Development of Physical Parameter Extraction Model for Detection and Monitoring Flood Disaster

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ABSTRACT:
Natural hazards, including floods can be seen from the characteristics of the danger, which is of magnitude (magnitude, intensity) and frequency. Remote sensing data can be used to support flood mitigation efforts. This study aims to develop a model of the physical parameter extraction from remote sensing data is for the detection and monitoring of floods. Research study conducted on the detection and monitoring of inundated areas using optical imagery, particularly Landsat and MODIS. Floodwaters identification method is done by comparing the values of reflectance and indices on suspected areas affected by floods in the period before the flood, during the flood, and after the flood. Parameter value is used reflectance reflectance in bands 1 to 7. While the parameter values used index is NDVI, EVI, NDWI, MNDWI, LSWI and DVEL. Based on the results of the analysis seen that all variables except LSWI can be used to detect the floodwaters. The study concluded that the MODIS optical images can be used to identify a pool of water caused by floods.

KEYWORDS: *Flood, Optical Image, Reflectance Parameters, Parameter Index Value*

I. INTRODUCTION

Flooding is a natural phenomenon that can be caused by natural factors, human factors, or a combination of both. According to Richard (1955), flooding can be interpreted in two senses, namely: 1) the overflow of river water caused by the river flow exceeds the capacity of the river in the state of high rainfall, and 2) a puddle on the flat low-lying areas that normally do not flooded.Sudaryoko (1987) defines a flood as a condition in an area where there is an increase in the amount of water that can not be accommodated in the water channels or shelters so that the water overflowed and flooded areas outside of the channel, the river valley, the water nor shelter. According Sutopo (1999), causes flooding can be divided into flooding problems caused by natural events and conditions and flooding problems caused by the activity of the population. Conditions and natural events such as heavy rainfall, a large amount of surface runoff, river water melimpasnya; damming estuaries and tidal rivers from the sea. Factors influence the activity of the population flood events, such as the growth of cultivated areas in floodplains, wetlands hoarding / situ or reclamation, narrowing the river channel as a result of settlements along the river border, and control settlements along the river banks are not implemented properly.Natural hazards, including floods can be seen from the characteristics of the danger, which is of magnitude (magnitude, intensity) and frequency (Ayala, 2002).

Magnitude of flood hazards can be known from the extensive inundation, depth or water level, water flow rate, material is washed away, water density or thickness of silt, long inundation, peak flow, and total flow volume. While the frequency of flooding can be measured from the number of flood events in an area within a certain time unit (Ayala, 2002).Flood disasters often cause harm either physically, economically, and socially and culturally. Demands on the development of information technology often raises issues that were raised, namely how the flood affected area distribution can be determined with more fast, precise, and accurate. Additionally, Which areas affected by the floods. It is closely tied to the condition of land cover and infrastructure affected by floodwaters.Remote sensing data are expected to be used to support flood mitigation efforts. One of them is to provide fast and accurate information about the areas affected by the floods. This study aims to develop a model of the physical parameter extraction from remote sensing data is for the detection and monitoring of floods. The study will be conducted this research focuses on the study of literature on methods of detection and monitoring of inundated areas using optical imagery, particularly Landsat and MODIS.

