

## INSTRUCTORS HANDOUT

**SUMMARY:** Over the past decades, the percentage of global urban population has grown from 30 % in 1950 to 54 % in 2014 (UN, 2015a), which has resulted in an increase in urban area even exceeding population growth rates (Seto et al., 2011). Projections indicate that this trend is likely to persist (Seto et al., 2012), and even accelerate in some regions of the world (UN, 2015b). These urbanization trends are expected to have a considerable effect on biodiversity (Seto et al., 2012), water quality, and urban microclimate (Foley et al., 2005). Another important consequence of urban expansion is the loss and displacement of fertile farmland - often located in proximity to urban areas - with significant implications for food security (Shi et al., 2016).

This case study aims at developing the systems thinking skills in students by helping them analyze the relationship between changes in population growth patterns and development policies and regulations, and the effect on the biophysical environment. Students will furthermore evaluate the importance of scale of analysis by transferring the findings of global and regional studies to the county level and understanding the significance of local policy drivers. They will practice how to apply technical skills like Geographic Information Systems (GIS) and spatio-temporal scenario simulations to improve understanding of socio-ecological system dynamics.

Students will work in project teams analyzing the observed and potential future farmland loss due to urbanization in a county of their choice, located in a mega-region the Southern



United States. They will analyze drivers of urbanization, develop a policy scenario to project future farmland loss, and test the scenario regarding its potential to reduce farmland loss. They will have to pitch their findings to their customers, run simulations with a spatio-temporal urban simulation model, and communicate their findings in a policy brief.

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### **Appropriate Course Level**

This case is appropriate for graduate level courses (500-600 level) focusing on modeling and simulation of socio-ecological systems and/or land systems. Students are expected to have solid GIS and spatial data processing skills. They are furthermore expected to have a basic understanding of scenario methodology and alternative futures analysis.

### **Software Requirements**

Following software products and add-ons are required to work on this case study:

- R ( $\geq 3.0.2$ ), download available at: <https://www.r-project.org/>
- GRASS GIS 7, download available at: <https://grass.osgeo.org/>
- GRASS GIS add-ons:
  - r.futures.pga
  - r.futures.potential
  - r.futures.demand
  - r.futures.devpressure
  - r.sample.category

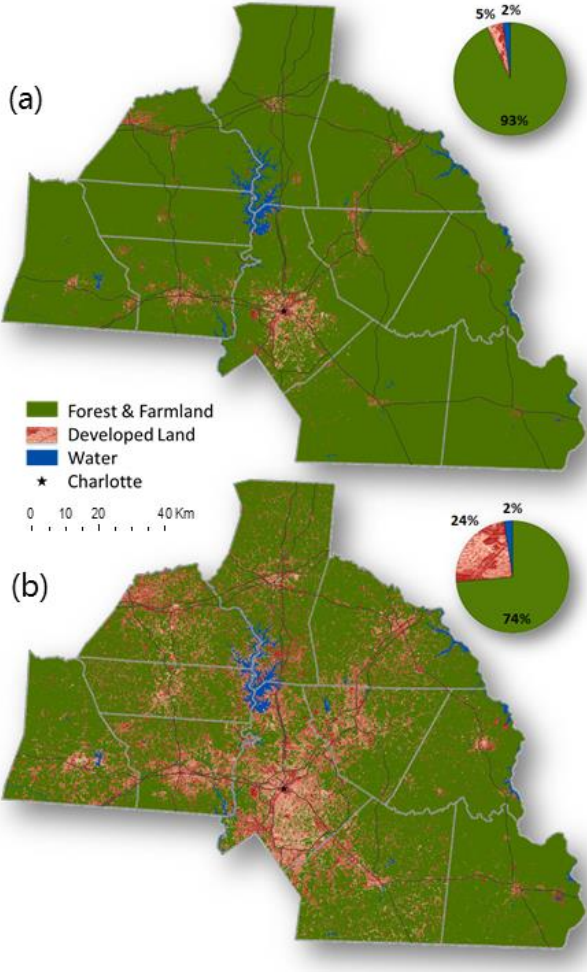


**1. Case Study Objectives**

Over the course of four weeks, students will work in groups of 3-5 on assessing observed farmland loss, analyzing local drivers of land use/cover change, and exploring potential future changes in urban area and farmland area. To successfully complete these tasks, students need to identify drivers of urban growth (and especially urban sprawl) and explore datasets suitable for the spatial analysis of the resulting farmland loss. They furthermore have to run spatial simulations of future farmland loss and communicate their research plan and findings to a non-academic audience.

**2. Case Study Scenario**

On her commute, the president of *State X's*\* Farm Bureau comes across a news article in *The Guardian* that sparks her interest. The article titled "Growing mega-cities will displace vast tracts of farmland by 2030, study says" describes a global study analyzing the effects of urban expansion on farmland loss. While the study mainly focuses on hotspots of farmland loss in Africa and Asia, the Farm Bureau's president is concerned about potential losses in her state, since several of the districts border the *XYZ*\* mega-region and have experienced farmland loss caused by urban sprawl over the past decades. The following day, the Farm Bureau's president approaches the city planners of the mega-region to inquire about their plans to avoid farmland loss and learns that there is currently no strategy in place. During the Farm Bureau's next Board of



**Figure 1.** The Charlotte Metropolitan region, located in the Piedmont Atlantic mega-region, is an excellent example for urbanization in the Southern United States. (a) Land use/cover for the year 1986 and (b) land use/cover for the year 2006. Figure adjusted from Meentemeyer et al. (2013).



