Climate Visualization for Natural Resources

Project Description and Clarification

Center for Sustaining Agriculture and Natural Resources

Gemini

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I. Introduction

The Center for Sustaining Agriculture and Natural Resources (CSANR) [1] sought out our help improving and expanding upon a climate visualization tool. The tool is a website where agriculture professionals can get information on the past, present, and future climate of many specific areas in the Columbia Basin as well as the entire United States. Our task is to expand the tool to include information on how climate change impacts cattle production in unpopulated lands called rangelands. The main focus of our tool will be to communicate data on four environmental variables that have the most impact on cattle production in rangelands: net primary productivity, interannual variability, heat stress, and vegetation type trajectory. Briefly, net primary productivity measures herbaceous vegetation; interannual variability refers to change in herbaceous vegetation; heat stress quantifies the physiologic stress of heat on cattle; and vegetation type trajectory refers to change in herbaceous vegetation relative to other vegetation types [2]. Data for these variables is provided by the United States Forest Service.

II. Background and Related Work

The project extends a climate visualization tool to quantify and visualize environmental change in the United States so that interested parties can better prepare for the future. The focus of the project is the development of data visualizations that present forecasts of indicators important to cattle production.

The United States Forest Service and a consortium of land-grant universities provide climate visualization tools in agriculture that relate most closely to the aim of the project.

Northwest Climate Hub. The Forest Service directs regional climate hubs that “deliver science-based knowledge and practical information” through educational materials and visualization tools for the purpose of helping “farmers, ranchers, forest landowners, and Native American tribes...adapt to climate change” [3]. The Northwest Hub maintains a set of tools for supporting decisions in agriculture against a backdrop of climate change. The tools make use of visuals to present location-specific forecasts for weather and terrain.

University Consortium. The United States Department of Agriculture collaborates with land-grant universities in Washington, Oregon, and Idaho through the REACHH project to sustain crops in the Pacific Northwest in spite of climate change [4]. A principle goal of the consortium is education of professionals in the agriculture community, which, in part, is accomplished through decision support tools. The consortium maintains an array of visualization tools that project weather and crop yield.

The project requires technical knowledge and skill new to the senior design team. The climate visualization tool uses the RShiny framework, which no team member has previously used. Most team members have little experience in the R language, the programming language that underpins RShiny. Few members of the team have experience in web development. No team member has formal knowledge of user experience design or user interface design. No team member has formal knowledge of data visualization. No team member has domain knowledge in agriculture. Over the course of the project, however, the technical knowledge and skill of the team will improve one milestone at a time.

III. Project Overview

Problem

The client has requested a web-based decision tool for aiding sustainable practices of agriculture in the face of climate change. The primary user group is agricultural professionals of the Pacific Northwest who advise agricultural producers on crop and livestock selection, growing and rearing practices, and pest management. The decision tool must orient the user to region of interest with a map, provide data categories to query, and display query responses both quantitatively and visually.

Objectives

The client has set forth a list of web application features and a mandate to estimate server costs for additional datasets:

Web application. The application shall incorporate modification to an existing feature and display a new feature.

- The existing feature derives from a dataset on crop-related variables and displays one forecast for growing degree day, temperature, precipitation, and climate analogues for the Pacific Northwest region. This feature shall be augmented to display up to four additional forecasts. The additional forecast data shall be provided by the client. The display of data shall remain intact but with modification to select from among multiple forecasts.
- The new feature derives from a dataset on rangeland-related variables. This feature shall display forecasts of metrics on vegetation and heat in rangelands of the United States. The data shall include up to four different forecasts and be provided by the client. The data shall be displayed by interactive map and plot. The display of maps shall adopt the style of the open-source JavaScript library Leaflet. The display of plots shall adopt the style of an open-source library specified by the client.

Cost analysis. The datasets shall be stored on a private server and the cost of server space shall be estimated. In order to obtain an estimate, the volume of data as well as the cost per unit space must be ascertained.

- The volume of data encompasses historical and forecast data of crop- and rangeland-related variables. The current data size is 20GB, which accounts for historical data and one forecast of crop-related variables. Each one of the two features shall display up to four forecasts. The upper bound on space is, then, 8*20GB.
- The cost per unit space on university-owned resources shall be requested.

Outcome

The senior design team shall deliver a web application that augments prior work with additional forecasts and displays a new feature on cattle rangelands. The team shall run a cost analysis on hosting data for the web application.

IV. Client and Stakeholder Identification and Preferences

Our main clients are Dr. Kirti Rajagopalan and the Center for Sustaining Agriculture and Natural Resources. The stakeholders considered in this project are agriculture professionals in the Columbia Basin and in the United States, agriculture producers, the United States Department of Agriculture, politicians, and anyone concerned with the future of agriculture and agriculture related resources in the United States. Agriculture professionals include mostly crop consultants who advise on crop choices and University extensions that advise on the best practices. The stakeholders need an easy-to-use interface for viewing and understanding complex data on climate and natural resources of their region. Our client seeks an addition to the tool that looks and feels like the existing tool. This will be achieved by using the same API (Leaflet) used in the climate visualization tool, using the same color schemes, and presenting the data in a similar way.

V. Glossary

Agriculture Professional - Crop consultant who advises on crop choices or university extension staff member that advises on best practices

Columbia Basin -The Columbia Basin is the drainage basin of the Columbia River in the Pacific Northwest region of North America

Net Primary Productivity - The amount of carbon uptake after subtracting Plant Respiration (RES) from Gross Primary Productivity (GPP). GPP is the total rate at which the ecosystem capture and store carbon as plant biomass, for a given length of time

Interannual Variability - Value describing the interannual standard deviation in annual average forage quantity for a region

Heat Stress - Negative effects on cattle due to higher than usual temperatures

Vegetation-type Trajectory - the position of edible vegetation in a multidimensional climatic space

Leaflet - Open-source JavaScript library for interactive maps

Rangeland - Open country used for grazing or hunting animals

RShiny - An open-source R package that provides an elegant and powerful web framework for building web applications using R

VI. References

[1] CSANR. (2017). *Center for Sustaining Agriculture and Natural Resources* [Online]. Available: http://csanr.wsu.edu

[2] M. C. Reeves, K. E. Bagne, J. Tanaka, "Potential Climate Change Impacts on Four Biophysical Indicators of Cattle Production from Western US Rangelands," *Rangeland Ecology & Management*, vol. 70, pp.529-539.

[3] USDA NW Climate Hub. (2017). Northwest Hub | OCE [Online]. Available: https://www.climatehubs.oce.usda.gov/northwest

[4] REACCH PNA. (2017). *Regional Approaches to Climate Change - Pacific Northwest Agriculture* [Online]. Available: https://www.reacchpna.org