6.5 Preparing Climate Change Scenarios

There are multiple ways to incorporate climate change scenarios into the Natural Capital Project's InVEST models and the RIOS spatial prioritization tool, as well as other ecosystem services tools. For more information on climate change-driven and many other varieties of scenarios, please refer to Scenarios for InVEST: A Primer. For additional guidance on climate change scenarios, please refer to NatCap's guidance document, Incorporating Climate Change Scenarios into InVEST and RIOS.

There are many model inputs which are both likely to vary with climate change and already possible to model based on existing science. We cover many such inputs in the above-linked document, but for the purposes of this exercise, we will be focusing on precipitation. In Module 6.4, we adjusted the precipitation by an arbitrary amount (20%), in order to do a basic sensitivity analysis. In this module, we will download real-world climate data and create a new spatially-explicit scenario based on those data.
After the session, participants should be able to:

- Find and download globally-available climate change data
- Create a new Precipitation Raster for the Water Yield model based on those data
- Run the model and compare the scenario results with the baseline from Module 6.4

A) Case study with proposed data

This exercise is an extensions of the Tana River basin study from Module 6.4. The Tana River basin supplies water for irrigation and domestic use that benefits millions of Kenyans. Major water users, including rural communities, the Nairobi water utility, and a hydropower company are establishing a Water Fund that will secure the provision of key water services. In this exercise, we will be focusing on the Gura subwatershed.

Credit: Johannes Hunink

B) Case study with your own data (optional)

Building on the inputs you sourced for the previous exercise (6.4), source and create the new precipitation raster to generate a climate change scenario for your study area.

Case study tasks

1. Find and download the appropriate Global Climate Data
2. Prepare a Precipitation Raster that reflects a climate change scenario
3. Run the model and compare your scenario results to the baseline run from Module 6.4

Reminder: Refer to the InVEST User's Guide for technical terms and input data:

http://data.naturalcapitalproject.org/nightly-build/invest-users-guide/html/reservoirhydropowerproduction.html

Incorporating Climate Change into the InVEST Water Yield Model

Several inputs to the InVEST Water Yield model may be influenced by climate change, particularly: precipitation, evapotranspiration, and the Z parameter. Average annual precipitation data are frequently available from climate change downscaling exercise. You can read more about the references and methods for evapotranspiration and Z parameter in the InVEST User's Guide.

For this exercise, we will be using WorldClim's downscaled IPCC5 climate projections. Because Exercise 6.4 utilized locally-sourced data, we will run a new baseline scenario with Current WorldClim data and future WorldClim data.

Step-by-step

Task 1: Retrieve the WorldClim IPCC5 climate data

- In a web browser, open http://www.worldclim.org and click the "Download" tab
- For this exercise, we are interested in the climate data for future conditions; click the link
- The data are available at several different resolutions; we will be using 30-second (of a longitude/latitude degree) spatial resolution data
- There are many considerations to be taken when choosing climate change data, including the timestep, representative concentration pathway (e.g. rcp26, rcp45, rcp60, rcp85), model source, and suitability of a model to your study area
- For the purposes of this exercise, we will be using the 2050s GFDL CM3 (while RCP 85 might represent a high extreme, that is useful for our teaching purposes)

Task 2: Project and clip the climate data to your study area

- For user's who are not familiar with GIS software, we recommend that you do this exercise with the included sample data, for which these layers have been pre-prepared.

Task 3: Run the InVEST Water Yield model for your baseline climate scenario

- Open the InVEST Water Yield model from your Windows Start Menu (on a Mac, command+click the file <invest_wateryield.command>)

- Select your working folder (1)
    - *Tip: keep working folders clearly and simply named and organized within your file structure, to save time in selecting and adjusting inputs/outputs (e.g. C:\course\exercise6.5)

- Assign a Results Suffix (2) (e.g. _baseline; separate runs with different suffixes can be saved within the same Workspace)

- Input data for the baseline scenario (the example files below can be found in the Module6.5sampledata.zip file, downloadable here [link to data]). If you have already completed Exercise 6.4, you will see the inputs for your last run from that exercise still in the user interface.
    - (3) Precipitation (Raster): precip_annual_current_Gura.tif
    - (4) Reference Evapotranspiration (Raster): ETo_annual_current_Gura.tif
    - (5) Depth To Root Restricting Layer (Raster): soil_depth_s.tif
    - (6) Plant Available Water Fraction (Raster): pawc_s.tif
    - (7) Land Use (Raster): lulc_s.tif
    - (8) Watersheds (Vector): watershed_Gura.shp
    - (9) Sub-Watersheds (Vector) (Optional): no subwatersheds file is used in this exercise
    - (10) Biophysical Table (CSV): biophysical_table_Gura.csv

- Set the Z parameter (11) (“Seasonality factor”) to a default value of 10

- Click run. The model will take several minutes to run. Upon successful completion of the model, a file explorer window will open to the output workspace specified in the model run. This directory contains an output folder holding files generated by this model. Those files can be viewed in any GIS tool such as ArcGIS, or QGIS.

Task 4: Run the InVEST Water Yield model for your future climate scenario

- Using the same working folder (1), assign a Results Suffix (2) to distinguish this model run from the previous (e.g. _2050rcp85; separate runs with different suffixes can be saved within the same Workspace)

- Input data for the future climate scenario (the example files below can be found in the Module6.5sampledata.zip file, downloadable here [link to data]). In the model user interface, you will see the inputs for your previous (baseline) run, so you will only need to change two inputs:
    - (3) Precipitation (Raster): precip_annual_gfdl_cm3_85_2050s_Gura.tif
    - (4) Reference Evapotranspiration (Raster): ETo_annual_gfdl_cm3_85_2050s.tif

- Leave the Z parameter (11) ("Seasonality factor") to a default value of 10

- Click run. The model will take several minutes to run. Upon successful completion of the model, a file explorer window will open to the output workspace specified in the model run. This directory contains an output folder holding files generated by this model. Those files can be viewed in any GIS tool such as ArcGIS, or QGIS.

How much does the predicted water yield vary between the baseline and future scenarios? How sensitive was the model to changes in precipitation and ET0? What are ways that you can show these results to stakeholders or decision-makers?