Agricultural Monitoring Feasibility Assessment

California represents approximately 12% of United States agriculture revenues and is the most agriculturally productive state in the United States. The Central Valley agroecosystem of California spans a distance north to south of more than 700 km and covers an area of approximately six million hectares between the Coastal and Sierra Nevada Mountain ranges. It includes seven of the most productive counties of the state (Fresno, Tulare, Kern, Merced, Stanislaus, San Joaquin, and King). Agricultural irrigation accounts for 75%–80% of the state's annual water budget. Climate variability and change, land use change, and other conspiring factors are expected to put further strain on water resources. Overuse of fertilizer and pesticides have a negative impact on groundwater resources.

The California Department of Food and Agriculture would like to develop a new agricultural monitoring platform for the primary growing season (March – October). The front end will consist of a Google Earth-like API from which famers can visualize the spatial distribution of various environmental indicators in their fields through time. Farmers can use such information to improve agronomic practices, such as the application of fertilizer, irrigation, and pesticides. They have hired you to evaluate the feasibility of using Earth observation (EO) as the main information stream on the back end of the platform. They are particularly interested in monitoring five environmental indicators shown in **Table 1**. An environmental indicator is a characteristic corresponding to the structure, condition or functioning of a specific environment. It can be evaluated with one or more biological, chemical or physical variables derived from EO or other sources.

Table 1. Evaluation matrix for the California agricultural monitoring platform linked to specified spatio-temporal scales and remotely sensed variables.

Indicator	Spatial Scale	Frequency	EO Variable
Crop type classes		Annual	Crop type
Crop growth stages	Regional (>10,000km^2)	Annual	Crop height
Crop productivity	County (100-1000km^2)	Monthly	Biomass
Crop water-use	Local (<100km^2)	Monthly	Evapotranspiration
Crop stress		Monthly	Nitrogen

At the end of the exercises, you will have

- used hierarchy theory as outlined in Phinn et al. (2003) and elaborated upon in Kennedy et al. (2009) to select appropriate EO image data and analytical methods to analyse five environmental indicators for California's agricultural monitoring platform

Steps

1. Explore the internet and provided articles with your group to become an "expert" on the following sensor categories: (i) passive microwave and RADAR, (ii) LIDAR, (iii) thermal, (iv) multispectral broadband or (v) hyper-spectral. Gather background information about the reflectance/emissions properties of the Earth's surface that the technology exploits; characteristics of different sensors (spatial, spectral, temporal and radiometric resolution); remote sensing methods (supervised image classification, multispectral broadband and hyperspectral vegetation indices, radiometric temperature, backscatter coefficients, canopy height model); applications in agronomy; and any other information to help you familiarize yourself with the technology. You can summarize your findings in a short PowerPoint presentation or other informative medium.

2. Repeat the process for an analytical method: (i) Timesat, (ii) Breaks for Additive Season and Trend (BFAST), (iii) LandTrendr, (iv) Box-Jenkins or (v) Continuous Change Detection and Classification (CCDC).

3. Switch groups and use your new expertise in a sensor category and analytical method to determine what combination of EO data and analytical method(s) should be used to monitor the five indicators at the specified spatial and temporal scales in Table 1. It is essential that you consider the spatial, temporal, radiometric and spectral characteristics of each sensor and effectiveness, reliability, efficiency and usability of each analytical method. You can summarize your findings in a short PowerPoint presentation or other informative medium.