# Natural Capital projects for visualizations

At The Natural Capital Project we are developing practical tools and approaches to account for nature's contributions to society, so that leaders of countries, companies, communities, and organizations worldwide can make smarter decisions for a more sustainable future.

https://naturalcapitalproject.stanford.edu/

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## Outcomes for students

For all of the projects proposed, students' work will be featured on Stanford's Natural Capital Project website and the most successful project's team members will be invited to present at the Natural Capital Project annual Symposium in California, March 2019. Possibilities of continuing work at Stanford (e.g master thesis) can also be discussed.

Each project may only be chosen by one team (except maybe Project 1, because it's so broad). The projects starred (☆) are the most likely to be interesting to present at the Symposium, at Stanford. Three to four students would be invited, the exact number of students invited will depend on the interest of the students, numbers of projects selected) and the quality of the work.

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T.O.C

# Nature's contribution to people in 2050 (IPBES)

# Project 1 ☆ *(Ch)*

Natural habitats purifies our water, protects us from floods, delivers pollinators to food crops to support nutritious diets, and provides countless other benefits to people. The forthcoming global assessment of the UN's *Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services* (**IPBES**) will address how nature's contributions to people will change in 2050, under different scenarios.

As part of this effort, we modeled 3 key nature's contributions (so-called *ecosystem services*):

- Coastal risk mitigation by natural habitat,
- Water quality via nutrient retention,
- Pollination contribution to nutrition

under 3 scenarios (sustainability, fossil-fuels, regional rivalry), worldwide, spatially (at the fine resolution of 300m).

These results can be analyzed under many different angles: exploring need for nature's contribution, change in the nature's contribution, number of people impacted… But also comparing across different regions, ecosystem services, or scenarios.

The multi-dimensionality of this problem makes it fascinating, because the choice of metric, and visualization style really can lead to different storylines. A number of different static figures have been developed for this analysis, but connecting this complex dataset interactively would really be useful.

We hope for a dashboard allowing us to explore the results under different angles and answer to different questions such as: "Where are people more vulnerable to water pollution?", "Where does nature protect us the most from coastal storms?", "How many people will be affected by a change in habitats in 2050, according to the *sustainability* scenario?". But the students are free to interpret the problem as they wish! The static figures developed may be re-used, the raw data will be provided as well.

## Pros&Cons:

(+) Lots of interesting data, and multi-dimensions very suitable for an interactive dashboard! Very interesting topic, will likely be showcased on a website and lead to future work

