REMOTE SENSING DATA FOR MANAGING LOCUST PEST PROBLEMS NEAR ARAL SEA, CENTRAL ASIA

Ramesh Sivanpillai, Associate Research Scientist
Wyoming Geographic Information Science Center

Alexandre V. Latchininsky, Assistant Professor
Department of Renewable Resources/Entomology
University of Wyoming
Laramie, WY 82071
sivan@uwyo.edu
latchini@uwyo.edu

Hans Wilps, Project Leader
Sustainable Control of Pest Locusts in Central Asia
Deutsche Gesellschaft fuer Technische Zusammenarbeit (GTZ) GmbH
Uzbekistan Field Office
100100 Tashkent – Uzbekistan

ABSTRACT

Managing locust pest problems of Central Asia requires information on a regular basis, for both prevention and control activities, and for very large geographic areas. Remotely sensed data are suited to provide information for preventive activities prior to an outbreak, and also assess damages to vegetation following an outbreak. We tested the utility of MODIS and Landsat data for identifying potential Asian Migratory locust (*Locusta migratoria migratoria*) habitats near Aral Sea, Uzbekistan. Suitability of Landsat data was evaluated to identify reed (*Phragmites australis*) beds, the primary locust habitats, in spring and fall. Our results indicate that the June Landsat image could correctly identify 75% of the reed beds, while the August Landsat image could correctly identify 80% of the reed beds. Multi-temporal MODIS data were able to identify 75% of the larger reed beds but could not identify several smaller patches of reeds. Our results indicate that moderate resolution data can provide information about the vegetation conditions to coincide with various life-stages of the Asian Migratory locust, while MODIS data could be used for periodic assessment of changes in vegetation growth.

INTRODUCTION

Amurdaya River Delta in Uzbekistan is one of the major habitats of the Asian Migratory locust (*Locusta migratoria migratoria* L.) (AML). The Plant Protection Specialists in the Karakalpakstan province of Uzbekistan have the formidable task of surveying this vast delta twice every year a) to estimate the locust egg pods laid in August/September, and b) to assess the survival rate (and hatching) of these eggs in May/June. Limited resources and access to sites often limit these surveys to easily accessible areas and therefore the inferences drawn from survey results are biased. This often results in over-prediction of locust risk leading to blanket application of harmful chemicals which adversely impacts the non-targeted fauna. In order to better target these chemical treatments accurate information is required on the amount of egg pods laid in August/September and their survival rate in the following spring (May/June).

One approach to assess the locust outbreak risk is to map the primary food of the locust – reeds (*Phragmites australis*). Reeds are annual grasses and their growth stages coincide with the life stages of AML. In August/September the adult AML lay their eggs in areas within the delta that contain reeds and bare ground. However in certain years their population density will be extremely high and their oviposition may not be influenced by the extent of reed distribution. For rest of the years this association holds well. In May/June of the following year, eggs hatch and the AML nymphs feed on reeds for their growth and survival. During their early growth stages – expressed in instars – the nymphs are immobile and therefore are entirely dependent on reeds. In summary oviposition and survival of AML nymphs are largely dependent on the reed distribution within the delta.

Therefore information on reed distribution within the delta could be used to distribute the sampling locations. Reed growth and distribution is based on the availability of water and therefore could change from year to year. These changes in the area covered by reeds could increase or decrease the available habitat for AML.

MAPPING REED DISTRIBUTION USING SATELLITE DATA

Satellite-based remotely sensed data are well suited for mapping reed distribution on a periodic basis. Medium to moderate resolution satellite data (> 10 m to 250 m pixel size) can provide the necessary information for mapping reed distribution to coincide with various AML growth stages which can then be used for allocating survey sites within the delta. Our work focused on evaluating the suitability of MODIS and Landsat data for mapping the reed distribution in the Amudarya River delta.

First the reed distribution was mapped using multi-temporal MODIS data acquired in the 2004 (Sivanpillai and Latchininsky, 2007). MODIS data acquired from May (start of the growing season) to October were used to construct the temporal signatures for the following thematic classes: reeds, reeds mixed with other vegetation, bare ground and water. These temporal signatures were used to distinguish the thematic classes and a reed distribution map (displayed in red color in Figure 1) showing the potential locust habitats was generated. The overall classification accuracy of this map was 74% and the individual class accuracy for reeds was 87%. These results indicate that multi-temporal MODIS data can be used to map reed distribution on an annual basis however the spatial resolution (250 m) of MODIS data might limit its use to map large patches of reeds.

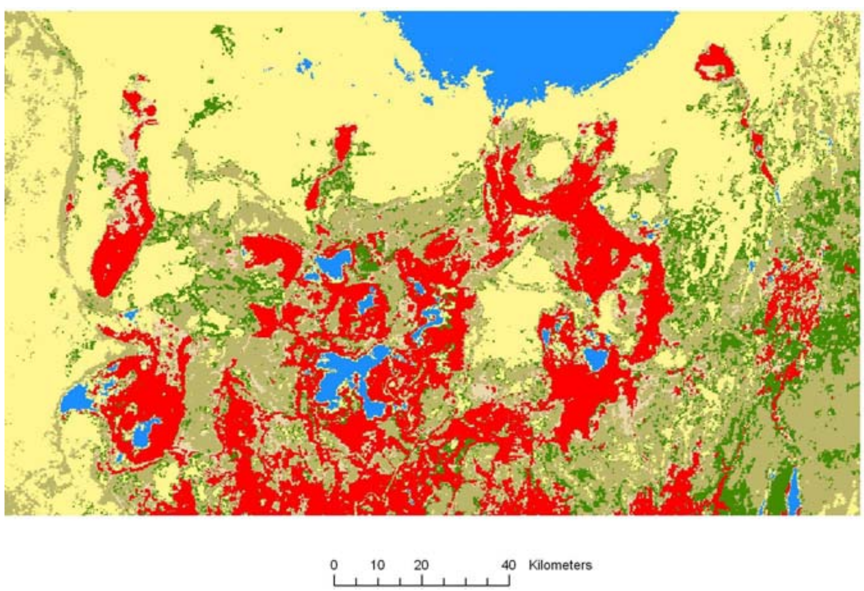

Figure 1. Reed (*Phragmites australis*) distribution map (red) derived from multi-temporal MODIS data.

