



# NEMATODE DETECTION SERVICE

## WEB SERVICES FOR THE NEMATODE DETECTION MODEL BASED ON THE MULTI-TEMPORAL DATA OF COTTON

P. K. Palacharla<sup>1</sup>, R.L. King<sup>2</sup>, G.W. Lawrence<sup>3</sup>

<sup>1</sup>Department of Electrical and Computer Engineering, <sup>2</sup>Center for Advanced Vehicular Systems, and <sup>3</sup>Department of Biochemistry, Molecular Biology, Entomology & Plant Pathology, Mississippi State University



### ABSTRACT

The reniform nematode *Rotylenchulus reniformis* is a nematode species affecting cotton production and is rapidly spreading across the southeastern United States. An effective management tool is the application of nematicides using variable rate technology. This requires knowledge of the intra-field variability of the nematode population, which depends on the collection of soil samples and analyzing them in the laboratory. This process which may be economically prohibitive. Hence estimating the nematode infestation using remote sensing and machine learning techniques which are both cost and time effective is the motivation for this study. In this research, the concept of multi-temporal remote sensing has been implemented to design a robust and generalized nematode detection regression model. Finally, a user friendly web-service is created which gives trustworthy results for the given input data and thereby reducing the nematode infestation in the crop and their expenses on nematicides.

The proposed methodology is implemented (Fig. 1) and the results were analyzed using standard metrics, RMSE and correlation coefficient. A 10-fold cross validation correlation coefficient of 0.8442 is obtained for the nematode detection model, which is a significant achievement. The 2-D and 3-D visualizations developed emphasize the importance of each stage of the algorithm.