Directors meeting, the issue of farmland loss is discussed, and the board hires a consulting firm – Shaping Futures, LLC - to conduct a study on potential farmland loss caused urbanization in *State X*.

You and your group work for Shaping Futures, LLC – a consulting firm that specializes in spatially explicit land-use scenario simulations for policy support. The Farm Bureau of *State X* hired your consulting firm to run simulations, to produce estimates for farmland loss in their mega-region caused by urbanization, and to help develop strategies to reduce said farmland loss. Shaping Futures has experience working on urbanization studies for which they used the FUTURES simulation model. Given the firm’s expertise with this simulation model, they decide early in the process to use FUTURES for the development of urbanization scenarios for the Farm Bureau.

### **3. Case Study Objectives**

To fulfill the needs of their client, each team of students has to work through the complete process of simulation studies: research the drivers of change, collect and pre-process model inputs, develop feasible scenarios, run the simulations, and communicate the scenario findings to their clients. They have to make sure to document the process and to work thoroughly as their findings have a direct effect on farmland loss and livelihoods in *State X*.

\*To allow for more flexibility, students can choose between different states and mega-regions in the Southern United States.

### **4. Learning Goals**

- a. Conceptualize urbanization making use of Ostrom’s Socio-Ecological Systems Framework. Identify the social system components and their relationships to the ecological system components.
- b. Understanding the concepts of scale and emergence. Evaluate global effects of urbanization and relate them to local/regional conditions and drivers of change. Develop location/region-specific research questions.
- c. Use free, open-source software packages to analyze spatio-temporal data and dynamics of socio-ecological systems. Understand the caveats of using scientific software.
- d. Communicate finding of socio-ecological systems analysis to a broad audience.





## 5. Learning Objectives

Student Learning Outcomes	Learning Goals
<ul style="list-style-type: none"> <li>• Students will be able to describe the concept of mega-regions.</li> <li>• Students will be able to define social and environmental drivers of urbanization.</li> <li>• Students will identify the geospatial characteristics of a mega-region of their choice.</li> <li>• Students will develop a concept map of urbanization.</li> </ul>	<b>a, b</b>
<ul style="list-style-type: none"> <li>• Students will analyze historic farmland loss in said county</li> <li>• Students will synthesize social and ecological drivers of urbanization in form of testable scenarios</li> <li>• Students will practice communicating their findings to a non-academic audience</li> </ul>	<b>a, b, c, d</b>
<ul style="list-style-type: none"> <li>• Students will research geospatial data on one county in the mega-region of their choice</li> <li>• Students will install scientific software and learn how to resolve problems</li> <li>• Students will repeat the instructions in the FUTURES GRASS-wiki tutorial</li> <li>• Students will discover data files and formats required to run FUTURES simulations</li> <li>• Students will identify suitable data sources and pre-process FUTURES input data</li> <li>• Students will run FUTURES simulations making use of the input datasets</li> </ul>	<b>b, c</b>
<ul style="list-style-type: none"> <li>• Students will carry out a spatial analysis of the FUTURES scenario simulation results</li> <li>• Students will prepare a technical report in order to document the steps of the scenario analysis</li> <li>• Students will synthesize the findings of your spatial analysis</li> <li>• Students will communicate your findings in form of a policy brief to a non-academic audience</li> </ul>	<b>c, d</b>



## 6. Case Study Setup

This case study consists of four modules: (1) conceptualizing urban areas as socio-ecological systems, (2) analyzing historic farmland loss and developing urbanization scenarios, (3) analyzing alternative urbanization futures, and (4) communicating urbanization findings. Each module is designed as a 4-6 hours work package. Students work in small groups of ideally 3-5 members. At least one computer (with admin rights) per group is required.

## 7. Case Study Modules

### Module 1 – Conceptualizing Urban Areas as Socio-Ecological System

*Time Estimate:* 4-6 hours

*Summary:* This module will introduce students to the concept of mega-regions. They will conduct a literature review and internet search to learn about the factors driving urbanization in a Southern US mega-region of their choice. Students will work in a group to discuss their findings and summarize their understanding of the relationships between social and ecological system components leading to urbanization in form of a concept map. In preparation for deliverables of following modules, they will document their progress and conclusions in form of short writing assignments.

*Learning Objectives:*

- Describe the concept of mega-regions
- Review literature on social and environmental drivers of urbanization
- Discuss the geospatial characteristics of a mega-region
- Synthesize the findings in a concept map of urbanization

*Materials:*

The instructor will bring print-outs of:

1. "Growing mega-cities will displace vast tracts of farmland by 2030, study says," December 27, 2016, The Guardian. <https://www.theguardian.com/environment/world-on-a-plate/2016/dec/28/growing-mega-cities-will-displace-vast-tracts-of-farmland-by-2030-study-says>



2. "Seattle Climbs but Austin Sprawls: The Myth of the Return to Cities," May 22, 2017, New York Times. [https://www.nytimes.com/2017/05/22/upshot/seattle-climbs-but-austin-sprawls-the-myth-of-the-return-to-cities.html?\\_r=0](https://www.nytimes.com/2017/05/22/upshot/seattle-climbs-but-austin-sprawls-the-myth-of-the-return-to-cities.html?_r=0)

Classroom Activities: see Assignment Sheet 1 (**Appendix A**)

