EVALUATION OF WILDFIRE DURATION TIME OVER ASIA USING MTSAT IMAGERY

Yusuke Matsumura, Wataru Takeuchi and Yoshifumi Yasuoka
Institute of Industrial Science, University of Tokyo, Japan
6-1, Komaba 4-chome, Meguro, Tokyo, JAPAN 153-8505
E-mail:yusukem@iis.u-tokyo.ac.jp

KEY WORDS: Wildfire, thermal anomaly analysis, MODIS

ABSTRACT

In this study, we present an approach that aims to evaluate how long does a wildfire continues. An-houly MTSAT imagery is quite powerful to obtain the duration time of rapid fire events such as a grass land fire that last a few hours cannot be detected with the frequency of MODIS. This research is focused on the season and the type of land surface, and tries to detect the feature of wildfire at the each land cover vegetation. The land cover vegetation we choose is evergreen conifer forest, evergreen broadleaf forest. This paper concentrates on concepts and requirements for the more detailed information about the wild fire. As a result, it is found that fire duration time is detected by comparing the pixel which contains hot spots with non-affected pixels around it.If there is some wildfire in a pixel, the temperature of the pixel shows higher than the non-affected pixels. This technique is useful to detect the wildfire duration time whether land coverage is evergreen needleleaf forests or evergreen broadleaf forests.

1 INTRODUCTION

1.1 Backgrounds

Wildfires are a prominent global phenomenon and the numbers of human-caused fires greatly exceeds naturally occurring fires. Fires are set intentionally for timber harvesting, land conversion, or shifting agriculture (UNDP, 2001). Since a lot of forest fires take place in hardly accessible areas, remote sensing seems to be the most appropriate tool to monitor forests. Several techniques have been developed to detect and map fire growth by using multi-spectral analysis of remote sensing data. High spatial resolution data such as Landsat TM, SPOT HRV and Terra ASTER have been used to get the surface information of fire damaged area by using principal component analysis, change vector analysis and NDVI classification (Takeuchi *et al.*, 2005). However, they may not cover an target area frequently because of their narrow swath width. Another objection to monitoring the fire with high resolution data is cost and logistics of handling the data volume. Monitoring the growth mapping would require to use wide coverage data, such as from NOAA AVHRR or Terra MODIS (Kaufman *et al.*, 1997).

At the current situation, however, despite the advent of satellite imagery and the growing significance of fires to the condition of global forests, no reliable global statistics are available for the hourly feature of wild fires. More information about the hourly feature of wild fires would be needed so far.

1.2 Objective

This research is focused on to investigate the duration time of fire events using MTSAT data and analyze the hourly feature of the wildfires. The fire duration time and relative risk assessment were carried out by time series of thermal anomaly analysis comparing with non-affected pixels (denoted as normal pixels).

2 METHODOLOGY

2.1 Forest fire duration evaluation model used in this study

Figure 1 shows a forest fire duration evaluation model based on MTSAT time series supplemented by MODIS hotspot and land cover information. First of all, MTSAT geo-coded time series of dataset covering the hotspot were generated for 72 hours after fire events. A set of processing were carried out using a web-based data processing system equipped with a direct broadcasting of MTSAT HRIT [1] at Yayoi research campus of University of Tokyo (Takeuchi *et al.*, 2007). Secondly,

[1] A web-based MTSAT processing system (http://webgms.iis.u-tokyo.ac.jp/)

hotspot information were collected and intensive fire events history were carefully investigated by using a near-real time MODIS fire database available at a direct broadcasting of Aqua/Terra MODIS [2] at Komaba research campus of University of Tokyo. Thirdly, two test sites with different forest and fire type characteristics were selected supplemented by MODIS hotspot database and land cover dataset (MOD12) developed by Boston University group [3]. Finally fire duration and relative risk assessment were carried out by time series of thermal anomaly analysis comparing with non-affected pixels (denoted as normal pixels).