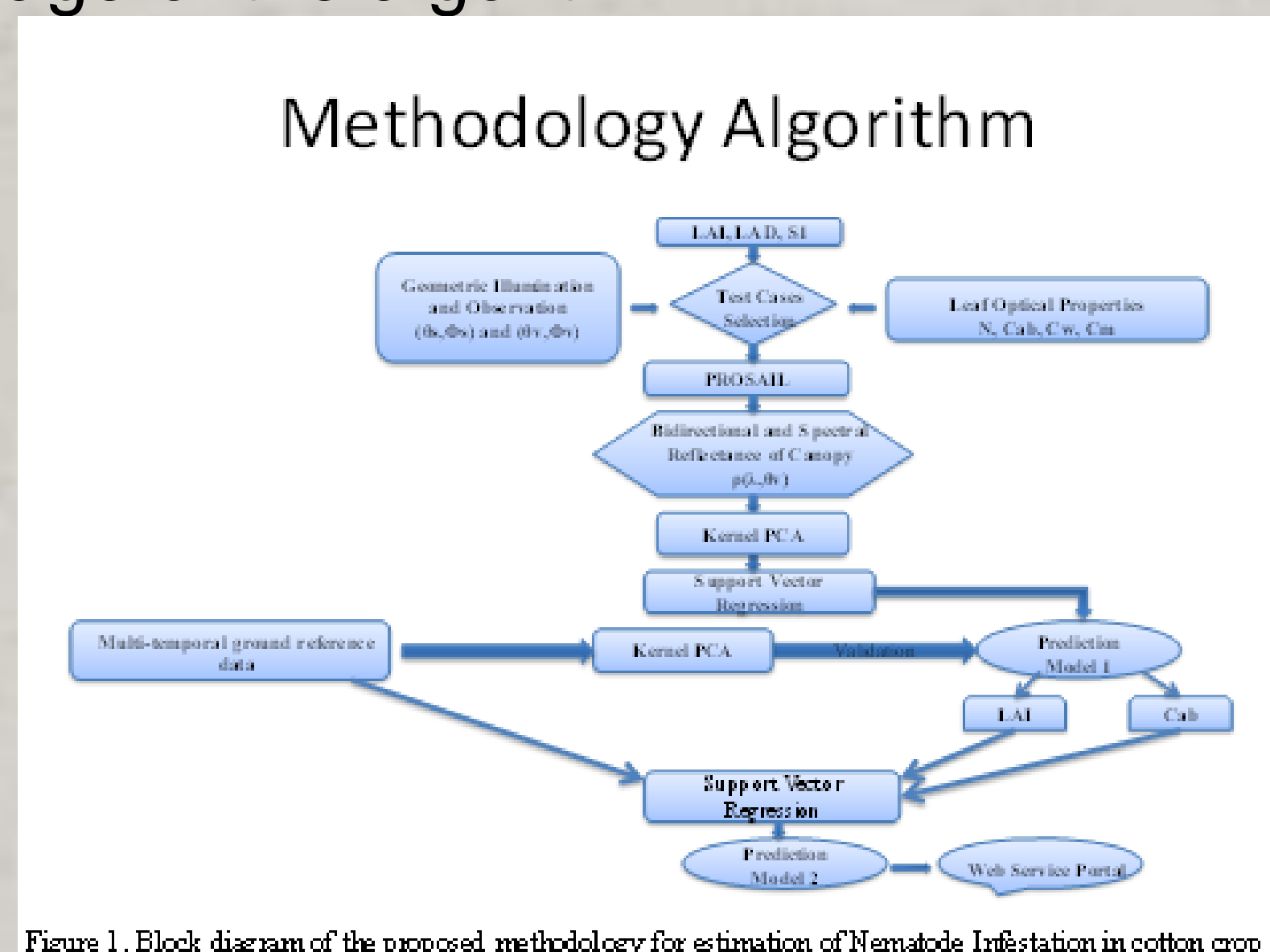


Figure 1. Block diagram of the proposed methodology for estimation of Nematode Infestation in cotton crop

### RESULTS

The web portal runs the nematode detection service and it provides a user friendly environment. The user uploads the required data and runs the models. The web portal returns the results on a visually appealing Google Map which makes the analysis easy for the user.