Assessments: Concept map

Scoring Rubric: see Assignment Sheet 1 (**Appendix A**)

Sources:

1. Ostrom (2009). A general framework for analyzing sustainability of social-ecological systems. *Science* 325(5939): 419-422.
2. Meentemeyer et al. (2013). FUTURES: multilevel simulations of emerging urban-rural landscape structure using a stochastic patch-growing algorithm. *Annals of the Association of American Geographers* 103(4): 785-807.
3. "Growing mega-cities will displace vast tracts of farmland by 2030, study says," December 27, 2016, The Guardian. <https://www.theguardian.com/environment/world-on-a-plate/2016/dec/28/growing-mega-cities-will-displace-vast-tracts-of-farmland-by-2030-study-says>
4. "Seattle Climbs but Austin Sprawls: The Myth of the Return to Cities," May 22, 2017, New York Times. [https://www.nytimes.com/2017/05/22/upshot/seattle-climbs-but-austin-sprawls-the-myth-of-the-return-to-cities.html?\\_r=0](https://www.nytimes.com/2017/05/22/upshot/seattle-climbs-but-austin-sprawls-the-myth-of-the-return-to-cities.html?_r=0)
5. d'Amour, C.B., Reitsma, F., Baiocchi, G., Barthel, S., Güneralp, B., Erb, K.H., Haberl, H., Creutzig, F. and Seto, K.C. (2016). Future urban land expansion and implications for global croplands. *Proceedings of the National Academy of Sciences* p.201606036.



## Module 2 – Analyzing Historic Farmland Loss and Developing Urbanization Scenarios

Time Estimate: 4-6 hours

Summary: In this module, students will use geospatial data to analyze historic farmland loss in their study area. Building on their knowledge of the driving forces of change in their selected county, students will develop a feasible scenario and start identifying corresponding FUTURES input data in preparation for simulations of future farmland loss in the study region. Students will summarize and communicate their findings, from modules 1 and 2, in an oral presentation targeted towards a broad, non-academic audience. Furthermore, they will continue to document their progress and conclusions in form of short writing assignments.

Learning Objectives:

- Analyze historic farmland loss in a county
- Synthesize social/ecological drivers of urbanization in form of testable scenarios
- Summarize findings and practice communicating them to a non-academic audience

Materials: None

Classroom Activities: see Assignment Sheet 2 (**Appendix B**)

Assessments: Presentation slides and oral presentation

Scoring Rubric: see Assignment Sheet 2 (**Appendix B**)

Sources:

1. Meentemeyer et al. (2013). FUTURES: multilevel simulations of emerging urban–rural landscape structure using a stochastic patch-growing algorithm. *Annals of the Association of American Geographers* 103(4): 785-807.
2. Dorning et al. (2015). Simulating urbanization scenarios reveals tradeoffs between conservation planning strategies. *Landscape and Urban Planning* 136: 28-39.
3. Environmental Scenario Analysis: <http://www.peer.eu/projects/metier-training-courses/course-7-environmental-scenario-analysis/>
4. GRASS GIS: <https://grass.osgeo.org/download/>
5. National Land Cover Database: <https://www.mrlc.gov/finddata.php>





## **Module 3 – Analyzing Alternative Urbanization Futures**

*Time Estimate:* 4-6 hours

*Summary:* This module will guide students through the full process of running a FUTURES scenario simulation. First, they will work through the FUTURES tutorial (see below) to better understand the required input data for FUTURES urbanization simulations and to learn about the required data pre-processing steps. Students will then transfer the newly acquired knowledge to prepare input data and run urbanization scenario simulations for their study area.

*Learning Objectives:*

- Research geospatial data in one county in a mega-region
- Install scientific software and learn how to resolve problems
- Repeat the instructions in the FUTURES GRASS-wiki tutorial
- Discover data files and formats required to run FUTURES simulations
- Identify suitable data sources and pre-process FUTURES input data
- Run FUTURES simulations making use of the input datasets

*Materials:* None

*Classroom Activities:* see **Assignment Sheet 3 (Appendix C)**

*Assessments:* FUTURES input and output files

*Scoring Rubric:* see **Assignment Sheet 3 (Appendix C)**

*Sources:*

1. FUTURES GRASS-wiki Tutorial: [https://grasswiki.osgeo.org/wiki/FUTURES\\_tutorial](https://grasswiki.osgeo.org/wiki/FUTURES_tutorial)



## Module 4 – Communicating Urbanization Findings

*Time Estimate:* 4-6 hours

*Summary:* In this last module, students will analyze their FUTURES scenario simulation results. They will conduct a GIS analysis to quantify the farmland loss projected under the scenario. Furthermore, students will summarize their findings in a policy brief and document their work in a technical report.