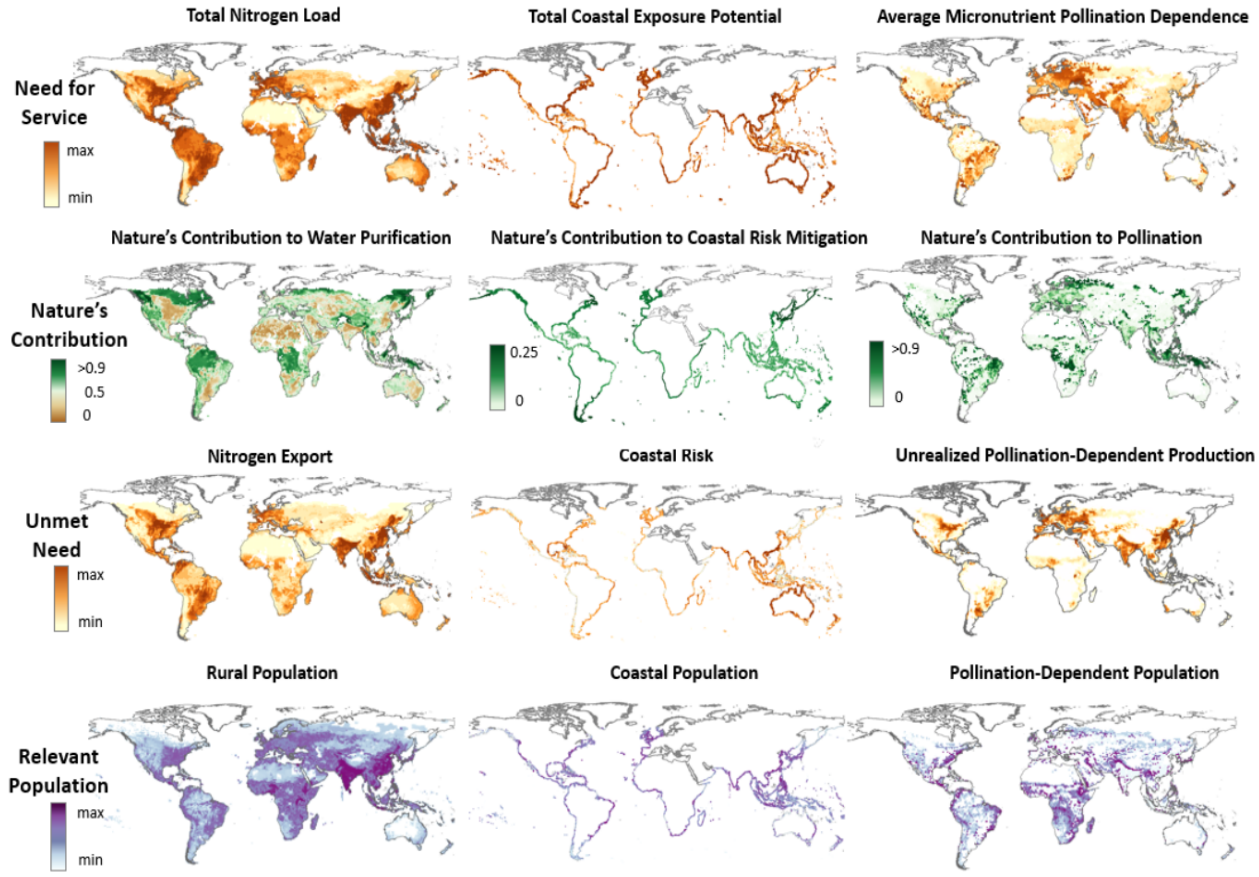
(-) This project will require a little bit of time upfront to dive in the topic and understand the metrics

## Data format:

3 CSV Tables for each service (coastal risk, pollination, water quality):

- with each row corresponding to a point in the world.
- Columns:
    - Geographical info: Region (continent), subregion, country, (we can add lat/lon if you want to map this directly from the csv)
    - The service quantity (e.g nutrition in calories for "pollination", or risk mitigated for "coastal risk"): for Current_2015, 2050_FutureScenario_1, 2050_FutureScenario_2, and 2050_FutureScenario_3
    - The relevant population (e.g all people living on the coast for "coastal risk), in each scenario.

Aditionnally, all these variables were mapped and are available as rasters, and pngs.


Total Nitrogen Load
Total Coastal Exposure Potential
Average Micronutrient Pollination Dependence
Need for Service
max
min
Nature's Contribution to Water Purification
Nature's Contribution to Coastal Risk Mitigation
Nature's Contribution to Pollination
Nature's Contribution
>0.9
0.5
0
0.25
0
>0.9
0
Nitrogen Export
Coastal Risk
Unrealized Pollination-Dependent Production
Unmet Need
max
min
Rural Population
Coastal Population
Pollination-Dependent Population
Relevant Population
max
min

# PRO Agua - Natural Resilience and Water Management in the Amazon: Spatial viz - Project 2 ☆ *(Charlotte)*

## Background

The Amazon is an area of incredible wealth - unparalleled biodiversity, natural resources, and human capacity. It also faces some serious challenges: in the past decade, rapid and often unplanned urban development in the Amazon, along with ongoing loss and degradation of natural forests, have exacerbated the effects of both severe drought and flooding. The 2-year project *Resilience and Land Use Planning for Water (PRO-Agua in its Spanish acronym)* is working with local collaborators in Peru, Brazil, and Bolivia to co-produce knowledge, tools, and to build capacity for identifying and acting upon opportunities for integrated watershed management to enhance water security and resilience to climate change.