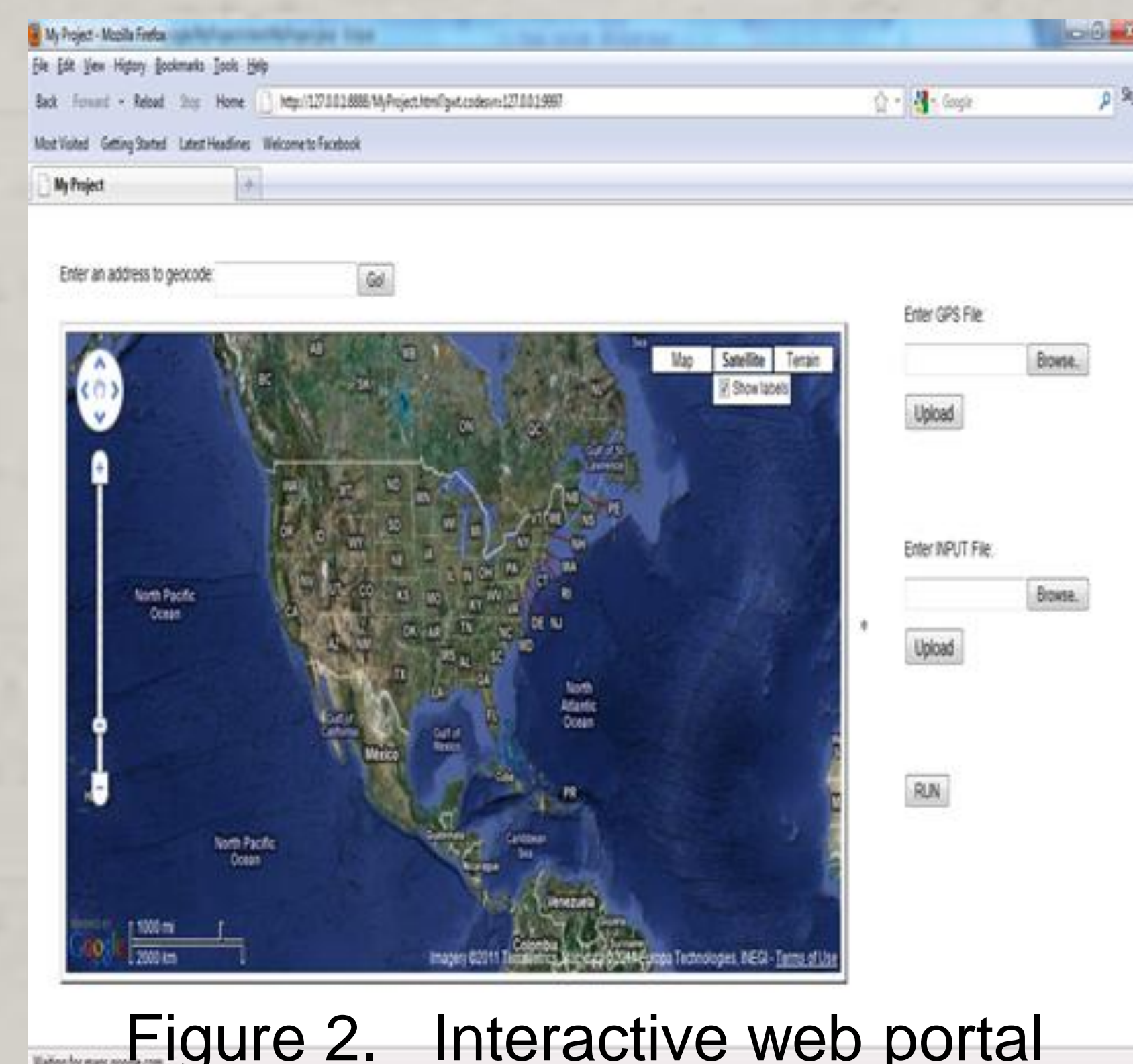


Figure 2. Interactive web portal

The Google Map functions implemented in this web application include the “map over view” and “geocoding”. The overview map generally covers a larger area than the main map. The part of the map displayed in the main map is placed within a small rectangle inside the overview map. The functionality of map over view control implemented in this web page provides an easy navigation for the user on the Google Map.