II. PREVIOUS STUDIES

Floodwaters can be identified from remote sensing image based on the spectral appearance of objects that exist in a puddle of water is. Wang et al. (2002) have developed an efficient method for mapping flood inundation broad multemporal using Landsat imagery and Digital Elevation Model (DEM). The research took place in North Carolina USA. The method developed is based on differences in spectral appearance of objects by non-water water on the Landsat series before and during flood events. It also said the DEM data is helpful in identifying flood. Wang et al. (2002) also stated that the method can be applied to a wide scope of areas with flat topography. Furthermore, Wang (2004) have also conducted research using Landsat imagery recording date the day after the flood event to determine the maximum extent of inundation on floodplains in coastal areas in the same region (North Carolina USA). The resulting map accuracy rate in the range of 82.5 to 99.3%.Ho et al. (2010) tried to flood hazard mapping using ASTER imagery, Landsat and DEM SRTM (Shuttle Radar Topography Mission). The method used to separate the area flooded and non-flooded is MNDWI (Modified Normalized Difference Water Index). Area of research taking place in the area in the alluvial plains Watershed Vu Gia - Thu Bon System, Central Vietnam. This study reveals the close relationship between water-saturated region, altitude, and flooding conditions in the area with water levels below 4 meters (classed as flood basins and plains deltaik) that were flooded in the long term. The results showed that the method can be used to separate MNDWI moist soil to predict flooding.Sakamoto et al. (2009) has developed the use of MODIS imagery to evaluate the agro-ecological interpretation of rice farming systems in flood-prone areas in the Mekong Delta of Vietnam. The parameters used was EVI (Enhanced Vegetation Index), LSWI (Land Surface Water Index), and DVEL (Value Difference between EVI and