CS486C – Senior Capstone Design in Computer Science

Project Description

Project Title: Preserving tropical forest biodiversity: an app to inform policy makers	
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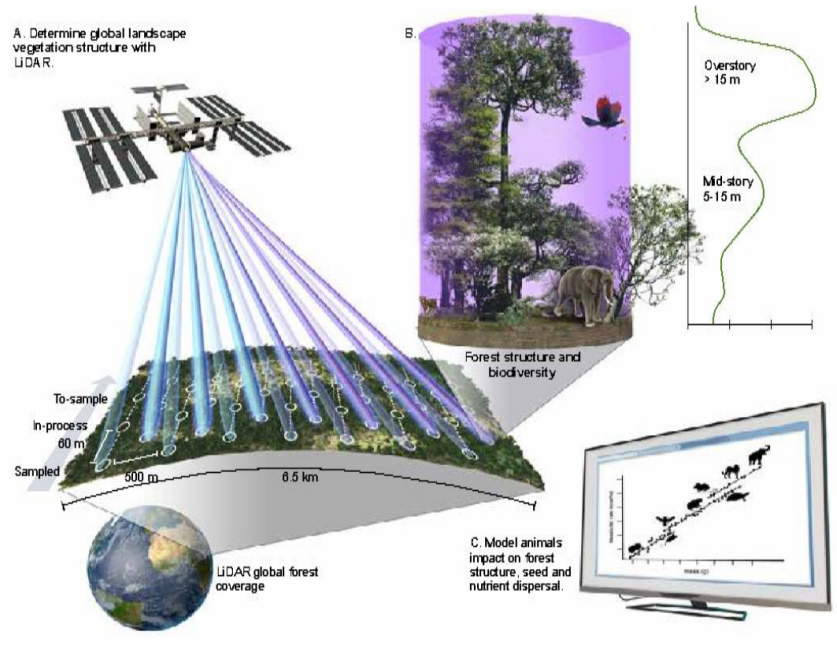
Project Overview:

Tropical countries are the most biodiverse places on the planet, but they are rapidly losing their biodiversity. This project will help to create an app used by three tropical countries (Peru, Brazil, and Gabon) to help them preserve their biodiversity. At NAU, there is a large NASA-funded project that combines NASA satellite data with a global ecosystem model to predict how biodiversity in tropical countries will be affected by climate change, deforestation, and bushmeat hunting. We want to make the maps created by this project as accessible as possible to policy makers across the tropics to help guide their decision-making process. Therefore, this project will combine a team of scientists that will create these maps with NAU capstone CS students who will create a powerful mobile application to make the map accessible to two groups of stakeholders: policy-makers and the general public. A secure, role-based permission system will allow the app to present quite different GUIs with different viewing, analysis, and feedback capabilities to each of these two groups.



The main science goals of the overall NASA project are to combine new global forest structure data (satellite lidar) with the Madingley model, a General Ecosystem Model (GEM), which can address the link between animals and ecosystem processes on a global scale. In tropical forests, animals move nutrients and impact carbon cycling. With Madingley, these services can for the first time be quantified and provide impetus across entire ecosystems to better preserve local biodiversity, thus preventing their extinctions. Because we envision this to be a pan-tropical tool, these services can also be integrated into national and local planning. Animals that contribute to accelerated carbon sequestration could be incorporated into REDD+ and SDG frameworks, leading to possible poverty reduction as well as co-benefits of reducing forest loss and increasing biodiversity preservation. In addition, Madingley will

calculate many key essential biodiversity variables (EBVs). Such pan tropical EBVs will provide much data to help specific partner countries preserve their biodiversity.

Most tropical countries are required to produce these EBV's and report them to intergovernmental panels so that metrics of biodiversity across the world are better understood. However, many EBV variables are difficult to measure and unknown under future scenarios like deforestation, climate change, and extensive bushmeat hunting. For example, suppose a local policy maker is designing a new nature reserve. Will it be large enough to preserve biodiversity in a future warmer world where metabolic costs of many animals will be higher? If a region recently was logged, how will this change EBVs both now and in a warmer future. If illegal poaching occurs how will this impact trophic cascades and broader EBVs. The Madingley model will produce this data and answer these question – but currently it is not accessible by the general public.