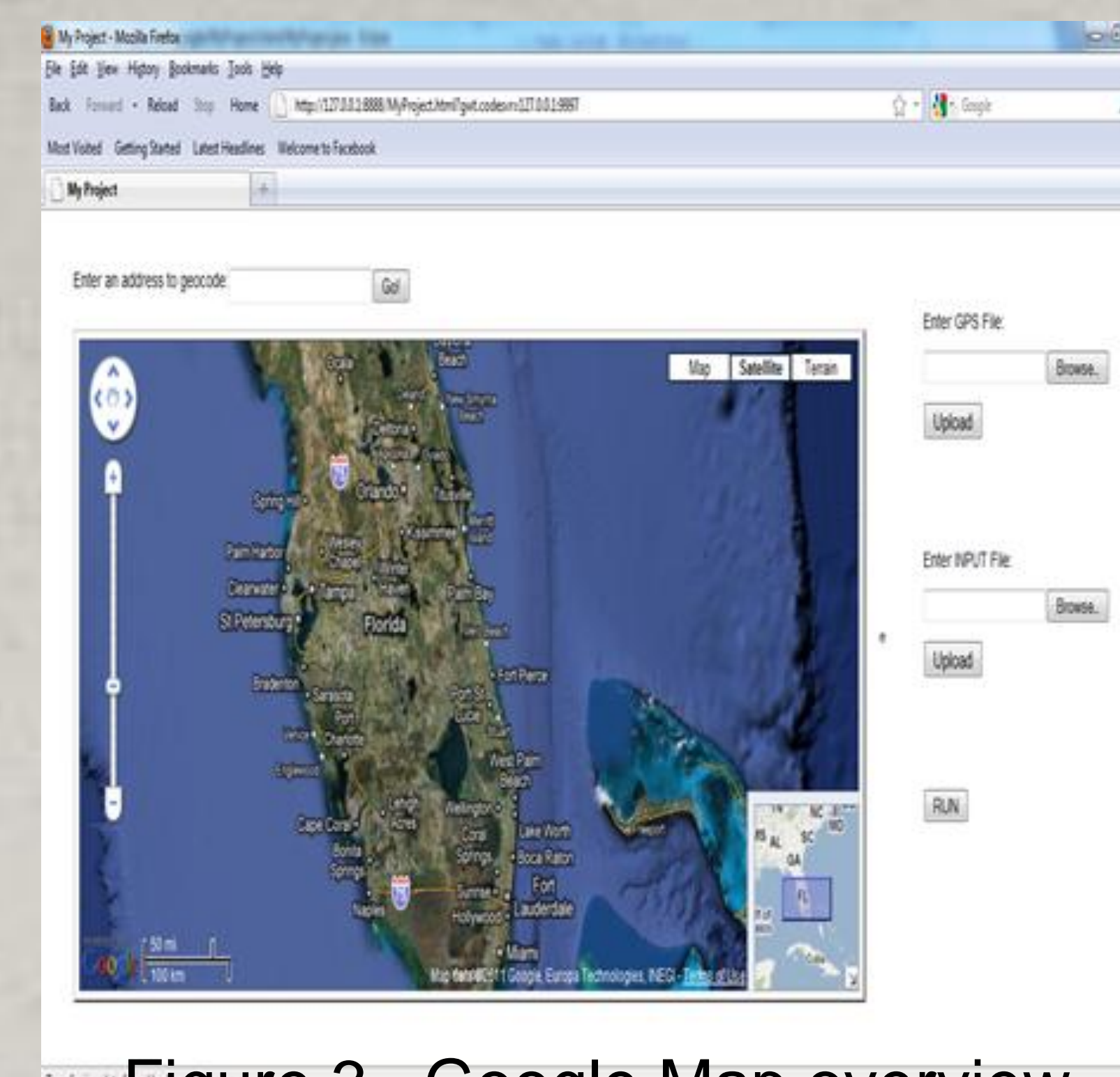


Figure 3. Google Map overview

Another feature implemented is geocoding. This allows the user to navigate to a place based on the name of the location or the GPS co-ordinates. By typing the name or the corresponding GPS co-ordinates in the space after “Enter an address to geocode” and click “Go!”. The map shifts to the place of interest and a marker is placed at the corresponding point (Fig.4).