In order to map the reed distribution coinciding with the AML egg-hatching stage, we tested the potential of an early season Landsat image to distinguish reeds from other land cover classes (Latchininsky et al. 2007). Landsat image was not only able to distinguish reeds from other land cover classes but also separated reeds by its vigor. Infrared reflectance was higher for reeds with high vigor, however the field data were not collected to distinguish these variations we combined them as a single reed class. The individual class accuracy for reeds was 87% but several sites that had reeds with other vegetation were misclassified as reeds resulting in over prediction of reeds.

Finally we evaluated the utility of late-season Landsat imagery to map reed distribution to coincide with the AML oviposition stage (Sivanpillai and Latchininsky, under review). Most of the reed stands were close to maturity (or senescence) and therefore were easily distinguishable from other land cover classes (Figure 2).

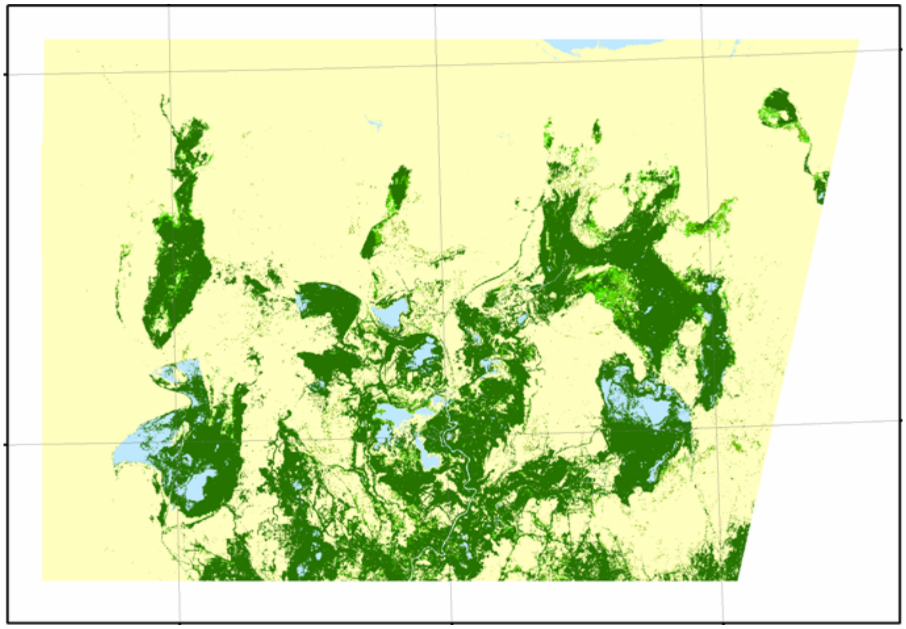

Figure 2. Reed (*Phragmites australis*) distribution (green) coinciding with locust egg laying stage derived from a late season Landsat Thematic Mapper data.

Sparse vegetation class was indistinguishable from the bare ground class and this might be due to crop stress following hot summer months. The overall accuracy of this image was 84% and the individual class accuracy for reeds was 90%. Similar to the earlier study involving early season Landsat imagery, misclassification of sites with reeds and other vegetation as reed was the major source of classification error.

CONCLUSION

Results from these three studies demonstrate that MODIS data can be used to map the annual reed distribution, and Landsat data can be used to map reed distribution to coincide with the oviposition or egg hatching of stages of the AML. Reducing the misclassification of sites that contain both reeds and other vegetation as reeds class could result in increased classification accuracy of these map products. Nevertheless, reeds and other vegetation class posses a certain degree of risk as a locust habitat in comparison to sites that contain mostly reeds. Incorporation of such information – that is updated on a periodic basis could reduce sampling bias during locust surveys. Maps derived from satellite data for multiple years could be used for monitoring changes to reed distribution.

REFERENCES

Latchininsky, A.V., Sivanpillai, R., Driese, K.L., Wilps, H., 2007. Can early season Landsat image improve locust habitat monitoring in the Amudarya River Delta, Uzbekistan?, *Journal of Orthoptrea Research*, 16(2):167-173.

Latchininsky, A.V., Sivanpillai, R., Wilps, H., 2007. Optimizing locust monitoring in Central Asia using remote sensing tools, In *Proceedings of the XVI International Plant Protection Conference*, Glasgow, UK.

Sivanpillai, R., Latchininsky, A.V., Driese, K.L., Kambulin, V.E., 2006. Mapping locust habitats in River Ili Delta, Kazakhstan, using Landsat imagery, *Agriculture Ecosystems & Environment*, 117(2-3):128-134.

Sivanpillai, R., Latchininsky, A.V., 2007. Mapping locust habitats in Amudarya River Delta, Uzbekistan with multi-temporal MODIS imagery, *Environmental Management*, 39(6):876-886.