COMPARATIVE PERFORMANCE OF WILDFIRE DETECTION IN SIBERIA BY ADVANCED HIMAWARI-8 IMAGER (AHI)

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KEY WORDS: Wien's displacement law, Lake Baikal, thermal infrared

ABSTRACT: In recent years, forest fire has become a global social issue. Originally, forest fills the role of preventing the global warming by photosynthesis. Once it is burned, however, it merely becomes the emission source of carbon dioxide. Besides this one, forest plays a multifunctional role, so wildfire destroying forest has serious effect on global environment and society. For this reason, the damage caused by forest fire must be minimized, and it is necessary to detect forest fire spreading accurately. In this study, the new generation Japanese satellite “Himawari-8” was focused on and forest fire detection was carried out. It is carrying Advanced Himawari-8 Imager(AHI) and the sensor composes of 16 observation bands. Himawari-8's strong point is revisit time. It is 10 minutes. This extremely high temporal resolution is quite advantageous for forest fire spreading. In this study the performance was verified by comparison with Landsat-8. Firstly, Landsat-8 data was collected and the active fire place was found. Then three active fires were picked out and spectral signature analysis was carried out. Considering Wien's displacement law, Himawari-8 band7(3.9μm) and band13(10.4μm) were compared. As a result, the correlation between Landsat-8 spectral signature and Himawari-8 spectral signature was confirmed. Regarding study site, the forest fire that occurred around Lake Baikal in Russia on August 2015 was employed.

1. INTRODUCTION

1.1 Background of this research

There are a lot of sensors used in remote sensing and each sensor has original spec and performance. By depending on what we want to know or what we want to observe, the sensor must be used properly. About forest fire, the detection had been carried out by high spatial resolution sensor.(Justice *et al.*, 2002) However, for the purpose of finding how to spread active fire and rescuing, it is necessity to detect wildfire by high temporal resolution sensor. In this study, Advanced Himawari-8 Imager(AHI) on Himawari-8 is focused on. The Himawari-8 forest fire detection performance is verified. Himawari-8 special mention point is the revisit time. It is 10 minutes and spatial resolution is 2[km].Regarding study site, the forest fire that occurred around Lake Baikal in Russia on August 2015 was employed.

1.2 Object of this study

The purpose of this study is to detect the forest fire by AHI on the Himawari-8. The extremely high revisit time 10 minutes is very effective in wildfire detection. By realizing the detection of forest fire using Himawari-8, it becomes possible to trace spreading forest fire, and it is benefit to rescue.

2. DATA AND METHODOLOGY

2.1 The flowchart of this study

Figure 1 shows the flowchart of this study. Firstly by MCD12Q1 the situation around Lake Baikal is obtained. Then comparing between MODIS Fire Product(MOD14) and Himawari-8 IR, forest fire is detected. The two methods are carried out about forest fire detection. One is to find thermal anomaly of Himawari-8 band7 and compare with MOD14. The other is calculating the alteration of heat radiation. These methods are compared, and each characteristic are verified.