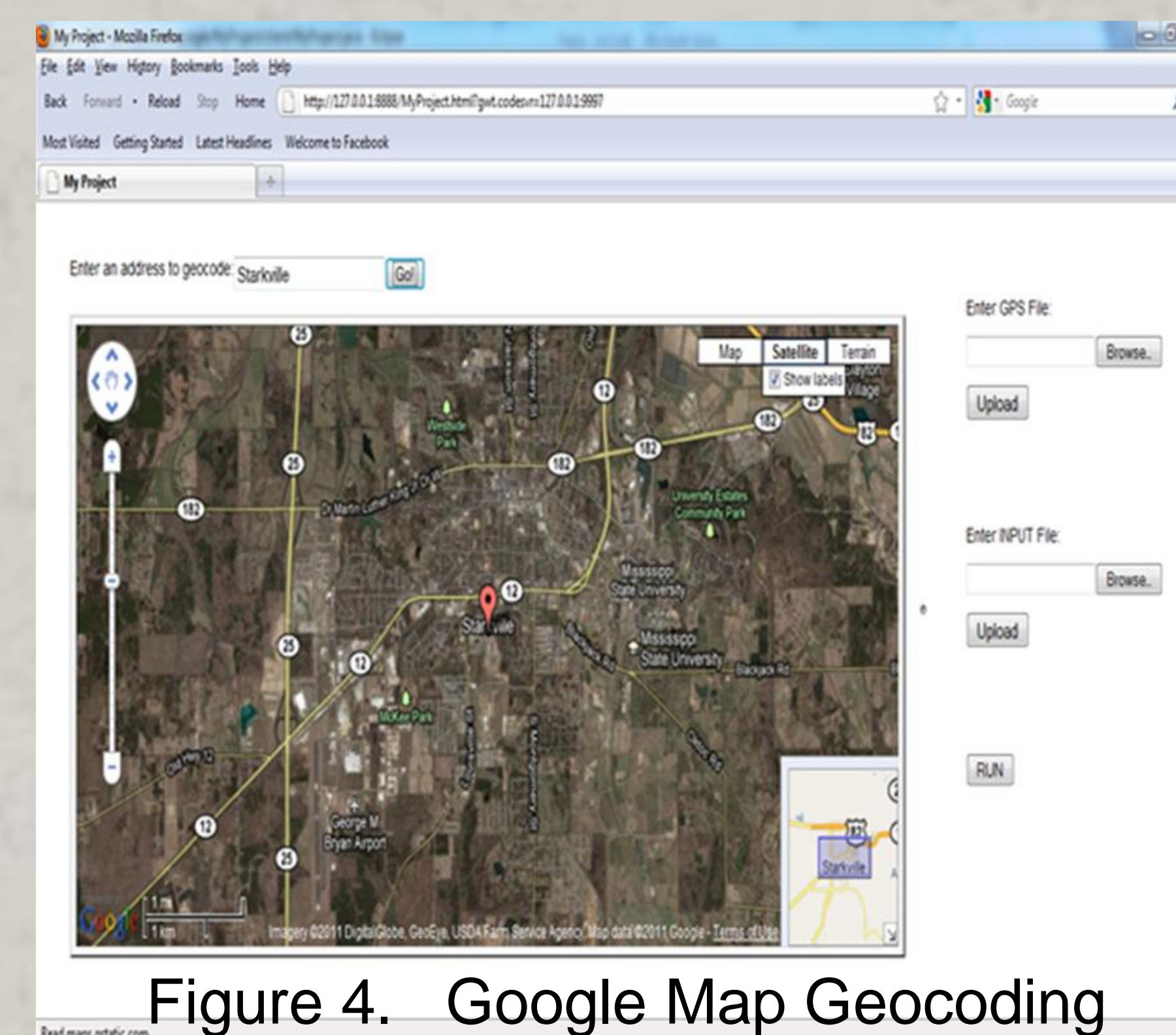


Figure 4. Google Map Geocoding

The necessary steps to be followed by the user to interact with the web portal are:

1. The user must upload the GPS co-ordinates file of the field of interest by providing the URL of the path of the specified file as input to the GUI (Fig. 2)
2. The GPS points are shown in the form of markers on the Google Map (Fig. 5).
3. The user must now upload the input file containing the reflectance GPS co-ordinates of the same field by providing the URL of the path of the specified file as input to the GUI. A marker is placed at each GPS co-ordinate of the individual sample (Fig. 5).