LSWI). EVI parameters, DVEL LSWI and has also been successfully used by Yan et al. (2010) to detect changes in spatial-temporal tidal flooding in the wetlands (wetland) around the mouth of the river. Moreover, Islam et al. (2009) also uses parameters NDVI, NDWI, and LSWI EVI from MODIS imagery to map flood inundation in Bangladesh and concluded that the MODIS imagery is very useful to clarify the spatial-temporal distribution of flood inundation in Bangladesh.

III. PHYSICAL PARAMETERS EXTRACTION MODEL

Based on a literature review of the methods of identification floodwaters can be done by comparing the reflectance values and indices on suspected areas affected by floods in the period before the flood, during the flood, and after the flood. Parameter value is used reflectance reflectance in bands 1 to 7. While the parameter values used index is NDVI, EVI, NDWI, MNDWI, LSWI and DVEL. Equation to calculate NDVI, EVI, NDWI, LSWI, and DVEL as table 1.

Table 1. The Parameter Values Used Index

NDVI = $\frac{\rho NIR - \rho RED}{\rho NIR + \rho RED}$	Huete et al. (2002)
EVI = 2.5* $\frac{\rho NIR - \rho RED}{\rho NIR + 6*\rho RED - 7.5*\rho BLUE + 1}$	Huete et al. (2002)
NDWI = $\frac{\rho RED - \rho SWIR}{\rho RED + \rho SWIR}$	McFeeters (1996)
MNDWI = $\frac{\rho GREEN - \rho MIR}{\rho GREEN + \rho MIR}$	Xu (2006)
LSWI = $\frac{\rho NIR - \rho SWIR}{\rho NIR + \rho SWIR}$	Xiao et al. (2006)
DVEL = EVI – LSWI	Sakamoto et al. (2009)

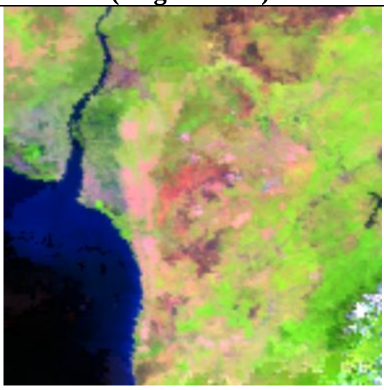
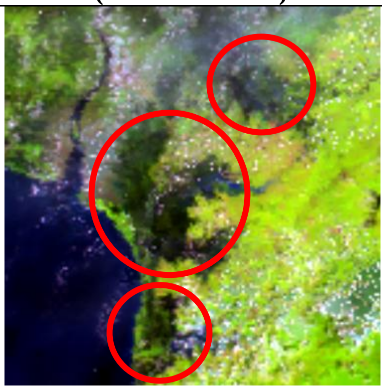
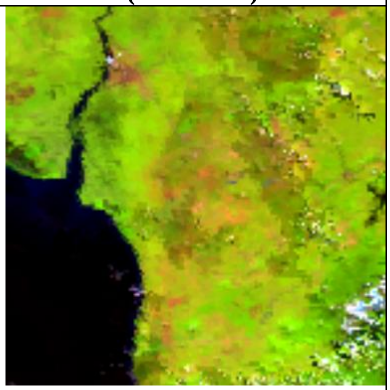
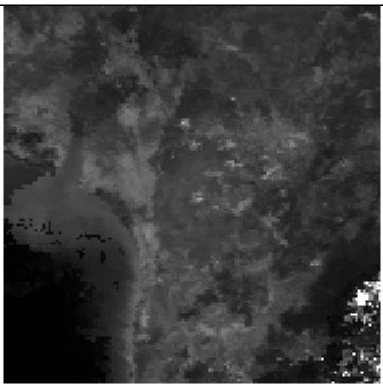
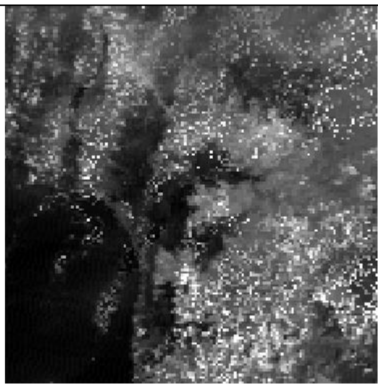
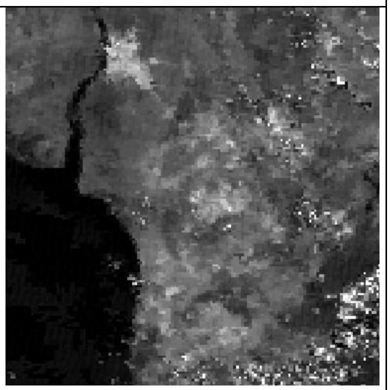
Where ρNIR is near infrared reflectance (841-875 nm, MODIS band 2), ρRED red reflectance (621-670 nm, MODIS band 1), ρBLUE blue reflectance (459-479 nm, MODIS band 3), ρGREEN green reflectance (545 - 565 nm, MODIS band 4), ρSWIR short infrared reflectance (1628-1652 nm, MODIS band 6) (see Table 2).