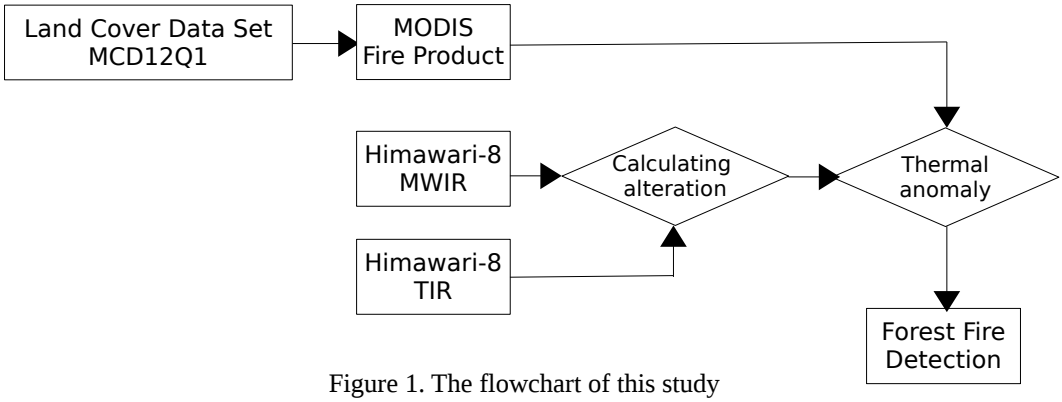


Figure 1. The flowchart of this study

2.2 MODIS Fire Product (MOD14)

MOD14 is the most basic fire product in which active fires are identified. MODIS band 31 (10.780 - 11.280[μm]) is used. Once a day the value of fire radiative power is obtaind every where and it becomes key to the place of forest fire.

2.3 MCD12Q1

MCD12Q1 is the MODIS land cover type product. In this study it is used for obtaining the trend in vegetation and grasping the situation around Lake Baikal. By distinguishing between broadleaf forest and needle leafforest

2.4 AHI-8 on the Himawari-8

In this study the brightness tempertures derived from Himawari-8 Band7(3.9μm) and Band13(10.4 μm) were used respectively. Due to the Wien's displacement law, when the radiation derived from heat increases, the peak of radiation shifts to SWIR. In this study Forest Fire detection was carried out by calculating the difference between Band7 and Band13.

3. RESULTS AND DISCUSSION

3.1 The Buryat Republic situation on August, 2015

Figure 2 shows the situation about Buryat Rupublic on August, 2015. The three zones are set as targets. It is defined Zoneα, Zoneβ and Zoneγ.

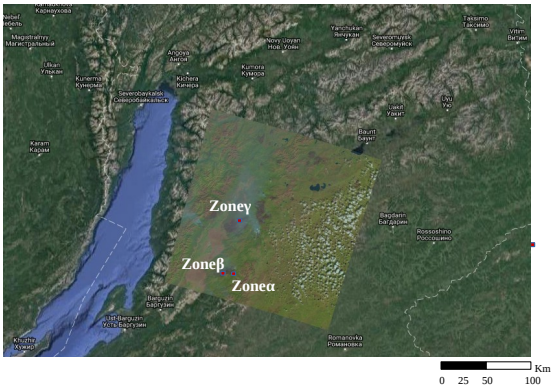
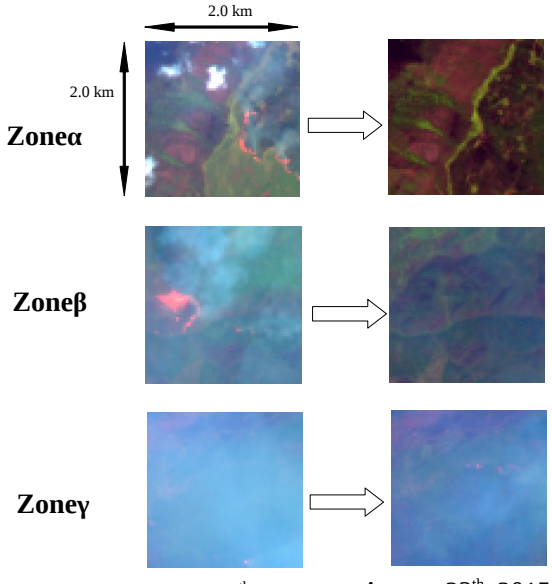


Figure 2. The situation around Buryat Republic on August, 2015



3.2 Vegetation alteration around Lake Baikal

Figure 3 shows the situation of vegetation in Buryat Republic. In recent years, the percentage of Mixed Forest is rapidly increased and Needleleaf forest is decreasing. This is considered due to effect of global warming. Broadleaf Forest, which is valuable for timber is still lower. It ia possible that more cutting these Broadleaf Forest, the more forest fire will be occurred.