*Learning Objectives:*

- Carry out a spatial analysis of the FUTURES scenario simulation results
- Prepare a technical report to document the steps of the scenario analysis
- Synthesize the findings of the spatial analysis
- Communicate findings in form of a policy brief to a non-academic audience

*Materials:* None

*Classroom Activities:* see Assignment Sheet 4 (**Appendix D**)

*Assessments:* Technical report and policy brief

*Scoring Rubric:* see Assignment Sheet 4 (**Appendix D**)

*Sources:*

1. How do I brief policy makers on science-related issues: <http://www.scidev.net/global/communication/practical-guide/how-do-i-brief-policy-makers-on-science-related-iss.html>
2. National Agricultural Statistics Service: <https://www.nass.usda.gov/>
3. Pachauri, R.K. and Meyer, L. (2014). Climate change 2014 Synthesis Report-Summary for Policymakers. [http://ipcc.ch/pdf/assessment-report/ar5/syr/AR5\\_SYR\\_FINAL\\_SPM.pdf](http://ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf)



## 8. References

- "Growing mega-cities will displace vast tracts of farmland by 2030, study says," December 27, 2016, The Guardian. <https://www.theguardian.com/environment/world-on-a-plate/2016/dec/28/growing-mega-cities-will-displace-vast-tracts-of-farmland-by-2030-study-says>
- "Seattle Climbs but Austin Sprawls: The Myth of the Return to Cities," May 22, 2017, New York Times. <https://www.nytimes.com/2017/05/22/upshot/seattle-climbs-but-austin-sprawls-the-myth-of-the-return-to-cities.html?r=0>
- d'Amour, C.B., Reitsma, F., Baiocchi, G., Barthel, S., Güneralp, B., Erb, K.H., Haberl, H., Creutzig, F. and Seto, K.C. (2016). Future urban land expansion and implications for global croplands. *Proceedings of the National Academy of Sciences* p.201606036.
- Dorning, M.A., Koch, J., Shoemaker, D.A., Meentemeyer, R.K. (2015). Simulating urbanization scenarios reveals tradeoffs between conservation planning strategies. *Landscape and Urban Planning* 136: 28-39.
- Foley, J.A., Defries, R., Asner, G.P., et al. (2005). Global consequences of land use. *Science* 309: 570–4.
- Meentemeyer, R.K., Tang, W., Dorning, M.A., Vogler, J.B., Cunniffe, N.J., Shoemaker, D.A. (2013). FUTURES: multilevel simulations of emerging urban–rural landscape structure using a stochastic patch-growing algorithm. *Annals of the Association of American Geographers* 103(4): 785-807.
- Ostrom (2009). A general framework for analyzing sustainability of social-ecological systems. *Science* 325(5939): 419-422.
- Pachauri, R.K. and Meyer, L. (2014). Climate change 2014 Synthesis Report-Summary for Policymakers. [http://ipcc.ch/pdf/assessment-report/ar5/syr/AR5\\_SYR\\_FINAL\\_SPM.pdf](http://ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf)
- Seto, K.C., Fragkias, M., Güneralp, B., Reilly, M.K. (2011). A Meta-Analysis of Global Urban Land Expansion. *PLoS One* 6: e23777.
- Seto, K.C., Güneralp, B., Hutya, L.R. (2012). Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. *Proceedings of the National Academy of Sciences* 109: 16083–16088.



Shi, K., Chen, Y., Yu, B., Xu, T., Li, L., Huang, C., Liu, R., Chen, Z., Wu, J. (2016). Urban Expansion and Agricultural Land Loss in China: A Multiscale Perspective. *Sustainability* 8: 790.

United Nations, Department of Economic and Social Affairs (Population Division) (2015a). *World Urbanization Prospects: The 2014 Revision*. New York.

United Nations, Department of Economic and Social Affairs (Population Division) (2015b). *World Population Prospects: The 2015 Revision*. New York.

## 9. Required Sources

1. America 2050
  - <http://www.america2050.org/megaregions.html>
2. Environmental Scenario Analysis
  - <http://www.peer.eu/projects/metier-training-courses/course-7-environmental-scenario-analysis/>
3. FUTURES Tutorial – GRASS-Wiki
  - [https://grasswiki.osgeo.org/wiki/FUTURES\\_tutorial](https://grasswiki.osgeo.org/wiki/FUTURES_tutorial)
4. GRASS GIS
  - <https://grass.osgeo.org/download/>
5. How do I brief policy makers on science-related issues
  - <http://www.scidev.net/global/communication/practical-guide/how-do-i-brief-policymakers-on-science-related-iss.html>
6. Knowledge Mapping Technologies
  - <https://i2insights.org/2017/03/30/knowledge-mapping-technologies/>
7. MentalModeler
  - <http://www.mentalmodeler.org/>
8. National Land Cover Database
  - <https://www.mrlc.gov/finddata.php>
9. National Agricultural Statistics Service
  - <https://www.nass.usda.gov/>
10. R Project Statistical Software
  - <https://www.r-project.org/>



## 10. Acknowledgements

The author was supported by the National Science Foundation under Grant No. OIA-1301789. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation. This work was furthermore supported by the National Socio-Environmental Synthesis Center (SESYNC) under funding received from the National Science Foundation DBI-1052875.



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## Appendix A



### Assignment Sheet 1

#### Module 1 – Conceptualizing Urban Areas as Socio-Ecological System

**Summary:** This module will introduce you to the concept of mega-regions. You will conduct a literature review and internet search to learn about the factors driving urbanization in a Southern US mega-region of your choice. You will work in a group to discuss your findings and summarize your understanding of the relationships between social and ecological system components leading to urbanization in form of a concept map. In preparation for deliverables of following modules, you will document your progress and conclusions in form of short writing assignments.

#### Learning Objectives:

- Describe the concept of mega-regions
- Review literature on social and environmental drivers of urbanization
- Discuss the geospatial characteristics of a mega-region of your choice
- Synthesize the findings in a concept map of urbanization

#### Required Readings:

##### Before class:

1. Ostrom (2009). A general framework for analyzing sustainability of social-ecological systems. *Science* 325(5939): 419-422.
2. Meentemeyer et al. (2013). FUTURES: multilevel simulations of emerging urban-rural landscape structure using a stochastic patch-growing algorithm. *Annals of the Association of American Geographers* 103(4): 785-807.