Community : www.facebook.com/proagua.natcap.cincia/

## Visualization project

In the style of a similar work we did in Myanmar (but it doesn't need to be that polished!), we are interested in a storymap showcasing the issues this project addresses, as well as the key ecosystem services in the area.

A prototype and drafts visuals have been developed and can be built on.

## Data format

This is a very map-heavy project, allowing also for storytelling approaches.
Maps (available as shapefiles or rasters, which we can convert to TopoJson if it's better for you) that can be displayed include:

- Carbon storage(carbon stored in the forest, modeled and measured data)
- Floods
- Land use / land cover
- Soil quality
- Rivers
- Mining zones
- Tourism, biodiversity, natural parks...

# Visualizing nature's benefits in the Paris region
# Project 3 *(PH)*

## Background

Nature provides a range of benefits to Parisians, from food production to clean water provisioning, cool air during heat waves, and opportunities for recreation. Like in many cities, these benefits may be threatened in the future, in particular by uncontrolled urban growth and climate change.
The objective of this project is to visualize the range of benefits provided by natural infrastructure in the Paris region, both for the current situation and the projected changes under future scenarios.

## Visualization task

Nature's benefits have been modeled using the InVEST software and GIS layers are available to the students. The visualization exercise aims to enhance these datasets and help make sense of the data, in particular highlighting observed trends at different spatial and temporal scales.

## Data format

It's mainly spatial data for now but we could provide different formats (e.g. climate) if students are interested.Raster data (.tif): maps of crop production, sediment and nutrient retention, water yield (services provided by natural infrastructure) in the Paris region, plus socio-economic, political and infrastructure data for the region (http://data.iau-idf.fr/). Maps of urban services (stormwater and urban heat island available on demand --work in progress).

## Additional opportunities for students

This project relates to several ongoing initiatives in the Paris region, which offer several opportunities to showcase the students' work. First, a research project funded by the French Agency for Energy and the Environment and the Ministry for the Environment started in September 2018 with the aim of integrating nature's benefits in urban planning decisions. Further meetings with stakeholders involved in planning decisions in Paris are scheduled throughout 2018-2019.
A second related project is led by NatCap for the City of Paris, with the goal to encourage citizens' engagement in climate adaptation and vegetalization projects throughout the city.

# Training program - Project 4 ☆ *(He)*

Project URL: n/a (kind of: https://naturalcapitalproject.stanford.edu/training-program/

## Background

Our training program teaches ecosystem services approaches to multiple audiences around the world. We want better ways of viewing stats of our performances.

## Visualization task

What is the total attendance (in # people/training and in trainee/days) per year, and specifically per training type ? per training level?
Where are we trained?
Where are the trainees from?

## Data format

Data is here

## Pro&cons

(+) Quite easy straight-forward project. Could be enhanced with web development skills to add qualitative content

# Food Production in Future Climates - Project 5 ☆ *(Ch)*

## Project background

*How much food will we produce in future climates?*
We have developed statistical models to predict crop yields worldwide under future climate scenarios, resulting in spatial fine-resolution maps for calories produced per hectares for the years 2008, 2050 and 2070, under different climate scenarios.

## Visualization task

This project is very open, and is left to students to decide which aspects of the dataset to focus on, but here are a list of possibilities with our data: The project could also be turn to a “story-telling” style, exploring the world in 2050 or 2070 and describing how/why crops production change… One may be interested in comparing different climate scenarios, different modeling approaches, different regions, or even a sensitivity analysis of modeling parameters...

## Data format

Maps (as CSV tables with lat/lon) of

- Crop production current, measured data
- Crop production current, modeled data (with several different models)
- Crop production under climate scenario RCP4.5 (warmer climate) in 2050, and in 2070
- Crop production under climate scenario RCP8.5 (much warmer climate) in 2050, and in 2070
  *(we can develop these maps for more years if you want to do a temporal-style thing)*
- Population for each of these years and scenarios

*A*ggregated metrics to summarize these maps:
For each model: model performance ($R^2$)
For each climate scenario and year: overall crop production increase/decrease, overall climate metrics (precipitation, temperature) changes. All these per regions/countries, etc and we can play around with the dataset to export any other metrics of interest.