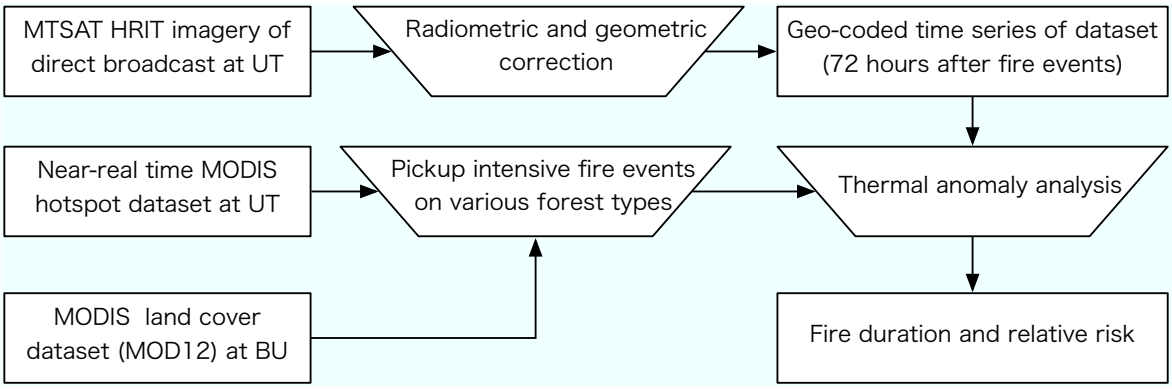

Figure 1. Flowchart of forest fire duration evaluation model based on MTSAT time series supplemented by MODIS hotspot and land cover information.

2.2 Test sites

We choose two as the typical forest fire cases. One is evergreen conifer forest located in east Siberia and the other is evergreen broadleaf forest located in Sumatra Island. Land cover was determined by using vegetation map and Google earth image at that site.

3 RESULTS AND DISCUSSIONS

3.1 Evergreen needleleaf forest in far east Russia

Figure 2 shows an hourly spectral change of thermal infrared region (channel 1, 10.5μm) of an evergreen needledleaf forest in far east Russia. Figure 3 shows a sketch of fire affected pixel and its surrounding pixels of a test site. The time which forest fire was detected by MODIS Fire product is July 4th and July 5th at the pixel C. Pixel A and pixel B is normal point. As the figure shows, the change of land surface temperature at the pixel A and pixel B, July 4th and July 5th is quite similar. However, the pixel C displays different behavior from normal pixels. At the peak of the graph, it shows about 3K higher temperature than normal pixel as A and B. From this information, the duration time of the forest fire is 4 or 5 hours. At the jul.6, both the land surface temperature of pixel A, B and C change in the almost same way. So the forest fire at pixel A is extinguished in this day. Note, however, that resolution of the pixels is rough such as 4km square, so the biggest difference between normal pixel and fire pixel. For your information, Pixel E is located to the sea, so the temperature stays constant.

3.2 Evergreen broadleaf forest in Sumatra Island, Indonesia

Figure 4 shows an hourly spectral change of thermal infrared region (channel 1, 10.5μm) of an evergreen needledleaf forest in Sumatra Island, Indonesia. Figure 3 shows a sketch of fire affected pixel and its surrounding pixels of a test site. The time which forest fire was detected by MODIS Fire product is Oct 5th and Oct 6th at the pixel A and pixel B. Pixel C and pixel D is normal point. As the figure shows, the peak of the temperature change at pixel A and B on Oct 5th and Oct 6th is higher than that of the pixel A and pixel B. from this figure, the duration time of at A is about 12 hour. In this case, the temperature of the peak at pixel A is quite high, so we can estimate that the area of the forest fire might be broad. At the Oct.7, both the land surface temperature of pixel A, B, C and D change in the almost same way, so there is no forest fire in these pixels.Forest fire occurred in the daytime. It is related to the fire setting for timber harvesting or developing fields artificially.