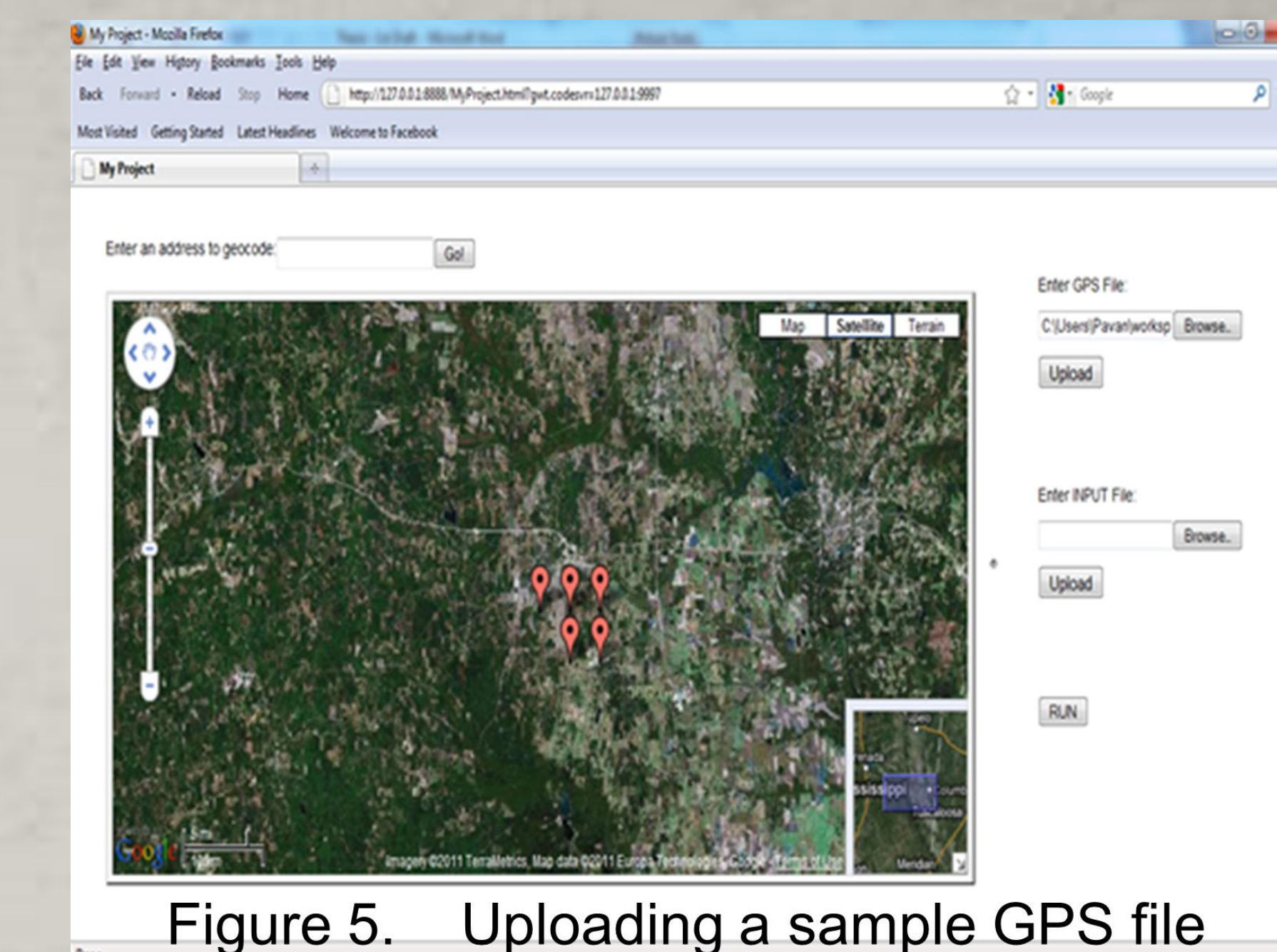


Figure 5. Uploading a sample GPS file

4. A text box window showing the “Input file has been loaded” appears, and the user can click “OK” (Fig.6).

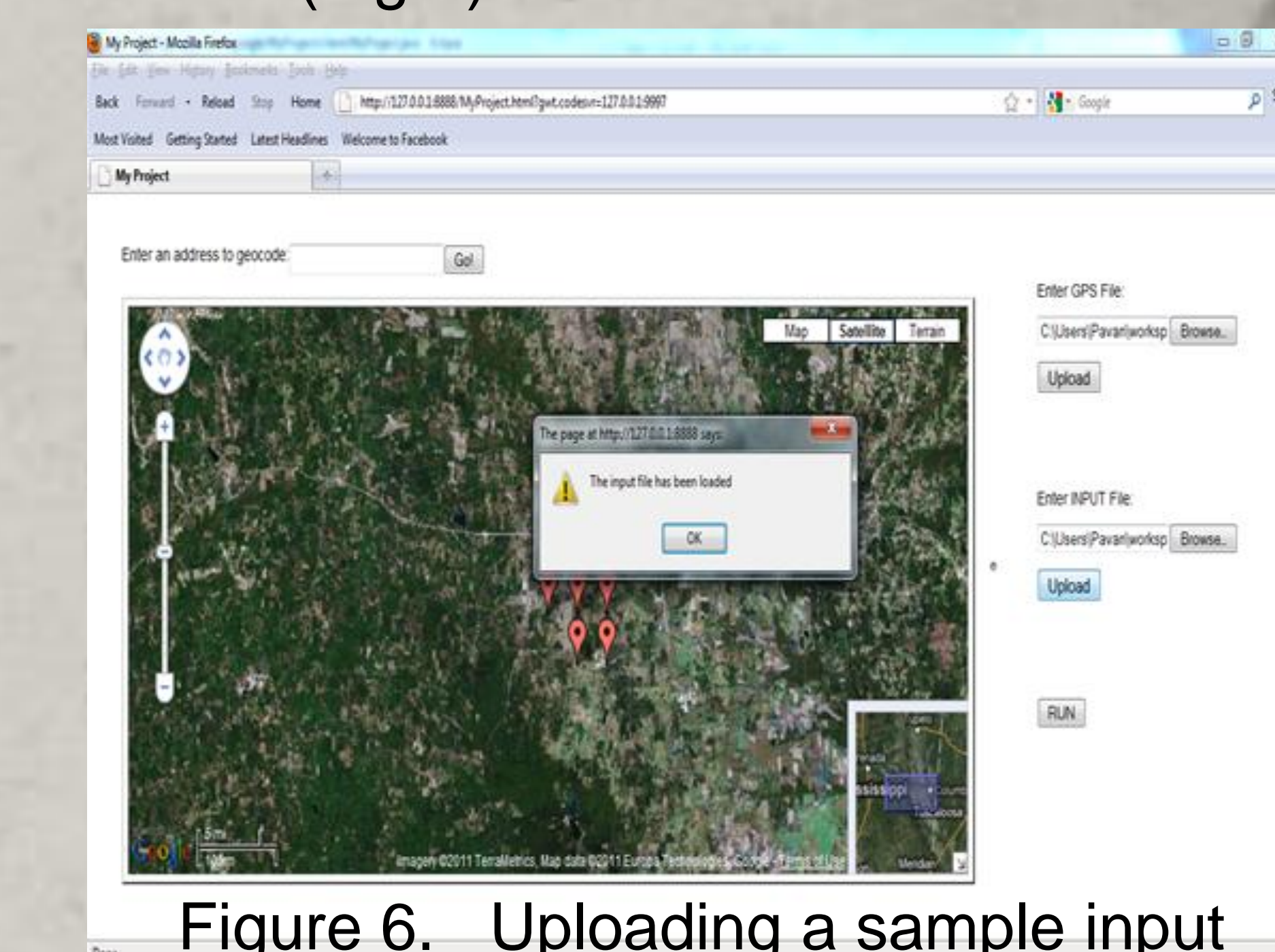


Figure 6. Uploading a sample input reflectance file

5. By clicking the “RUN” button the user request for the nematode detection service, which actually implements the proposed methodology and returns the nematode count as response. The nematode population at each sample is shown in a pop-up window above the corresponding marker (Fig. 7).