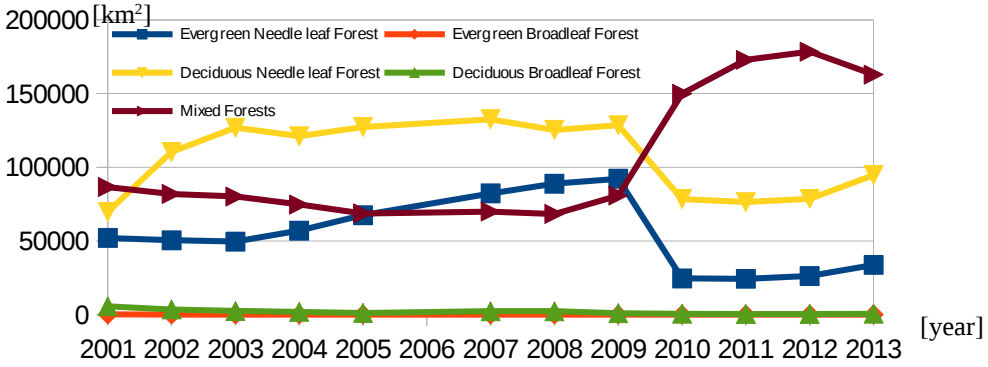


Figure 3. Vegetation situation in Buryat Republic

3.3 Forest Fire Detection by Himawari-8 Band7(MWIR)

Figure 4-6 shows the britness temperture captured by Himawari-8 Band7 aroud August, 2015. Regarding Zoneβ ZONEγ there are extremely strange values. There is one point in Zoneβ and 6 points in ZONEγ. Compared with MODIS Fire Product(MOD14), about Zoneβ the value of MOD14 is 307.09[MW/m2]. However, about Zoneγ forest fire was detected by MODIS and the value is 16.30-22.46[MW/m2]. This Himawari-8 band7 thermal anomaly is considered to indicate extremely large heat radiation, and the forest fire which is occurred 23rd to 24th Augst, 2015 in Zoneγ is possible to be equal to Zoneβ forest fire on 8th August 2015.

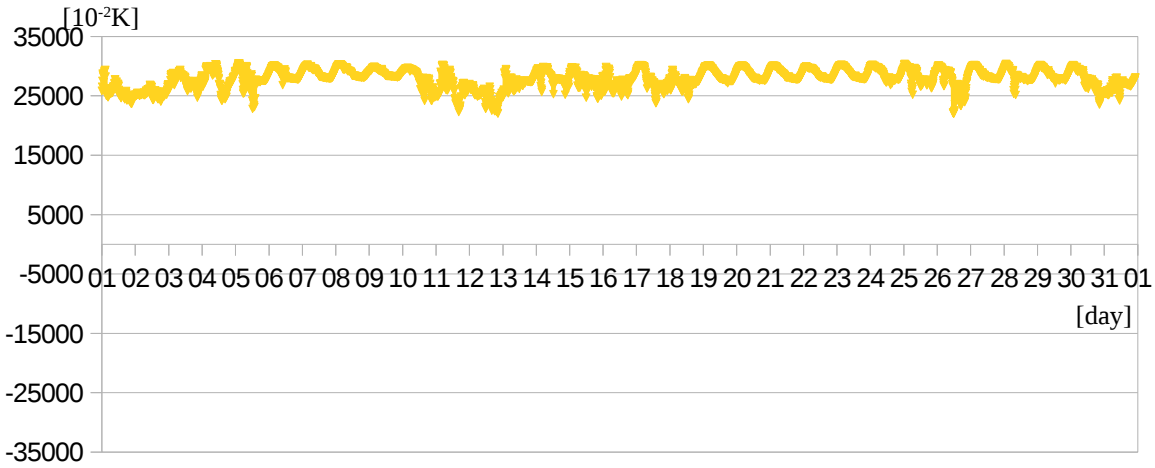


Figure 4. ZONEα August 2015 by Himawari-8 Band7

[10⁻²K]

