4th Intercontinental Geoinformation Days

igd.mersin.edu.tr

View angle importance of SAR satellite imageries for mapping areas susceptible to floods: A case study of Kumamoto Prefecture, Japan

Ayub Mohammadi[1], Himan Shahabi *[1]

[1]University of Kurdistan, Department of Geomorphology, Sanandaj, Iran

Keywords
Remote Sensing
Satellite Imagery
Flood
View Angle
Japan

Abstract

Natural hazards including landslides, flash floods, earthquakes and hurricanes have been constituted a significant problem in many countries. Kumamoto Prefecture in Japan was selected as the study area in the current research. One of the most considerable natural hazards in the study area is flood. Without using any automated classifier, this paper aims to map flooded areas in the region using synthetic aperture Radar (SAR) imagery of ALOS-2 PALSAR-2. A total number of six satellite imageries (before and right after the events) were collected. Using Sentinel application platform (SNAP) software the images were corrected, stacked and combined in order to map flooded areas. Results indicate that this kind of flood mapping is precise, fast and easy to use. This paper can be helpful to policy and decision makers in order to map flooded areas immediately, especially when we need a quick action for settling camps for evacuees during flooding days.

1. Introduction

Natural disasters like flash floods, landslides, earthquakes, and hurricanes result in a considerable threat to human life and loss of property not only in the study area but also in many parts of the Earth (Khan, Shaari, Bahar, Baten, & Nazaruddin, 2014; Lawal, Matori, Hashim, Wan Yusof, & Chandio, 2012; Rahman & Di, 2017). In recent years, Japan has been hit by heavy floods (Yang, Panjaitan, Ujiie, Wann, & Chen, 2020), causing millions of dollars in property damage and loss of life.

Flood is one of the common phenomenon in the study area (Yang et al., 2020). Study area has been faced flooding almost every year, which is seen as common natural disaster in the region. The problems caused by flash floods, can be addressed if effective planning and detailed studies are taken.

Flood is a very common disaster in Japan (Yang et al., 2020). However, identifying the flood prone areas is highly essential for decision and policy makers for sustainable development. Because of the all-weather capability and sensitivity to the structure of flooded surface, SAR remote sensing has made notable contribution in flood studies, (Dronova, Gong, Wang, & Zhong, 2015; Martinez & Le Toan, 2007; Tehrany, Pradhan, & Jebur, 2014). This study is significant in two ways (1), (1) without using any classification algorithms we distinguished flooded areas precisely, and (2) ALOS-2 PALSAR-2 was used as L-band satellite imagery. Fully control over these kinds of floods is a challenging task to a great extent.

Many studies have been conducted using different methods and models for mapping flood susceptible areas, including analytical neural network (Pradhan & Buchroithner, 2010), analytic hierarchy process (Lawal et al., 2012), support vector machine (Tehrany et al., 2014; Tehrany, Pradhan, Mansor, & Ahmad, 2015), fuzzy logic (Jiang, Deng, Chen, Wu, & Li, 2009; Perera & Lahat, 2015), frequency ratio (Lee, Kang, & Jeon, 2012; Tehrany et al., 2015), random forest classifier (Feng, Liu, & Gong, 2015), logistic regression (Pradhan, 2010) and Neural Network Algorithm (Li, Xu, & Chen, 2016).

The main objective of the current study was to employ L-band SAR imagery to map flooded areas for crisis management using a quick approach.

2. Description of the Study Area

Because of data availability, the Kumamoto Prefecture in Japan was selected as the study area for performing this research. Figure 1, shows the study area.

* Corresponding Author

(ayubmohammadi1990@gmail.com) ORCID ID 0000-0001-8848-8917
*(h.shahabi@uok.ac.ir) ORCID ID 0000-0001-5091-6947

Cite this study

Mohammadi, A., & Shahabi, H. (2022). View angle importance of SAR satellite imageries for mapping areas susceptible to floods: A case study of Kumamoto Prefecture, Japan. 4th Intercontinental Geoinformation Days (IGD), 108-110, Tabriz, Iran

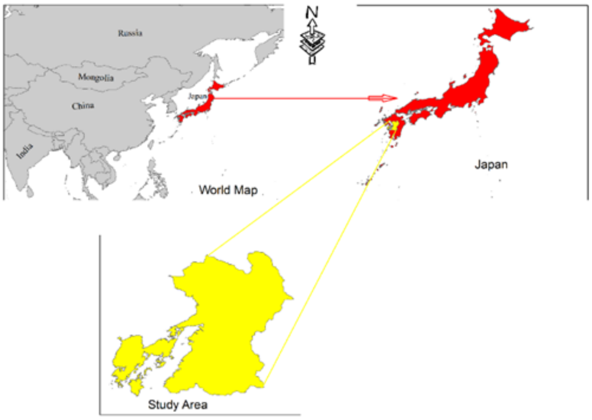

Figure 1. Geographical location of the study area

3. Material and Methods

To acquire information, ALOS-2/PALSAR-2 emits microwave and receives the reflection from the ground. The L-band SAR data is less affected by clouds and rains, which is suitable for monitoring rapid disasters. In addition, L-band microwave can penetrate through vegetation to obtain information. ALOS-2/PALSAR-2 has a spotlight mode of 1m×3m resolution in azimuth/range direction.