## Hey this matters!

We are what we eat and the food system drives everything. The way we grow food impacts every aspect of our global system. This is an opportunity to work on a concrete, impactful research, and potentially publish papers along with the current researchers.

# Map of International Environmental Projects
# Project 6 *(Ch+L)*

## Project description

This is a mapping project that aims to locate about 20 case studies across the world. These example are all about ecosystem management (e.g Carbon market, conservation lands, water-funds…)

The data provided consists in spatial datasets of various regions, at different resolutions. The interface should allow users to locate these around the world, zoom and pan on a world map.

Additional functionalities can be implemented by students, the data is very well suited for visualization and creative connections (e.g abilities to search a case study by key word, sorting the cases by water/land/habitat...)

Static visuals of each project will be given to students.

## Pros&Cons

(+) At minima, locating on a map the different case studies is enough. Then, each case study is a different, generally relatively simple, dataset. So this project can be thought of as an aggregate of 20 mini-projects, each very simple. Of course, we don't expect the students to necessarly do something about each of these 20 datasets, but they get to pick which ones they are excited about. We have static visualizations for each of the 20, so for the ones you don't decide to work on, we can re-use the figures we currently have.
(-) Web-development skills are a plus, to build a nice interface to connect the cases. These are mostly (but not only!) spatial datasets, so if you're not excited about maps, not for you!

## Context

This project can be thought as a spatial table of contents for the to-be-published book about Green Development and International Experience in Ecosystem Services Management. A successful visualization might be published as an online supplement.

# Water flow impacts of source water protection programs Project 7 *(JDF,AV)*

Project URL: https://snappartnership.net/teams/water-flow-impact/

## Project background

Maintaining reliable freshwater flows is essential for human health and well-being, sustainable economic development, and ecological integrity. Both floods and droughts can cause significant damage and even loss of human life; both are expected to increase as climate changes and anthropogenic land-use increases. Water funds and other watershed service programs have begun investing in nature-based solutions to maintain or restore reliable flows by protecting the source water area. To effectively implement the right actions in the right places in specific watersheds, we need to understand how and where different source water protection actions can contribute to achieving reliable freshwater flows. The SNAPP water flow impacts project brings together hydrology and adaptation experts with stakeholder group representatives to both examine the science relating land cover to reliable flows  and to interpret that science through the lens of those stakeholders.

## Data format

The data will come in a SQLite relational database file. The primary table in the database has rows that correspond to particular watersheds where experiments have been run, the characteristics of those watersheds (lat/long, rainfall, elevation, etc.), and the characteristics and results of the experiment (type of experiment, the area changed for the experiment, the amount and type of flow change, and a normalized version of the result). This experimental watershed table is linked to a similar table that describes the watershed that serves as the control, as well as to a table that has the relevant references.

## Visualization task

This project would develop an interactive data visualization of the database to summarize the results of the systematic literature review of the evidence of land-cover change effects on river flows, for use by both scientists and stakeholders. The project would first develop a figure that presents a broad summary of the results across activities and key flow metrics for quick review, including: the type of activity and relevant flow metric; sign and amount of (normalized) change observed; and the number of studies that show these results. The project would also include interactive tools to further interrogate the data across study types, locations, and results, by interaction with the overview figure or through specific querying. This may include displaying the distribution of flow changes across watershed characteristics or type of land-cover change, or showing the spatial distribution of the studies and their results across space. The students would be encouraged to generate novel and intuitive representations of the data.

## Pros&Cons

(+) This project is a good opportunity to develop skills using multidimensional data with a database backend, similar to the way many modern web visualizations are managed.
(+) There are lots of links between the data, so that the student will have the opportunity to develop interesting ways to demonstrate the data: show the distribution; look at both the normalized and actual observed flow changes; compare across watershed characteristics. The students would be encouraged to find interesting ways to look at the data, in coordination with us.