Table 2. Characteristic spectral and spatial resolution of MODIS reflectance channels 1-7

Channel	Central Wavelength (nm)	Bandwidth (nm)	Spatial resolution (m)
1	645	620 - 670	250 m
2	858.5	841 - 876	250 m
3	469	459 - 479	500 m
4	555	545 - 565	500 m
5	1240	1230 - 1250	500 m
6	1640	1628 - 1652	500 m
7	2130	2105-2155	500 m

IV. RESULTS AND DISCUSSION

The data used in the application of the model is the preferred data remote sensing image acquired by Space agency, which especially optical Landsat and MODIS imagery. Location chosen for the study is the application of the model flood inundation areas in Banjar Regency South Kalimantan Province of Indonesia. At the end of 2011 (December 2011), the flood-affected areas, where floods inundated 90 villages in the region are home to about 68.264 inhabitants (BNPB, 2012).

	BEFORE THE FLOOD (August 2011)	IN THE FLOOD (December 2011)	AFTER THE FLOOD (June 2012)
RGB 621			
BAND-1			

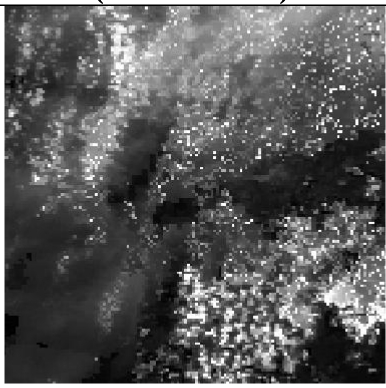
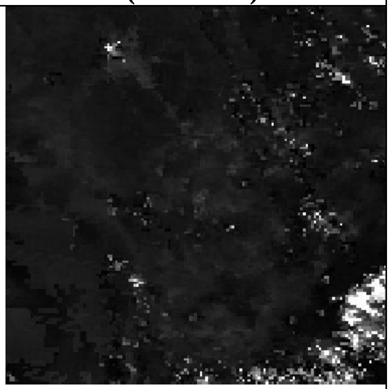
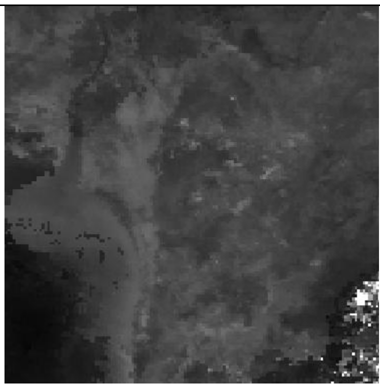
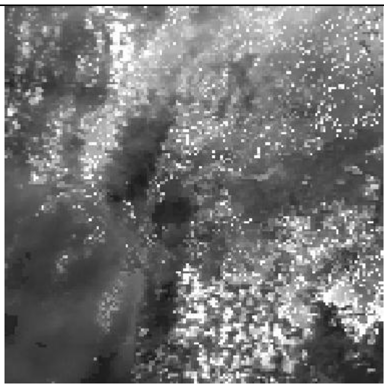
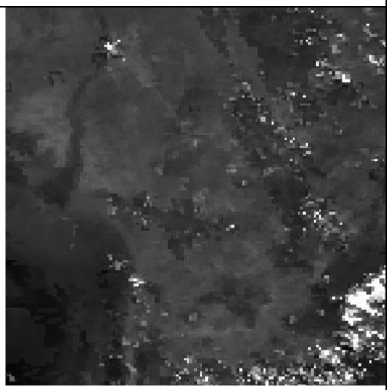
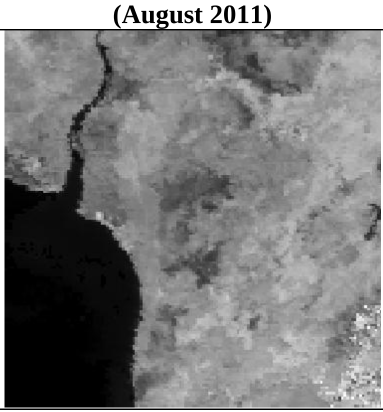
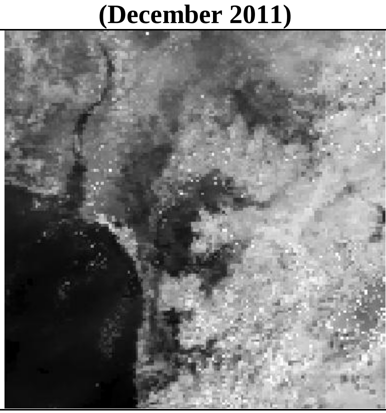
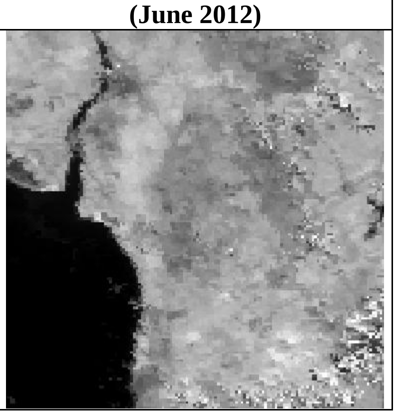
	BEFORE THE FLOOD (August 2011)	IN THE FLOOD (December 2011)	AFTER THE FLOOD (June 2012)
B A N D - 3			
B A N D - 4			
	 **0** **0.25**		

Figure 1. Floodwaters appearance on MODIS visible channel (1, 3 and 4). Red circles are the locations of floodwaters

	BEFORE THE FLOOD (August 2011)	IN THE FLOOD (December 2011)	AFTER THE FLOOD (June 2012)
B A N D - 2			