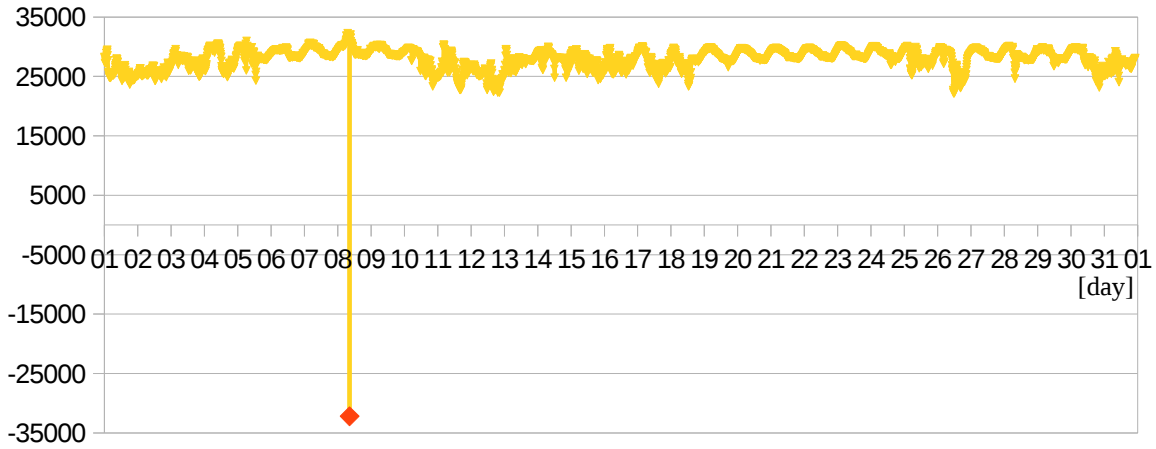


Figure 5. ZONEβ August 2015 by Himawari-8 Band7

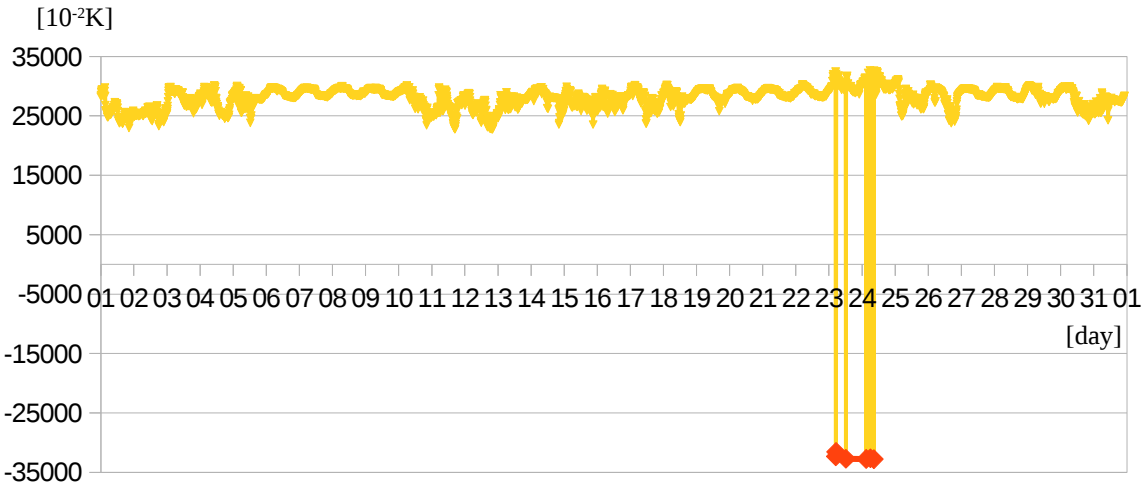


Figure 6. ZONEγ August 2015 by Himawari-8 Band7

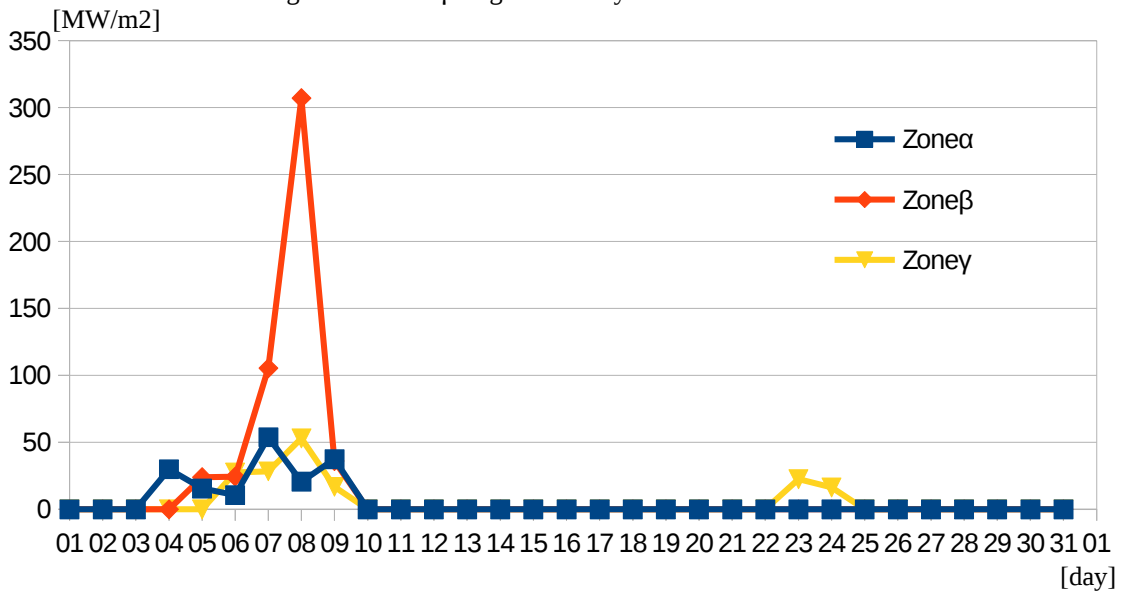


Figure 7. MODIS Fire Poduct on August 2015

Table 1. Comparison between Thermal anomaly by Himawari-8 band7 and MODIS Fire Poduct

	Location	Thermal anomaly [point]	MODIS FRP [MW/m2]	Himawari-8 Band7 Average [10-2 K]	Himawari-8 Band7 Maximum [10-2 K]
Zoneα	53 59' 30.01”N 110 48'59.98”E	0	*	*	*
Zoneβ	54 0'30.01”N 110 39'59.98”E	1	307.09	31404	32287
Zoneγ	54 28'30.01”N 111 4' 59.98”E	6	19.38	30921	32663

3.4 Forest Fire Detection by Difference between Himawari-8 Band7(MWIR) and Band13(TIR)

Figure 8-10 shows the difference between Himawari-8 Band7(MWIR) and Band13(TIR). Considering Wien's displacement law, at the heat point, the heat radiation shifts to shoter wave length. On 8th August, relatively the Zoneβ value is largest and on 23rd to 24th August zoneγ value is highest.This indicates the successful in forest fire detection. About wildfire detection by using the difference between IR, relative verification is essential.