(-) There is relatively little spatial data in this dataset--just the locations where the studies occur. While a nice visualization of the study locations would be great, this project won't lend itself to the same kind of shapefile visualization as some other projects.

# Dashboard Viewer of Water Yield Model results Project 8 *(H+L)*

## Project description

Motivation: The NatCap training program has been having great success with hands-on exercises that no longer require learners to actually utilize InVEST or any GIS to create and view outputs. Links above under the "Project URL" heading are examples of web-based model-output viewer/dashboards for the HRA and CV InVEST models. What NatCap lacks, as of yet, is any similar viewer for any FWAT models, and it would be a great benefit to our training program to have a viewer for case study outputs from models like SDR or SWY.

## Visualization task

A web-hosted viewer tool, to see the result of the water yield model (or other model, you choose!) InVEST. Final product would be similar to this or this: We hope for a fully-usable web-based dashboard/viewer tool to show how our Water Yield Invest Model works InVEST. If possible, to handle multiple scenarios/model runs as well.

## Data format:

Inputs data:
https://drive.google.com/file/d/0BwUKVy28u1maOUtlNHk5cmJEb2c/view?usp=sharing
(there will be additional output data)

## Pros & Cons

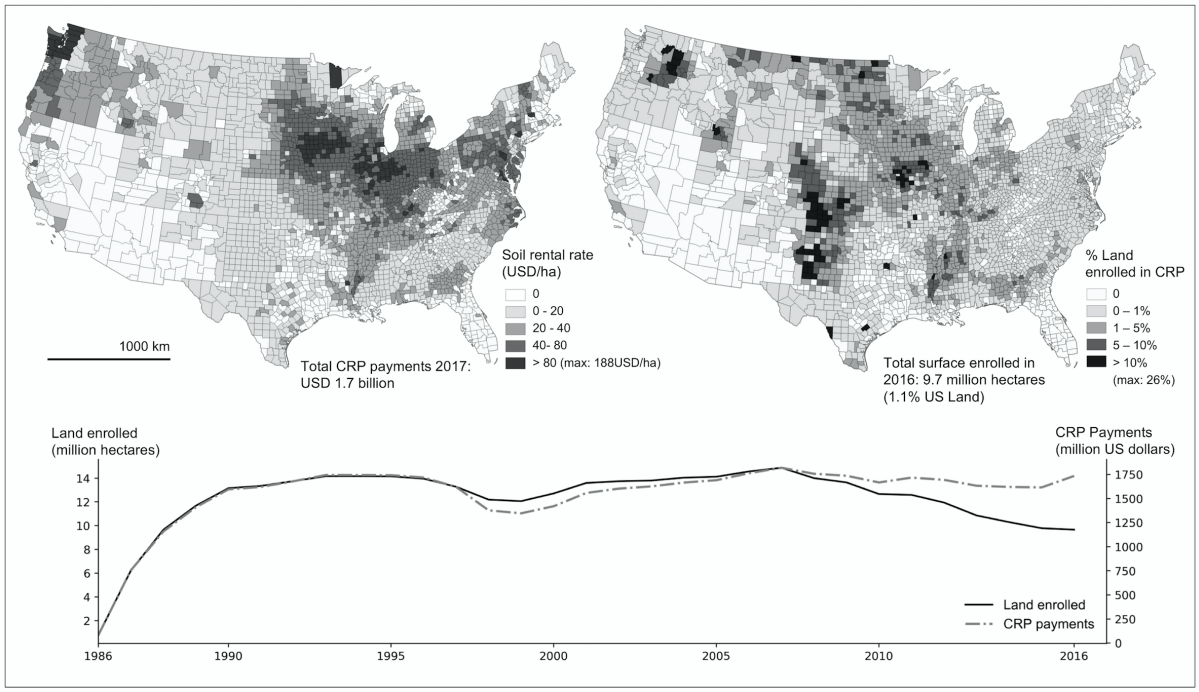
(+) This project is useful : Result will immediately enter into training materials used on an on-going basis by NatCap's training program (and may also appear places like in our MOOC through Stanford Online)
(+) Existing examples of similar visualizations/dashboards exist, so that might appeal to students who are looking for clear guidelines for what they're expected to produce