##### During class:

1. "Growing mega-cities will displace vast tracts of farmland by 2030, study says," December 27, 2016, The Guardian. <https://www.theguardian.com/environment/world-on-a-plate/2016/dec/28/growing-mega-cities-will-displace-vast-tracts-of-farmland-by-2030-study-says>
2. "Seattle Climbs but Austin Sprawls: The Myth of the Return to Cities," May 22, 2017, New York Times. <https://www.nytimes.com/2017/05/22/upshot/seattle-climbs-but-austin-sprawls-the-myth-of-the-return-to-cities.html? r=0>

#### Deliverables:

1. Concept map

#### Homework:

Read the original research article on urbanization and farmland loss (d'Amour et al. 2016).



### **In-Class Group Tasks:**

#### ***Task 1: Urban area - urbanization and resulting farmland loss***

Read the two following articles to learn about urbanization, the underlying drivers, and its effect on farmland loss:

1. New York Times:
  - Seattle Climbs but Austin Sprawls: The Myth of the Return to Cities
  - <https://www.nytimes.com/2017/05/22/upshot/seattle-climbs-but-austin-sprawls-the-myth-of-the-return-to-cities.html? r=0>
2. The Guardian:
  - Growing mega-cities will displace vast tracts of farmland by 20130, study says
  - <https://www.theguardian.com/environment/world-on-a-plate/2016/dec/28/growing-mega-cities-will-displace-vast-tracts-of-farmland-by-2030-study-says>

Summarize the key points of each article in a paragraph (circa 150 words each). In a third paragraph, describe how the research presented in the two news articles relates to scenario studies with the FUTURES simulation model (Meentemeyer et al., 2013).

#### ***Task 2: Mega-regions – concept and selection***

Explore the America 2050 webpage (<http://www.america2050.org/megaregions.html>) to get acquainted with the mega-region concept. Discuss how a mega-region is defined. Go to the maps section of America 2050 (<http://www.america2050.org/maps/>) and download two shapefiles – one with the mega-region outlines and one with counties located in mega-regions. Use the shapefiles in combination with your findings from task 1 to select one county in a mega-region located in the Southern US, which is a good fit for a FUTURES study of the impacts of urbanization. Draft a paragraph describing your county selection criteria and justifying your selection.

#### ***Task 3: Drivers of urbanization – discussion and concept mapping***

To understand the context and socio-ecological setting of the county in the mega-region of your choice, conduct an internet search and quick literature review on the mega-region specific driving forces of change (i.e. which factors lead to variations in the system under study). Draft a paragraph describing the socio-environmental setting and the main factors driving urbanization in your megaregion. Include all county-specific information you can find.

Use your newly gained understanding of the processes in your study area to draft a concept map of the urban system in the county of your choice. To learn more about knowledge mapping in general and concept maps specifically, read through the following





blog entry: <https://i2insights.org/2017/03/30/knowledge-mapping-technologies/>.  
 Implement your concept map making use of the MentalModeler modeling software, which is available at <http://www.mentalmodeler.org/>.

**Scoring Rubrics:**

Following scoring rubric will be used to assess the module’s deliverable:

Category\Score	Weight	High	Medium	Low
System Components	40%	<ul style="list-style-type: none"> <li>- Included components are part of the system</li> <li>- Key system components are included</li> <li>- Appropriate level of detail</li> </ul>	<ul style="list-style-type: none"> <li>- Up to two components that were included are not part of the system</li> <li>- Up to two key system components are missing</li> <li>- The concept map is too detailed</li> </ul>	<ul style="list-style-type: none"> <li>- More than two of the included components are not part of the system</li> <li>- More than two of the key system components are missing</li> <li>- The concept map does not include enough detail</li> </ul>
Relationships	30%	<ul style="list-style-type: none"> <li>- All key relationships between system components are included</li> <li>- No incorrect relationships between components are included</li> <li>- All relationships show correct directionalities</li> </ul>	<ul style="list-style-type: none"> <li>- Up to two key relationships between system components are missing</li> <li>- Up to two relationships are displayed for un-related system components</li> <li>- Up to two relationships between system components show incorrect directionality</li> </ul>	<ul style="list-style-type: none"> <li>- More than two key relationships between system components are missing</li> <li>- More than two relationships are displayed for un-related system components</li> <li>- More than two relationships between system components show incorrect directionality</li> </ul>
Dynamic Processes	40%	<ul style="list-style-type: none"> <li>- The concept map includes processes explaining both spatial and temporal dynamics of the system</li> </ul>	<ul style="list-style-type: none"> <li>- Spatial and temporal process explanations are included, but they are incorrect or lack detail</li> </ul>	<ul style="list-style-type: none"> <li>- Only spatial or only temporal process explanations are included</li> <li>- Included explanations are incorrect and lack detail</li> </ul>



## Appendix B



### Assignment Sheet 2

#### Module 2 – Analyzing Historic Farmland Loss and Developing Urbanization Scenarios

**Summary:** In this module, you will use geospatial data to analyze historic farmland loss in your study area. Building on your knowledge of the driving forces of change in your selected county, you will develop a feasible scenario and start identifying corresponding FUTURES input data in preparation for simulations of future farmland loss in your study region. You will summarize and communicate your findings from modules 1 and 2 in an oral presentation targeted towards a broad, non-academic audience. Furthermore, you will continue to document your progress and conclusions in form of short writing assignments.