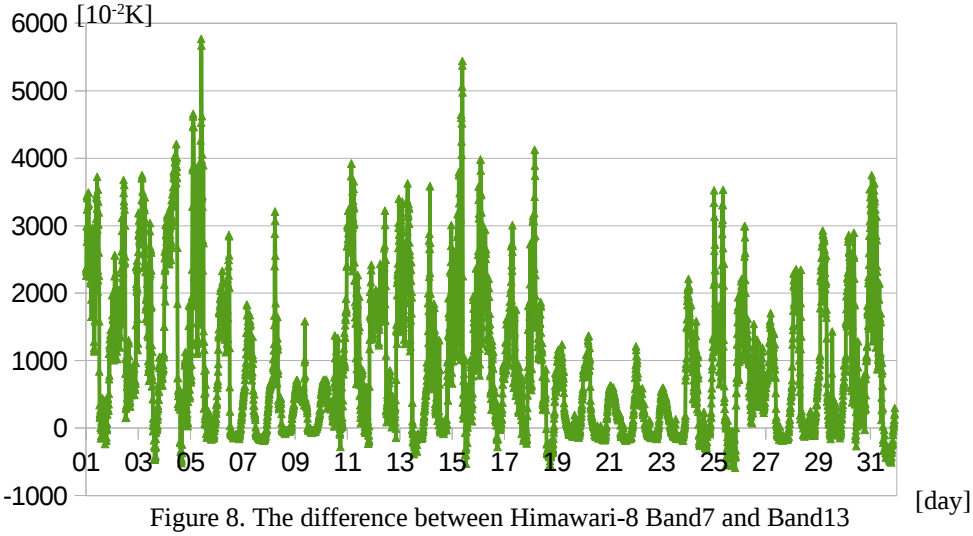


Figure 8. The difference between Himawari-8 Band7 and Band13
ZONEα August 2015

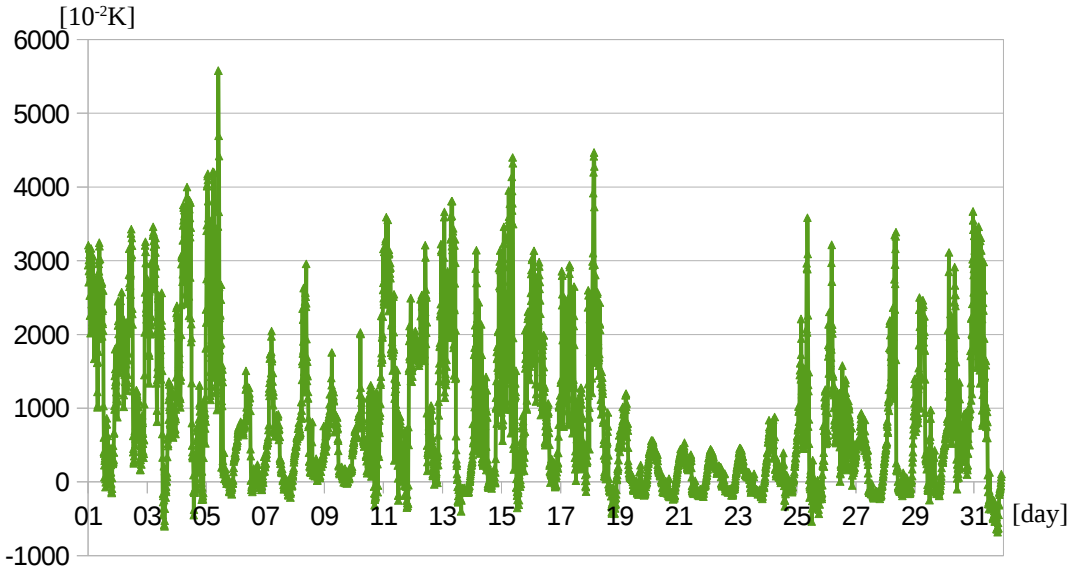


Figure 9. The difference between Himawari-8 Band7 and Band13
ZONEβ August 2015

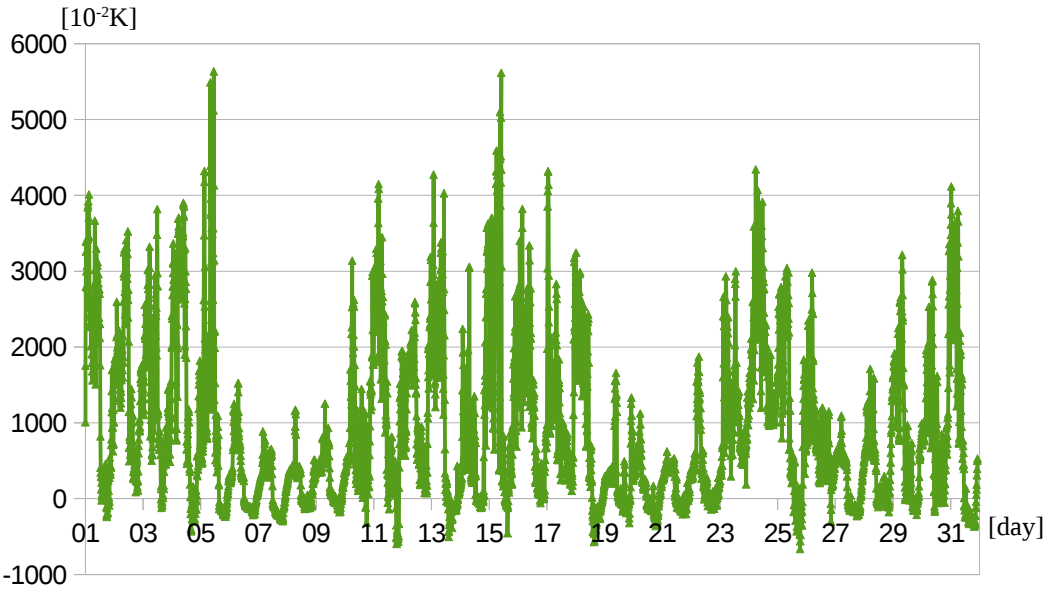


Figure 10. The difference between Himawari-8 Band7 and Band13
ZONEγ August 2015

4. CONCLUSION

In this study two methods about forest fire detection were carried out. One is Himawari-8 band7 detection, and the other is the defference between Himawari-8 band7 and ban13 detection. About Himawari-8 band7 detection, large-scale forest fire which MODIS couldn't detect was found. Capturing thermal anomaly it is better to use Himawari-8 for the purpose of detecting large scale forest fire than MODIS. However about spatial resolution MODIS is advantageous. Grasping the situation of forest fire appropriate use is important.

Regarding forest fire detection by calculating difference between Himawari-8 band7 and band13, forest fire detention was successful and that rerative verification is vital was found. In the future increasing study site, the knowledge is necessary to be increased and it is necessary to compare with neighboring pixels.

As a future work, obtaing soil information, methodology, rainfall data and population data, the environmental situation is considerd. By adding historical element, geography element, considering forest fire generating situation, more accrate forest fire detection is aimed.

REFERENCES

References from Journals:

Boles, S. H., & Verbyla, D. L. (2000). Comparison of three AVHRR-based fire detection algorithms for interior Alaska. Remote Sensing of Environment, 72(1), 1-16.

Justice, C. O., Giglio, L., Korontzi, S., Owens, J., Morisette, J. T., Roy, D., ... & Kaufman, Y. (2002). The MODIS fire products. Remote Sensing of Environment, 83(1), 244-262.

Justice, C. O., Giglio, L., Korontzi, S., Owens, J., Morisette, J. T., Roy, D., ... & Kaufman, Y. (2002). The MODIS fire products. Remote Sensing of Environment, 83(1), 244-262.

San-Miguel-Ayanz, Jesus, and Nicolas Ravail. "Active fire detection for fire emergency management: Potential and limitations for the operational use of remote sensing." *Natural Hazards* 35.3 (2005): 361-376.

Oertel, D., et al. "BIRD fire recognition and comparison with Terra/MODIS." *Small Satellites for Earth Observation-Selected Proceedings of the 5th International Symposium of the International Academy of Astronautics, Berlin 4-8, 2005, H.-P. Röser, R. Sandau, A. Valenzuela (eds.), ISBN: 3-11-018851-1*. 2005.

DAAC, LP. "Land Cover Type Yearly L3 Global 500 m SIN Grid (MCD12Q1)." *Land Processes Distributed Active Archive Center (LP DAAC), located at the US Geological Survey (USGS) Earth Resources Observation and Science (EROS) Center (lpdaac. usgs. gov), Sioux Falls. URL: https://lpdaac. usgs. gov/lpdaac/products/modis_products_table/land_cover/yearly_ l3_global_500_m/mcd12q1* (2009).

Bessho, Kotaro, et al. "An introduction to Himawari-8/9—Japan's new-generation geostationary meteorological satellites." Kishoshushi. No.2 94.2 (2016): 151-183.