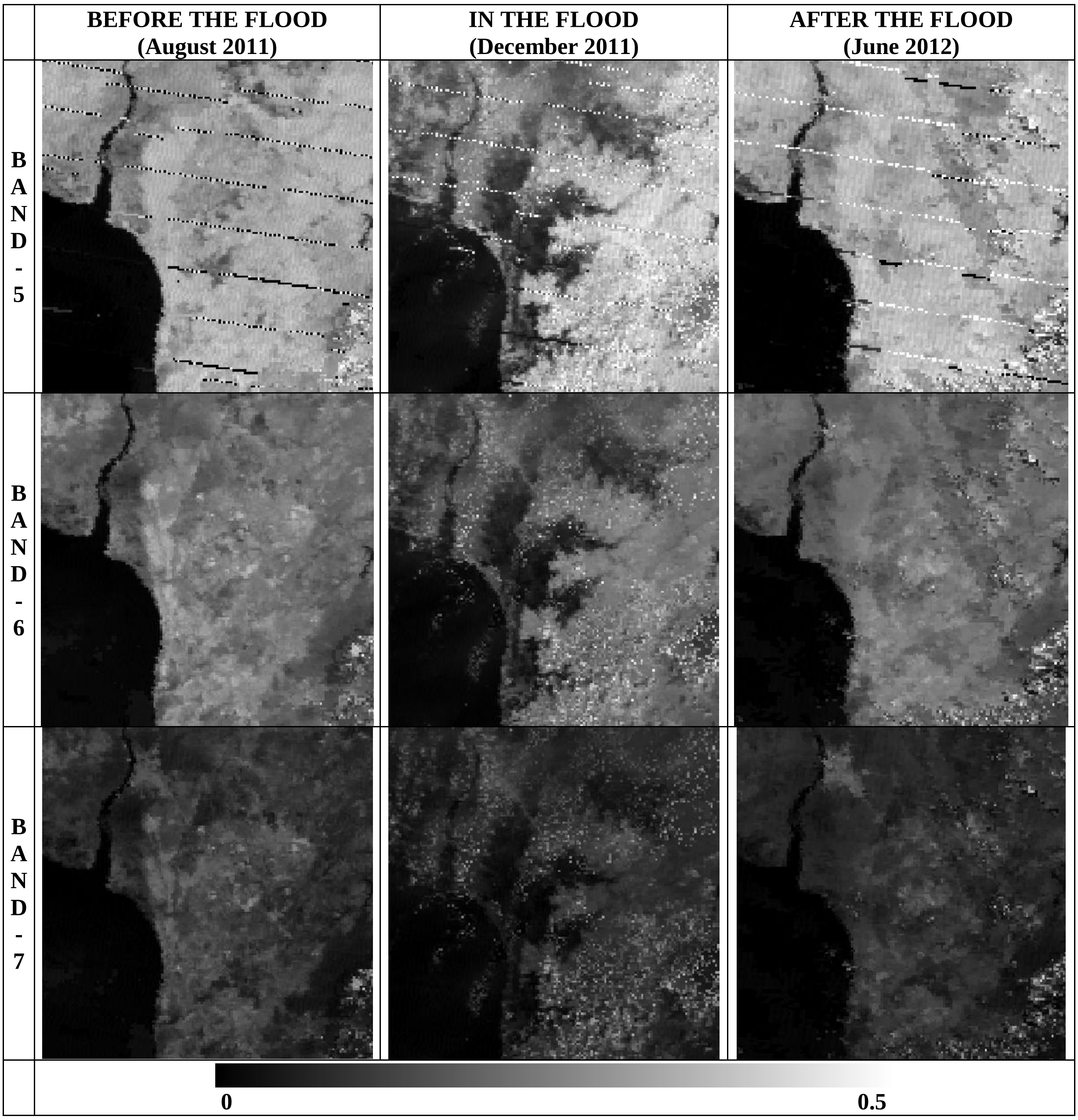
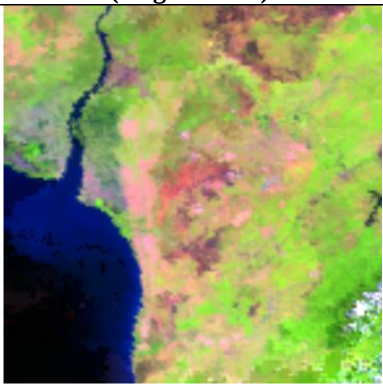
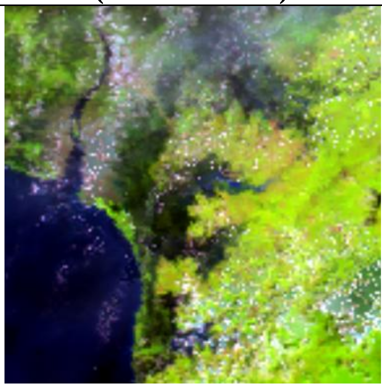
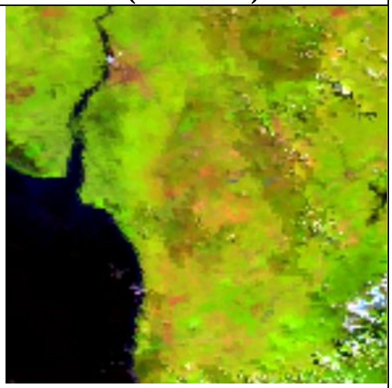
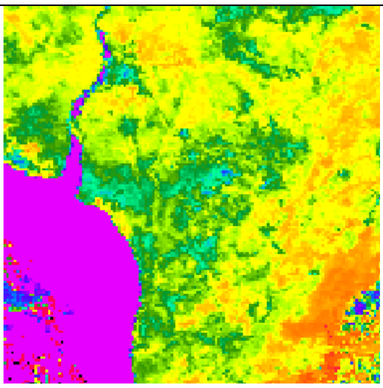
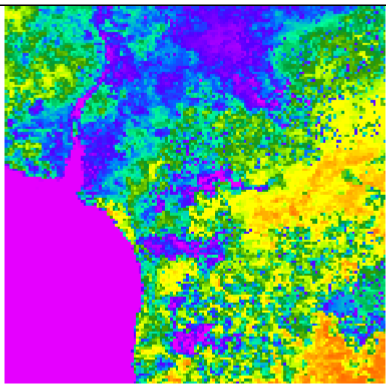