# Land Conservation in the US Project 9 *(Ch+L)*

## Project description

In the 1970s in the United States, agricultural policy and domestic demand led to steep increases in the price of agricultural commodities. In order to increase supply, American farmers were encouraged to plant “fencerow to fencerow.” As a result, most lands were converted to crop production. This had detrimental environmental effects, including increases in soil erosion, decreases in water quality from runoff of agricultural pollutants, and loss of habitat for wildlife.
The Conservation Reserve Program (CRP) was established in 1985 to reduce the environmental impacts of agricultural production, while also supporting farmers: CRP provides subsidies to farmers to convert environmentally sensitive croplands to perennial vegetation in order to improve environmental conditions.

We would be interested in visualizing our dataset of land enrolled in CRP (hectares) and CRP payments from 1986 to 2016. This dataset is available by US county, interesting to visualize spatially and temporally.




Bonus data that will be shared and may be visualized on top (not a requirement!) include other US conservation programs such as carbon markets forest offsets, wetlands conservation banks, and land trusts.

## Outcomes for students

This project corresponds to a chapter of our to-be-published book about Green Growth and International Experience in Ecosystem Services Management. A successful visualization might be published as an online supplement.

# 11 Dimensions of Environmental Benefits for Parcels in Minnesota - Project 10 *(R)*

## Project URL: http://pebat.umn.edu/

## Project background

At the request of the state organization that makes recommendations on how to spend the state's lottery revenue on natural resources, we created a tool to provide consistent, quantitative information on the environmental benefits for any potential acquisition. To provide context for how a proposed acquisition compares to alternatives, we scored over 300,000 privately held and undeveloped 40 acres parcels on 11 environmental benefit metrics.

## Visualization task

The visualization we created focuses on how a single parcel compares to alternatives, but the dataset has many unexplored visualization opportunities.

Potential visualizations include; identifying co-benefits and trade-offs (both spatially in the state and between benefits), highlighting and filtering parcels which perform better than others on certain criteria, or analyzing the benefits of past state-funded acquisitions.

