LCCM and Ecological Functions

The implementation of a high-resolution spatial grid allows us to estimate changes in landscape metrics. In landscape ecology these metrics are good predictors of the ecosystem ability to support important ecosystem functions. We use a set of landscape metrics derived from information theory to model the use of the complex spatial pattern of land use and cover on human and ecological processes. These metrics characterize the composition (e.g. diversity, dominance etc.), spatial configuration (e.g. density, size, shape, edge, connectivity, fractal dimension) and spatial neighborhood (e.g. heterogeneity and contagion) of the landscape.

Integration of LCCM and UrbanSim

UrbanSim has been initially linked to the LCCM, providing location demand outputs as a variable to compute the probability of land cover transition, but there is currently no feedback from LCCM back to UrbanSim. Current configurations of UrbanSim models consider location, land value, land use, and a limited set of land cover descriptors as inputs or constraints on land (re)development. We propose to “close the loop” between the LCCM and UrbanSim. Feedbacks from the LCCM about parcel land cover and, as well as contextual land cover metrics representing composition, configuration, and spatial neighborhood could make UrbanSim predictions more robust. This version of the LCCM used an earlier, grid-cell based version of UrbanSim, and the current project would upgrade the LCCM to work with UrbanSim at a parcel level of detail to achieve more behavioral realism. The new location demand outputs from UrbanSim could then influence predictions for the LCCM. Adding spatial configuration and neighborhood effects of the location demand patches also provides additional realism to the urban and land cover models.

Increasing evidence shows that these patterns influence human preference and well-being, so spatial metrics will be used to model the effects of land use and cover patterns and ecosystem change on UrbanSim agent decisions.

Effects of mid-twenty-first century climate and land cover change on the hydrology of the Puget Sound basin, Washington

Cuo, L., Lettemeier, D.P., Alberti, M., Richy, J.E. 2009. The distributed hydrology–soil–vegetation model (DHSM) was used to study the potential impacts of projected future land cover and climate change on the hydrology of the Puget Sound basin, Washington, in the mid-twenty-first century. A 60-year climate model output, archived for the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4), was statistically downscaled and used as input to DHSM. From the DHSM output, we extracted multi-decadal averages of seasonal streamflow, annual maximum flow, snow water equivalent (SWE), and evapotranspiration centered around 2030 and 2050. Future land cover was represented by a 2027 projection, which was extended to 2050, and DHSM was run (with current climate) for these future land cover projections.

Results: Comparison of the influence of Climate versus Land Cover Change on the hydrology of the Puget Sound Basin, Washington

- In urbanized sub-basins (examples lowlands east and Green) land cover dominates climate change impacts on hydrology, while in snow and transient upland sub-basins (examples Stillaguamish, Snohomish and Cedar), climate change impacts dominate.
- Dominant impact of climate is on seasonal runoff patterns: earlier runoff, especially in snow-dominant sub-basins.
- However, the signature of a warmer climate (i.e. long term climate change) is greatest in transient rain-snow zones; and less in highest elevations, and least in lowest elevations.
- Land cover change, in contrast, led to changes in total runoff volume only modestly affecting seasonal distribution.
- The largest land cover change signature was on lowlands – mostly due to increased impervious fractions in urbanized areas.
- In the lowlands, land cover is predicted to affect flooding, due to reduced soil infiltration capacity making the populous areas vulnerable to increased flooding.

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References

2. Funded by the National Science Foundation (BIOCOMPLEXITY BCS-0120024) to develop an integrated strategy to model land population changes in response to urbanization and (BECOMM-0005022) to develop models of urban landscapes as complex systems.
3. Integrated Assessment. 11/2: 215-227

Figure 1: Historic and projected land cover in the Central Puget Sound

Figure 2: LCCM model architecture to extend land cover change predictions from 2030 based on 1991, 2002, 2007 observed datasets and projected land cover in the Central Puget Sound region.

Figure 3: The integrated Urban Development and Ecological Model: Framework for integrating variables of urban processes, environmental drivers and biophysical processes and impacts.