The satellite data were acquired from Department of architecture and building engineering, Tokyo Institute of Technology. Table 1, demonstrates technical characteristics of data used in this study. It is worth mentioning that six satellite data of ALOS-2/PALSAR-2 (two descending and four ascending) were used.

Table 1. Technical attributes of ALOS-2 PALSAR-2 satellite imagery

Observation Mode (Sensor)	Processing Level	View Angle	Date
Spotlight	SLC (1.1)	Ascending Descending	2016/04/16 2020/07/04 2020/07/04 2016/04/30 2018/02/20 2020/07/07

In order to extract accurate information, once, satellite imageries have been collected then pre-processing must be applied on them (Jensen & Lulla, 1987). Therefore, using SNAP software, images were radiometrically corrected, multi-looked and filtered. Moreover, before projected to Universal Transverse Mercator (UTM) coordinate system, they were geo-referenced.

After correction process, for saving time it is better to clip imageries as the study area. In order to place the maximum accuracy, we loaded imageries in decibels (dB). Furthermore, for combining bands of satellite images they must be stacked. Therefore, we can separate flooded areas from the other areas by selecting dB or actual band of before event imagery as Red and after event image for both Green and Blue in RGB band combination (Figure 2).

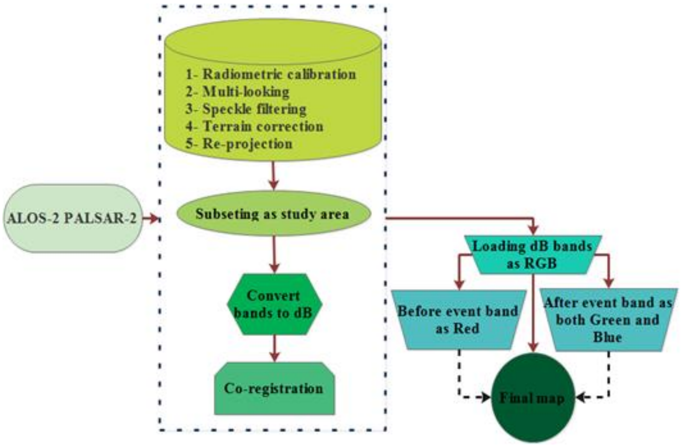

Figure 2. Research methodology of the study.

4. Results and Discussion

In this study using SAR imagery of ALOS-2/PALSAR-2, areas prone to flood were mapped, which can be valuable for authorities to consider it in the preventive actions in the study areas during flooding times.

In order to prevent such disasters, it is needed to develop an accurate technique to map areas prone to flood. In such situations, the first action is to map areas prone to flood so that policy makers can do preventive actions; including settling lifeguards in high susceptible areas, to act against unlicensed housing in high susceptible regions as well as to build shields along the highly sensitive river banks. Despite this fact that flood events are generally unavoidable (Pradhan & Youssef, 2011); however, authorities should not be easy-going on this matter and should try to reduce the fatalities and damages from such events in near and remote future.

Figure 3 clearly shows the flooded regions in the study area. In fact, this method is precise, accurate and easy to apply in SNAP and ArcGIS software environments. Electromagnetic waves of SAR imagery will be reflected from water surfaces specularly; therefore, in the imagery appears in black color (Oliver & Quegan, 2004). Overall, in this model flooded areas in red color are differentiated from the other water resources in black color.

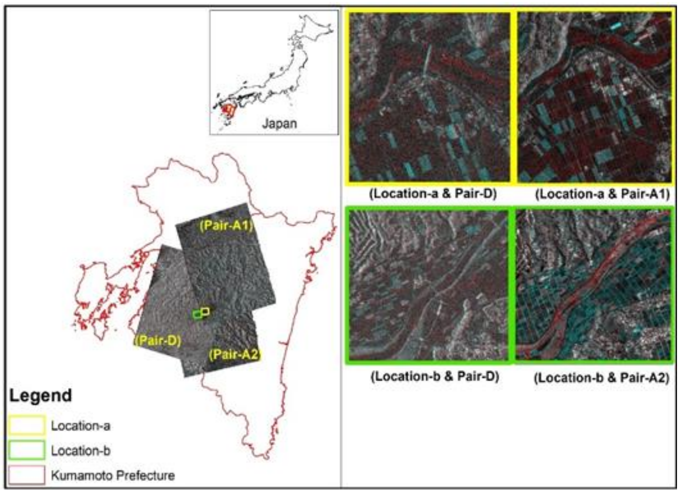

Figure 3. Flooded area of Kumamoto Prefecture, Japan.