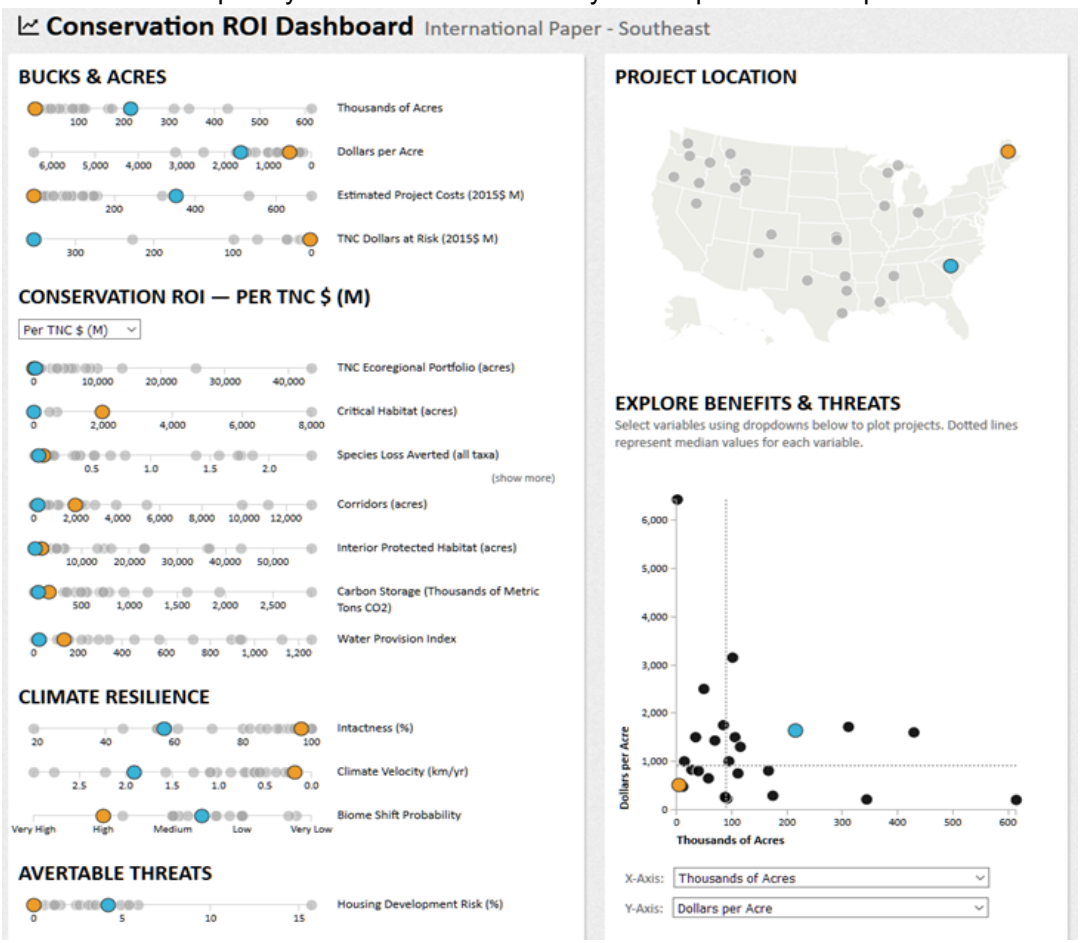
## Data format

Students would have access to a shapefile of all undeveloped parcels in the state, each of which is scored on 11 environmental benefit metrics, as well approximately 100 parcels that have already been acquired that have associated cost data.

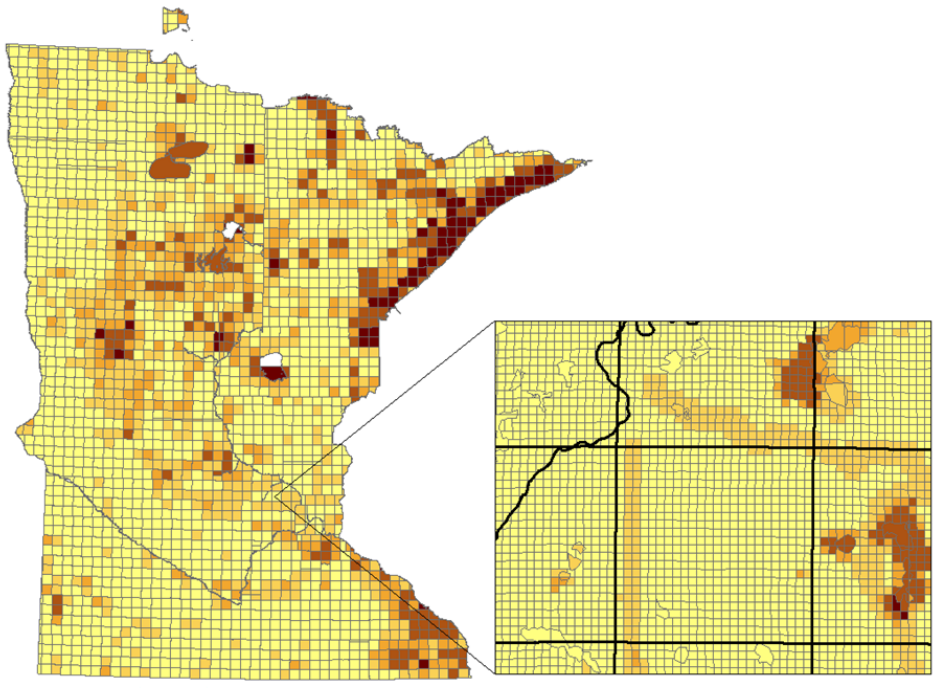
## Illustrations

See next page →

Dashboard developed by The Nature Conservancy that inspired some aspects of our tool:




A view of the resolution of the data:



Aggregated by township for display

Scores at 40 acre PLS level