed provides and produces, please refer to the attributes that are calculated by the PE/WI model (e.g., biodiversity, cattle production, area of corn and soybean crops) but you are free to envision others, e.g., ecotourism opportunities created by the beauty of your landscape design. We do not have time in this exercise to identify 'optimal' designs from any point of view, so in each scenario, simply try to identify two designs that are appealing in some way and that create different bundles of goods and services.

3) As noted, your two designs for each scenario should differ from each other in the bundle of goods and services that each produces. In other words, please attempt to identify a trade-off between goods and services produced by each design; the strengths and weaknesses of the designs should differ.

4) Here are some details to consider as you create your designs:
   - Bear in mind the 'farmability' of your design. Mixing different plant communities together in fine-grained patterns creates difficulty for mechanized farming. Instead, consider changing land-use types to create 'squared-off' boundaries for areas of crops to facilitate mechanized farming, i.e., use of tractors, harvesting machines etc.
   - Also bear in mind the aesthetics of your landscape. Try to envision what the landscape might look like for residents of the area and for visitors.
   - Use the topographic and other maps that are provided in the PE/WI model to guide your thinking. The maps can help you identify particular landscape areas that are important to the flow of water (e.g., because they are steep) and to soil erosion and risk of release of phosphorous from the watershed into waterways. Changing land use in these areas can have larger effects than changes in other areas.

Please be well aware that there is no single 'right way' to do this project. Please use your creativity and imagination and have fun.

Each group should then create a report providing a concise narrative that describes each of your four landscape designs, and provide a screenshot of your design and its performance. In your narrative, describe what land-use changes you made in each in each design, your goals in each design, the bundle of goods and services produced by the design, and the strengths and weaknesses of each design. Please refer explicitly to the Elm Creek AEA that I presented in class on 2/26, and discuss how you think the restructuring that you propose for your project area in each design will affect specific drivers (if relevant), stressors, ecological effects, and attributes that we discussed in our Elm Creek watershed case study.

In doing so, it will be helpful to review the discussions of landscape management to provide ecosystem services related to water resources, climate change and biodiversity, and the discussion of trade-offs in Smukler et al. 2012. Ecosystem Services in Agricultural Landscapes. Please also include a reflective discussion of how landscape redesign could be used to address the kinds of stressors that are operating in Elm Creek, according to the agroecosystem conceptual model discussed in class on 2/26. Can you identify any approaches, strategies or concepts for land-use change that seem particularly efficient or effective in improving key attributes in the watersheds like Elm Creek? If yes, consider and briefly discuss any key assumptions or premises related to your recommendations. Finally, please include a reflective discussion (one-two pages) of your group's experience in this exercise. Please identify and discuss one or two things that you learned, individually and as a group, in the process. As well, please identify and discuss one or two difficulties or challenges you encountered in this exercise.

What to hand in: Each group should write a single report as a group effort; these should be typed and double-spaced, including all of the above components; I suggest an upper limit of 10 double spaced pages in addition to your map. ***Group AEA Reports are due in class 3/12/14.***