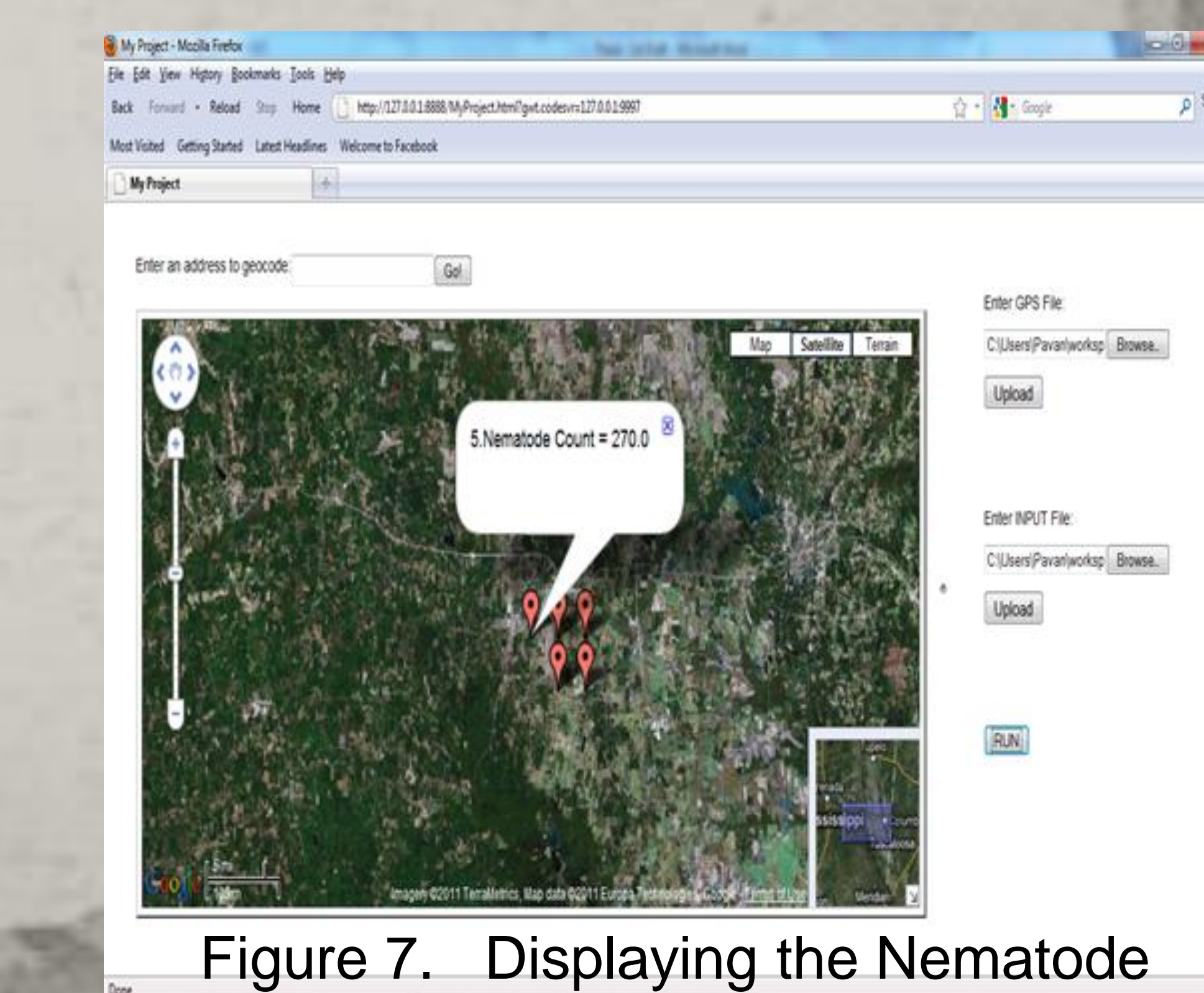


Figure 7. Displaying the Nematode count after running the models

### MATERIALS AND METHODS

A machine learning based algorithm is developed which exploits the available multi-temporal hyper-spectral data of the cotton crop and derives a relationship between the biophysical variables of the plant and the corresponding amount of nematode infestation (Fig 1).

The algorithm exploits the usage of jenny software for the purpose of test case reduction; a radiative canopy reflectance model PROSAIL provides an analysis of the reflectance from the vegetation based on the interaction of the solar radiation and the canopy. Use of feature extraction techniques and feature subset selection allowed the derivation of a more heterogeneous feature space to design a generalized regression model. A combination of the Kernel PCA feature extraction technique and support vector machine regression is used in deriving a robust model. A user friendly web portal is developed in Java using Google Web Toolkit, which allows the users to interact with the Nematode detection model. A Nematode detection service is developed using the Service Oriented Architecture (SOA) which performs the same steps involved in the proposed methodology and displays the result on a visually appealing Google Map.