[2] A web-based MODIS processing system (http://webmodis.iis.u-tokyo.ac.jp/)
[3] Boston University land use and land cover dynamics (http://www-modis.bu.edu/landcover/)

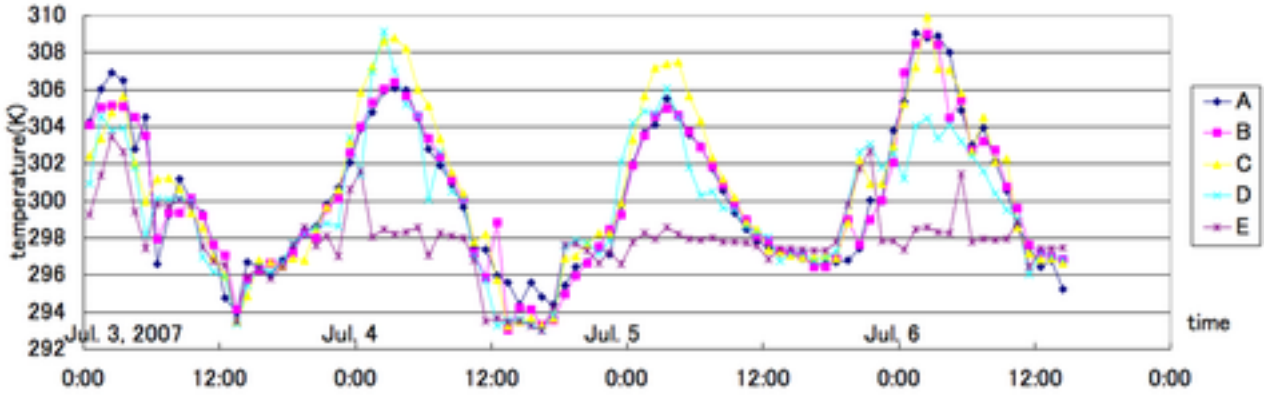

Figure 2. Hourly spectral changes of thermal infrared region (channel 1, 10.5μm) of an evergreen needleleaf forest in far east Russia.

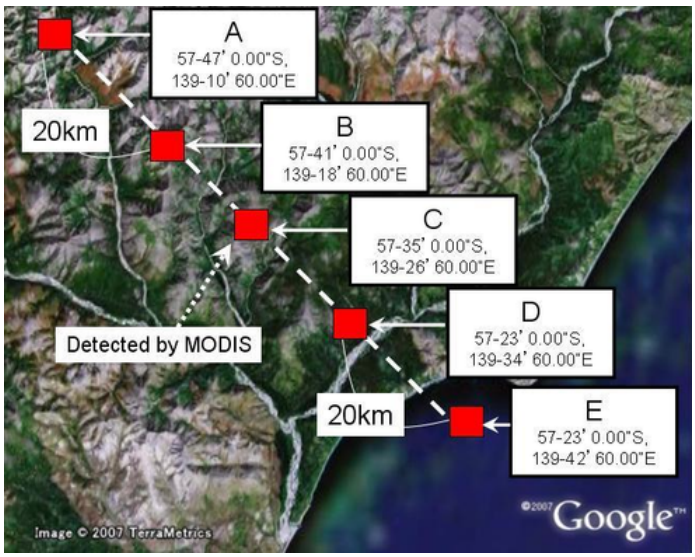

Figure 3. A sketch of fire affected pixel and its surrounding pixels of an evergreen needleleaf forest in far east Russia.

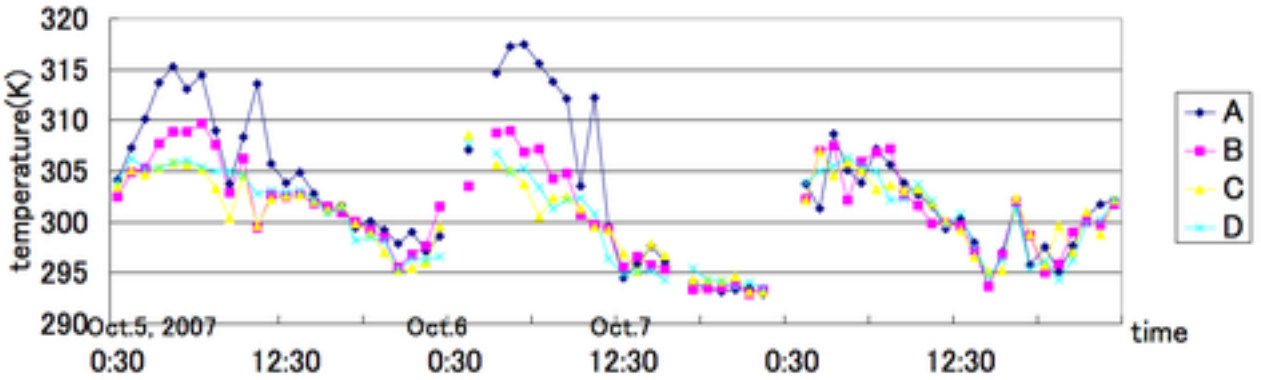

Figure 4. An hourly spectral change of thermal infrared region (channel 1, 10.5μm) of an evergreen needleleaf forest in Sumatra Island, Indonesia.