As it can be seen from Figure 3, based on the geomorphological condition of the study area, ascending imageries are more suitable for the study area from which the flooded areas are more visible than the descending ones.

5. Conclusion

One of the most common disasters in the study area is flooding, which mostly induced by heavy rainfall. In this manuscript, we have shown how to map flooded areas by using SAR imagery without using any automated classifier. For this model, two SAR satellite imagery of before and right after floods should be acquired. These data through SNAP software were corrected, stacked and combined in order to map flooded areas. For obtaining the maximum accuracy, we loaded both imageries in decibels (dB). Furthermore, for combining the satellite images, they were stacked first and in order to map the flooded areas, the data were loaded in RGB combination. Moreover, this kind of flood mapping is precise, fast and easy to use, especially when we need to map flooded areas immediately to settle evacuees in safer places.

Acknowledgement

Many thanks are given to the Department of architecture and building engineering, Tokyo Institute of Technology for providing us with the satellite imageries.

References

Dronova, I., Gong, P., Wang, L., & Zhong, L. (2015). Mapping dynamic cover types in a large seasonally flooded wetland using extended principal component analysis and object-based classification. Remote Sensing of Environment, 158, 193-206.

Feng, Q., Liu, J., & Gong, J. (2015). Urban flood mapping based on unmanned aerial vehicle remote sensing and random forest classifier—A case of Yuyao, China. Water, 7(4), 1437-1455.

Jensen, J. R., & Lulla, K. (1987). Introductory digital image processing: a remote sensing perspective.

Jiang, W., Deng, L., Chen, L., Wu, J., & Li, J. (2009). Risk assessment and validation of flood disaster based on fuzzy mathematics. Progress in Natural Science, 19(10), 1419-1425.

Khan, M. M. A., Shaari, N. A. B., Bahar, A. M. A., Baten, M. A., & Nazaruddin, D. A. B. (2014). Flood impact assessment in Kota Bharu, Malaysia: a statistical analysis. World Applied Sciences Journal, 32(4), 626-634.

Lawal, D. U., Matori, A. N., Hashim, A. M., Wan Yusof, K., & Chandio, I. A. (2012). Detecting flood susceptible areas using GIS-based analytic hierarchy process.

Lee, M.-J., Kang, J.-e., & Jeon, S. (2012). Application of frequency ratio model and validation for predictive flooded area susceptibility mapping using GIS. Paper presented at the Geoscience and Remote Sensing Symposium (IGARSS), 2012 IEEE International.

Li, L., Xu, T., & Chen, Y. (2016). Improved urban flooding mapping from remote sensing images using generalized regression neural network-based super-resolution algorithm. Remote Sensing, 8(8), 625.

Martinez, J.-M., & Le Toan, T. (2007). Mapping of flood dynamics and spatial distribution of vegetation in the Amazon floodplain using multitemporal SAR data. Remote Sensing of Environment, 108(3), 209-223.

Oliver, C., & Quegan, S. (2004). Understanding synthetic aperture radar images: SciTech Publishing.

Perera, E. D. P., & Lahat, L. (2015). Fuzzy logic-based flood forecasting model for the Kelantan River basin, Malaysia. Journal of Hydro-environment Research, 9(4), 542-553.

Pradhan, B. (2010). Flood susceptible mapping and risk area delineation using logistic regression, GIS and remote sensing. Journal of Spatial Hydrology, 9(2).

Pradhan, B., & Buchroithner, M. F. (2010). Comparison and validation of landslide susceptibility maps using an artificial neural network model for three test areas in Malaysia. Environmental & Engineering Geoscience, 16(2), 107-126.

Pradhan, B., & Youssef, A. (2011). A 100-year maximum flood susceptibility mapping using integrated hydrological and hydrodynamic models: Kelantan River Corridor, Malaysia. Journal of Flood Risk Management, 4(3), 189-202.

Rahman, M. S., & Di, L. (2017). The state of the art of spaceborne remote sensing in flood management. Natural Hazards, 85(2), 1223-1248.

Tehrany, M. S., Pradhan, B., & Jebur, M. N. (2014). Flood susceptibility mapping using a novel ensemble weights-of-evidence and support vector machine models in GIS. Journal of hydrology, 512, 332-343.

Tehrany, M. S., Pradhan, B., Mansor, S., & Ahmad, N. (2015). Flood susceptibility assessment using GIS-based support vector machine model with different kernel types. Catena, 125, 91-101.

Yang, S.-H., Panjaitan, B. P., Ujiie, K., Wann, J.-W., & Chen, D. (2020). Comparison of food values for consumers' preferences on imported fruits and vegetables within Japan, Taiwan, and Indonesia. Food Quality and Preference, 87, 104042.