#### Learning Objectives:

- Analyze historic farmland loss in a county of your choice
- Synthesize social/ecological drivers of urbanization in form of testable scenarios
- Summarize findings and practice communicating them to a non-academic audience

#### Required Readings:

##### During class:

1. Dorning et al. (2015). Simulating urbanization scenarios reveals tradeoffs between conservation planning strategies. *Landscape and Urban Planning* 136: 28-39.
2. Environmental Scenario Analysis: <http://www.peer.eu/projects/metier-training-courses/course-7-environmental-scenario-analysis/>

#### Deliverables:

1. PowerPoint slides as visual aid for the oral presentation
2. Delivery of the 15-minutes oral presentation

#### Homework:

Explore different data sources to prepare the quantification of your scenarios in form of FUTURES input data.





### **In-Class Group Tasks:**

#### ***Task 1: Install GRASS GIS – using free, open-source GIS software***

Visit <https://grass.osgeo.org/download/> to get to the GRASS GIS download page. FUTURES is implemented as a GRASS GIS module. Hence, install GRASS GIS to run FUTURES on your computer. Click the field that is appropriate for your computer's operating system (NOT the "... and Addons" or "Source Code" links).

Click the **download (32-bit)** or **download (64-bit)** link, based on your computer and operating system under the current stable section. Wait for the .exe file to finish downloading and double-click on the finish to initiate the installation. Select all available components to install (also the sample datasets).

#### ***Task 2: Use GRASS GIS to analyze historic farmland loss***

Use GRASS GIS and the National Land Cover Database (NLCD - <https://www.mrlc.gov/finddata.php>) products for the years 2001 and 2011 to assess areas where farmland was present in 2001 and that are identified as urban area in the 2011 dataset.

#### ***Task 3: Development of a (FUTURES) scenario***

Based on your findings on the socio-ecological system under study and your FUTURES knowledge, work on the elaboration of a scenario (besides the business-as-usual (BAU) scenario) suitable to explore urbanization in your selected county. Refer to following source to learn more about environmental scenario analysis: [http://www.peer.eu/fileadmin/user\\_upload/opportunities/metier/course7/c7\\_course\\_book.pdf](http://www.peer.eu/fileadmin/user_upload/opportunities/metier/course7/c7_course_book.pdf).

Revisit Meentemeyer et al. (2013) and consult the materials and methods section of Dorning et al. (2015) to learn more about the required input for FUTURES simulations. Describe, as detailed as possible, the required inputs and model parameters for your scenario. Furthermore, justify why this is an interesting scenario for your customer and the selected mega-region. Document and summarize your scenario and your justification in two paragraphs.

#### ***Task 4: Summary and communication of findings***

Prepare the contents and slides for a 15-minute oral presentation. In this presentation, summarize the findings and key points of your findings from modules 1 and 2. Make sure to present your contents in a way appropriate for a non-academic, broad audience. Give the 15-minute oral presentation.





**Scoring Rubrics:**

Following scoring rubric will be used to assess the module's deliverables:

Category\Score	Weight	High	Medium	Low
<b>Content</b>	50%	<ul style="list-style-type: none"> <li>- Content is accurate</li> <li>- Content is organized in logical order</li> <li>- Key points are emphasized</li> <li>- Questions are answered correctly</li> </ul>	<ul style="list-style-type: none"> <li>- Presented content has some errors</li> <li>- The general structure is clear, but some content is presented in an illogical order</li> <li>- Most of the key points are clear</li> <li>- Almost all questions are answered correctly</li> </ul>	<ul style="list-style-type: none"> <li>- Presented content has more than two error</li> <li>- Content order is confusing</li> <li>- Key points are unclear</li> <li>- More than two question is answered incorrectly</li> </ul>
<b>Visuals</b>	10%	<ul style="list-style-type: none"> <li>- Appropriate background</li> <li>- Limited number of fonts</li> <li>- Font format and size enhance readability</li> <li>- Graphics support explanations</li> </ul>	<ul style="list-style-type: none"> <li>- The background does not support the content, but is also not distracting</li> <li>- No more than two different fonts are used</li> <li>- Size is only just readable</li> <li>- The majority of the graphics supports the content explanations</li> </ul>	<ul style="list-style-type: none"> <li>- Background reduces readability of content</li> <li>- More than two different fonts are used</li> <li>- Font size is too small</li> <li>- Graphics are not tied to content</li> </ul>
<b>Audience</b>	20%	<ul style="list-style-type: none"> <li>- Presenter maintains audience interest</li> <li>- Content demonstrates awareness of audience interests</li> </ul>	<ul style="list-style-type: none"> <li>- Presenter maintains audience's interest during majority of the presentation</li> <li>- Majority of the content is adjusted to the audience's background</li> </ul>	<ul style="list-style-type: none"> <li>- Content is presented in a monotone voice</li> <li>- Content is not adjusted to the background knowledge of the audience</li> </ul>
<b>Delivery</b>	20%	<ul style="list-style-type: none"> <li>- Eye contact</li> <li>- No obvious use of notes</li> </ul>	<ul style="list-style-type: none"> <li>- Eye contact during the majority of the presentation</li> <li>- Index cards are used for notes</li> </ul>	<ul style="list-style-type: none"> <li>- No eye contact with audience</li> <li>- Letter format notes are used</li> </ul>



## Appendix C



### Assignment Sheet 3

#### Module 3 – Analyzing Alternative Urbanization Futures

**Summary:** This module will guide you through the full process of running a FUTURES scenario simulation. First, you will work through the FUTURES tutorial (see below) to better understand the required input data for FUTURES urbanization simulations and to learn about the required data pre-processing steps. You will then transfer your newly acquired knowledge to prepare input data and run urbanization scenario simulations for your study area.

