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A time-series analysis of flood disaster around Lena river using Landsat TM/ETM+

Toru Sakai (1), Shigemi Hatta (2), Makoto Okumura (3), Wataru Takeuchi (4), Tetsuya Hiyama (1), and Gen Inoue (1)

(1) Research Institute for Humanity and Nature, Kyoto, Japan (torus@chikyu.ac.jp/+81-75-707-2531), (2) Tomakomai National College of Technology, Tomakomai, Japan, (3) Center for Northeast Asian Studies, Tohoku University, Sendai, Japan, (4) Institute of Industrial Science, The University of Tokyo, Tokyo, Japan

Landsat satellite has provided a continuous record of earth observation since 1972, gradually improving sensors (i.e. MSS, TM and ETM+). Already processed archives of Landsat image are now available free of charge from the internet. The Landsat image of 30 m spatial resolution with multiple spectral bands between 450 and 2350 nm is appropriate for detailed mapping of natural resource at wide geographical areas. However, one of the biggest concerns in the use of Landsat image is the uncertainty in the timing of acquisitions. Although detection of land cover change usually requires acquisitions before and after the change, the Landsat image is often unavailable because of the long-term intervals (16 days) and variation in atmosphere. Nearly cloud-free image is acquired at least once per year (total of 22 or 23 scenes per year). Therefore, it may be difficult to acquire appropriate images for monitoring natural disturbances caused at short-term intervals (e.g., flood, forest fire and hurricanes). Our objectives are: (1) to examine whether a time-series of Landsat image is available for monitoring a flood disaster, and (2) to evaluate the impact and timing of the flood disaster around Lena river in Siberia. A set of Landsat TM/ETM+ satellite images was used to enable acquisition of cloud-free image, although Landsat ETM+ images include failure of the Scan Line Corrector (SLC) from May 2003. The overlap area of a time series of 20 Landsat TM/ETM+ images (path 120-122, row 17) from April 2007 to August 2007 was clipped (approximately 33 km $\times$ 90 km), and the other area was excluded from the analyses. Image classification was performed on each image separately using an unsupervised ISODATA method, and each Landsat TM/ETM+ image was classified into three land cover types: (1) ice, (2) water, and (3) land. From three land cover types, the area of Lena river was estimated. The area of Lena river dramatically changed after spring breakup. The middle part of Lena river around Tabaga (61.83°N, 129.60°E) was frozen hard until early May 2007. River-ice breakup began in patches on 13 May 2007. Then, the area of Lena river rapidly increased due to overhead flooding on 14 May 2007, and reached the peak on 15 May 2007. In the brief period of one or two days, the area of Lena river was more than twice. After this, the area of Lena river exponentially decreased over three months, and it was quite stable in late August 2007. A time-series of Landsat TM/ETM+ images could detect these large temporal variations. In addition, the temporal variations in the area of Lena river synchronized with water stage measured in the field. These results indicate that a time-series of Landsat TM/ETM+ images enables to monitor natural disturbances caused at short-term intervals, although significantly limited to local scales. The requirement of spatial and temporal resolution is often application specific in the context of the desired measurement goals. This type of research and resultant information is critical for the utilization of remote sensing data to the fullest extent.