The problem we want the capstone team to work on is communicating our science output to policy makers. We want an easy tool where policy makers can create simple scenarios on their phones and get useful, actionable information. The science team will create the maps under a wide range of scenarios, but the capstone team will create the app that uses this information. For instance, we envision a tool where a policy maker can simulate biodiversity in their country under a climate change scenario, a logging scenario, and an overhunting scenario or a combination of them. A major challenge will be developing clear visualization and easy-to-use GUIs; we look forward to working with team closely in later development phases to refine this element. Depending on the design (to be determined), members of the general public could also use the app, but would be presented with a different interface with limited capabilities, e.g., they could overview local biodiversity, and explore only future scenario analyses that have been officially vetted and released.

Ideally the app will be developed using a cross-platform framework like Ionic or React Native, which could allow both iOS and Android versions to be driven by the same codebase. For development purposes, the team may choose to focus on the Android version first, just to ease the logistics of development. Due to the diversity of the stakeholder population, the app should also be internationalized, i.e., could set the language to English, Spanish or French; sponsor will assist the team is finding local language experts to help with this aspect.

We hope to work closely with the team to develop this vision into a well-specified feature set. Some of the key features will include:

Basic, minimum viable product:

- A modern secure Android mobile application, designed to run on a variety of Android devices.
- A role-based user management system. Power users (admins and scientists) can create/manage account; public users need no account.
- App supports GUI interactions in English
- a rudimentary cloud-based server that interfaces with the Madingley model server and provides backend service for the mobile app.
- Ability to grab the user's current GPS location and to use this to pull up a summary of the biodiversity statistics. The Madingley model outputs hundreds of variables, but initially we will output 5 key variables as both a time series and a regional map.

- Ability to select from at least three pre-defined future scenarios (climate change, logging and illegal hunting); model computes the scenarios for the local location and shows biodiversity stats for that scenario based on Madingley model results.
- Ability to specify the location (rather than computing only info for your current location). User is able to specify the "target" location graphically (pin on a map) and explore biodiversity scenarios freely at that location, regardless of his/her actual location.

Complete, a well-appointed app. All elements of basic core, plus:

- A fully developed web app as server side backend. Allows power users to log in, and add/edit/delete content and manage system configuration.
- Product is internationalized, providing a user profile and associate management system where users can, among other profile details, select between English, French and Spanish as the interface language. GUI supports interaction in chosen language.
- Power users are able to create, configure and deploy an unlimited number of scenarios using the webapp. Once deployed, new scenarios are available for review on the mobile app.
- Power users can manipulate key modeling parameters in a given scenario, to explore differences in predicted biodiversity outcomes that result.
- More powerful Delivery of both Android and iOS apps. Both apps tested, demo'd and equally capable.

Nice bells and whistles: stretch goals:

- Supports user "lab notebooks" within their accounts; users can save off interesting datasets along with commentary for later reference, and can easily "share" such items, e.g., as email attachments.
- Incorporation of educational materials of some sort, e.g., short video clips about each scenario, or information about the project or the Madingley modeling approach.

During this time of unprecedented stress on biodiversity, policy makers need the actionable information that this app will provide. If successful, this app will not only provide critical location-specific information on biodiversity to policy makers and members of the public in Brazil, Peru, and Gabon, but may serve as a model for providing such information anywhere on the planet.

Knowledge, skills, and expertise required for this project:

- Knowledge of mobile application programming frameworks, with particular emphasis on cross-platform frameworks like Ionic and React Native.
- Knowledge of modern Web2.0 programming techniques required to develop the administrative web app
- Knowledge of back-end server and database technologies, with emphasis on configuration and deployment of cloud-based server resources like AWS.

Equipment Requirements:

- There should be no equipment or software required other than a development platform and software/tools freely available online.
- A cloud-based server may eventually be required as a deployment platform to support the webapp and backend. Development can be done on a free-tier server available from AWS. At product delivery, the client will take over this server and any future costs.

Software and other Deliverables:

- The software applications as described above, deployed and tested successfully with real data.
- Must include a complete and clear User Manual for configuring and operating the software.
- A strong as-built report detailing the design and implementation of the product in a complete, clear and professional manner. This document should provide a strong basis for future development of the product.
- Complete professionally-documented codebase, delivered both as a repository in GitHub, BitBucket,or some other version control repository; and as a physical archive on a USB drive.