#### Learning Objectives:

- Research geospatial data in one county in a mega-region of your choice
- Install scientific software and learn how to resolve problems
- Repeat the instructions in the FUTURES GRASS-wiki tutorial
- Discover data files and formats required to run FUTURES simulations
- Identify suitable data sources and pre-process FUTURES input data
- Run FUTURES simulations making use of the input datasets

#### Required Readings:

*During class:*

1. FUTURES GRASS-wiki Tutorial: [https://grasswiki.osgeo.org/wiki/FUTURES\\_tutorial](https://grasswiki.osgeo.org/wiki/FUTURES_tutorial)

#### Deliverables:

1. FUTURES scenario input data for one county
2. FUTURES scenario simulation results for one county

#### Homework:

*None*



### **In-Class Group Tasks:**

#### **Task 1: Explore FUTURES input files**

Visit [https://grasswiki.osgeo.org/wiki/FUTURES\\_tutorial](https://grasswiki.osgeo.org/wiki/FUTURES_tutorial) to get the FUTURES tutorial Wiki.

**BEFORE** you start working through the tutorial in the next step, go to the "Input data used in this tutorial" section of the Wiki page. Download the sample dataset. Unzip the archive and thoroughly examine the input datasets. Use GRASS GIS to look at the different input files. If you have not worked with GRASS GIS before, look at the "Workflow" section in the FUTURES tutorial Wiki and do a quick online search on GRASS GIS resources. The tutorial lists the data sources for the different input files. Potential data sources are important information to keep in mind for step four.

#### **Task 2: Work through the FUTURES tutorial**

Visit [https://grasswiki.osgeo.org/wiki/FUTURES\\_tutorial](https://grasswiki.osgeo.org/wiki/FUTURES_tutorial) to get the FUTURES tutorial Wiki.

Read the text carefully - not all steps are necessary, and some of the described steps are not carried out in GRASS GIS, but as Python scripts. Carry out the individual steps in GRASS GIS. While working on this, bring up a text editor and copy the GRASS GIS commands into one text file. Save the text file for future reference. This will make your life much easier when you run FUTURES with your county's input data. If you encounter error messages stating that a package is not installed, do the following on the command line:

```
>R
>install.packages("MuMIn")
>install.packages("optparse")
>install.packages("lme4")
>quit()
```

The first command starts the R software in the GRASS GIS environment. Commands two to four install different R packages on your computer. The last command closes the R software and lets you return to the GRASS GIS environment.

#### **Task 3: Download and pre-process the FUTURES input data**

In preparation for running futures for your selected county, download the datasets required for FUTURES for your study area. Use GRASS GIS to clip the datasets to the extent of your county. Load all input data into GRASS GIS in order to run FUTURES for your scenario.

#### **Task 4: Run FUTURES scenario simulations**

Under step two, you saved all the different commands to run FUTURES in a text file. Bring up that text file. Analyze, which of the statements refer to input data files required to run FUTURES. Adjust the commands to work with your newly created input files. Make sure to





use filenames that have no spaces in them. Also, consider where you stored your input files. You have to ensure that the software knows where your files are located. Once you have all commands and paths adjusted to your newly created input, run FUTURES for your county making use of those commands. After successfully running the simulation, check your output files. Where are they located? How big are they? Also, use GIS software to display the output. Is the output correct?

**Scoring Rubrics:**

Following scoring rubric will be used to assess the module’s deliverables:

Category\Score	Weight	High	Medium	Low
<b>Geoprocessing</b>	30%	<ul style="list-style-type: none"> <li>- Appropriate projection was selected</li> <li>- All datasets are in the same projection</li> <li>- All datasets have the correct format</li> </ul>	<ul style="list-style-type: none"> <li>- The projection is suitable for the larger area, but one with less distortion is available</li> </ul>	<ul style="list-style-type: none"> <li>- Not all datasets are in the same projection</li> <li>- Some datasets have an incorrect format resulting in errors when running the model</li> </ul>
<b>Completeness</b>	35%	<ul style="list-style-type: none"> <li>- Download date and source are documented</li> <li>- All files are organized in a logical file structure</li> <li>- Mnemonic file and folder names were used</li> </ul>	<ul style="list-style-type: none"> <li>- Download date and time documented for majority of data</li> <li>- Majority of files and folders is easy to locate</li> </ul>	<ul style="list-style-type: none"> <li>- Download date and source are not documented for all datasets</li> <li>- Users have difficulties locating files and folders</li> <li>- File and folder names do not indicate the content type</li> </ul>
<b>Accuracy</b>	35%	<ul style="list-style-type: none"> <li>- All datasets are for the same year</li> <li>- All datasets cover the same area</li> </ul>	<ul style="list-style-type: none"> <li>- Datasets cover different years because of data availability (explanation included in metadata)</li> </ul>	<ul style="list-style-type: none"> <li>- Datasets are for different years, even though all of them are available for one year</li> <li>- Area covered differs between datasets resulting in errors when running the model</li> </ul>



## Appendix D



### Assignment Sheet 4

#### Module 4 – Communicating Urbanization Findings

**Summary:** In this last module, you will analyze your FUTURES scenario simulation results. You will conduct a GIS analysis to quantify the farmland loss projected under your scenario. Furthermore, you will summarize your findings in a policy brief and document your work in a technical report.