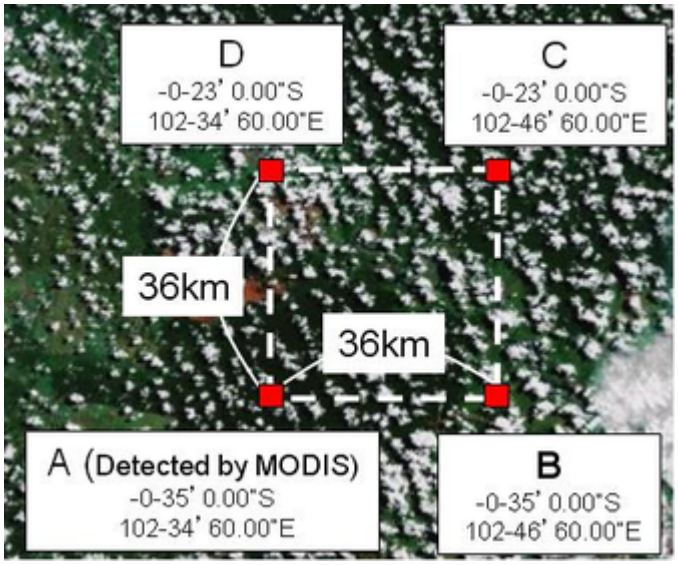

Figure 5. A sketch of fire affected pixel and its surrounding pixels of an evergreen needledleaf forest in Sumatra Island, Indonesia.

4 CONCLUSIONS AND FUTURE WORKS

In summary, a new technique for providing the detection of the duration time of wild fires has been proposed in this paper to compare the pixel that forest fire occur with the normal pixel around the point. By focusing on the difference between normal pixel and active pixel, we can detect the duration time of the forest fire. The key findings in this study is summarized as follows;

- Fire duration time is detected by comparing with non-affected pixels around hot spots.If there is some wildfire in a pixel, the temperature of the pixel shows higher than the non-affected pixels
- This technique can be applied both the evergreen needleleaf forest and the evergreen broadleaf forest.

We must continue to study hard toward and the routine or operational development of wildfire maping over Asia and there are still many lessons to be learned and problems to be solved.

ACKNOWLEDGMENT

This study is financially supported by the Japan Society for the Promotion of Science (JSPS) under the research project "Development of environment and disaster extraction algorithm and monitoring system with MTSAT focusing on international dissemination and knowledge transfer (Grant number: 19569002)". The authors would like to thank JSPS for their support. We would like to express our great thanks to Dr. Vivarad Phonekeo with Asian Institute of Technology for his effort on MODIS data receiving at Thailand.

REFERENCES

Takeuchi, W., and Y. Yasuoka, 2005. Near-real time active fire mapping over Asia using Aqua/Terra MODIS. *Proceed. 26th Asian conf. on remote sens. (ACRS 2005)*, Hanoi, Vietnam.

Takeuchi, W., T. Nemoto, T. Kaneko and Y. Yasuoka, 2007. Development of MTSAT data processing, distribution and visualization system on WWW. *Proceed. Int. symp. remote sens. (ISRS 2007)*, Jeju, Korea.

Kaufman, Y. J., C. O. Justice, L. P. Flynn, J. D. Kendall, E. M. Prins, L. Giglio, D. E. Ward, W. P. Menzel, and A. W. Setzer, 1998, Potential global fire monitoring from EOS-MODIS. *J. Geophys. Res.*, 103: 32215-32238.

UNDP, UNEP, World Bank and WRI, 2001, World Resources 2000-2001, *Elsevier Science,* 87-102.