#### Learning Objectives:

- Carry out a spatial analysis of the FUTURES scenario simulation results
- Prepare a technical report to document the steps of the scenario analysis
- Synthesize the findings of your spatial analysis
- Communicate your findings in form of a policy brief to a non-academic audience

#### Required Readings:

##### During class:

1. How do I brief policy makers on science-related issues:  
<http://www.scidev.net/global/communication/practical-guide/how-do-i-brief-policy-makers-on-science-related-iss.html>

#### Deliverables:

1. A 2-pages technical report documenting data source, data processing, and scenario analysis
2. A 1-page policy brief

#### Homework:

*None*





### **In-Class Group Tasks:**

#### **Task 1: Download farmland raster file**

In order to calculate the farmland loss under different urbanization scenarios, download a farmland raster file. Derive potential candidate files from the National Land Cover Database (NLCD) or the National Agricultural Statistics Service (NASS). Both provide raster datasets for different years. Select the dataset and year that is most appropriate for your analysis. Write a paragraph summarizing the justification for your selection. Here are the links to the datasets:

- National Land Cover Database: <https://www.mrlc.gov/finddata.php>
- National Agricultural Statistics Service: <https://www.nass.usda.gov/>

#### **Task 2: Overlay simulation output with farmland raster**

Use GRASS GIS to overlay the downloaded raster file with the simulated raster files. Use a raster calculator to assess the farmland loss caused by urban expansion, i.e. areas where the map displays urbanization on cells categorized as farmland in the downloaded raster file. Calculate the total area of farmland loss in your study area, making use of GIS functionality and tools. Describe the geoprocessing steps and the results of your analysis in two paragraphs.

#### **Task 3: Write a 2-pages technical report**

Write a technical report to document the analysis process for future reference. Start by compiling the text fragments prepared in the previous steps of the case study. Fill in the details in order to provide a thorough documentation of all data source, processing steps, and important decisions carried out during the analysis. Where appropriate, also include Python (or other programming language) code fragments to support your explanations. Include the URL's to all data sources used in the analysis.

#### **Task 4: Write a 1-page policy brief**

Summarize the major findings of your analysis as well as the resulting recommendations for your customers in form of a policy brief. Read through example policy briefs, e.g. from the Intergovernmental Panel on Climate Change (Pachauri and Meyer, 2014). This will help you to understand the type of language used in this type of summaries and to understand the required level of detail. Also use following resource to learn more about writing a policy brief:

- How do I brief policy makers on science-related issues:  
<http://www.scidev.net/global/communication/practical-guide/how-do-i-brief-policy-makers-on-science-related-iss.html>



### Scoring Rubrics:

Following scoring rubric will be used to assess the module's deliverables:

Category\Score	Weight	High	Medium	Low
<b>Content</b>	25%	<ul style="list-style-type: none"> <li>- Content of report and brief is correct, detailed, and concise</li> <li>- Important process steps are documented in the technical report</li> <li>- The technical report has all details required to repeat the analysis</li> </ul>	<ul style="list-style-type: none"> <li>- Technical and/or policy brief include some minor inaccuracies</li> <li>- One to two important process steps are missing from the technical report</li> <li>- The technical report lacks some details, but it is still possible to carry out the analysis</li> </ul>	<ul style="list-style-type: none"> <li>- There are several errors in both, the policy brief and the technical report</li> <li>- The documentation of the simulation process is incomplete</li> <li>- Technical report has insufficient detail to repeat the analysis</li> </ul>
<b>Accuracy</b>	25%	<ul style="list-style-type: none"> <li>- Data processing and simulation steps are correctly described</li> <li>- Data sources and download dates are included in the technical report</li> </ul>	<ul style="list-style-type: none"> <li>- There are up to two errors in the description of data processing and simulation</li> <li>- Up to two of the data sources and/or download dates are not included</li> </ul>	<ul style="list-style-type: none"> <li>- There are more than two errors in the description of data processing and simulation</li> <li>- More than two of the data sources and/or download dates are missing in the report</li> </ul>
<b>Organization</b>	25%	<ul style="list-style-type: none"> <li>- Both texts have a clear, logical structure</li> </ul>	<ul style="list-style-type: none"> <li>- One of the two texts has an unclear structure or it is difficult to follow the argument</li> </ul>	<ul style="list-style-type: none"> <li>- The structure of both texts is unclear, it is difficult to follow the argument</li> </ul>
<b>Audience</b>	25%	<ul style="list-style-type: none"> <li>- Policy brief avoids jargon and only highlights crucial points</li> <li>- Clear and simple language is used</li> <li>- Potential solutions are easy to identify</li> <li>- Technical report uses modeling and simulation terminology</li> </ul>	<ul style="list-style-type: none"> <li>- Policy brief makes use of some jargon</li> <li>- Most crucial points are highlighted</li> <li>- Up to two overly long sentences</li> <li>- The majority of potential solutions was clearly communicated</li> </ul>	<ul style="list-style-type: none"> <li>- Policy brief is written making extensive use of jargon and modeling and simulation terminology</li> <li>- Many long sentences are used</li> <li>- Solutions were not clearly communicated</li> </ul>