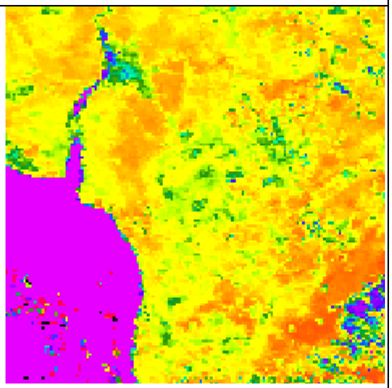
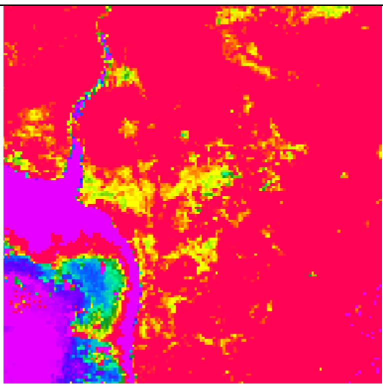
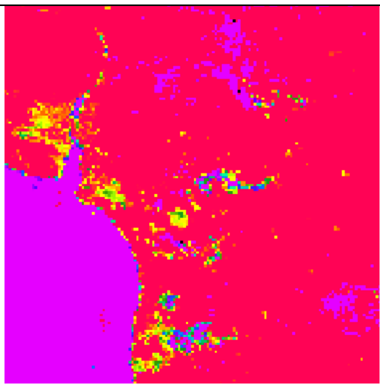
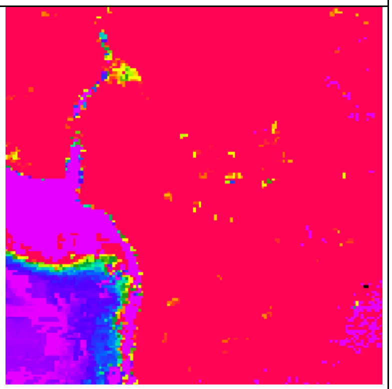
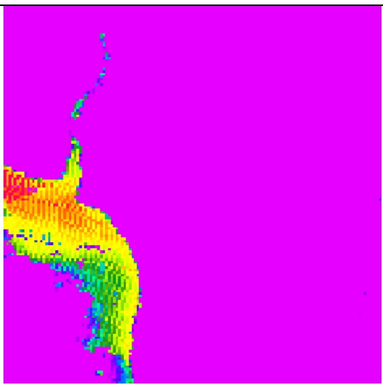
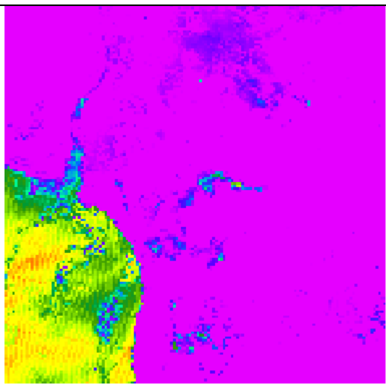
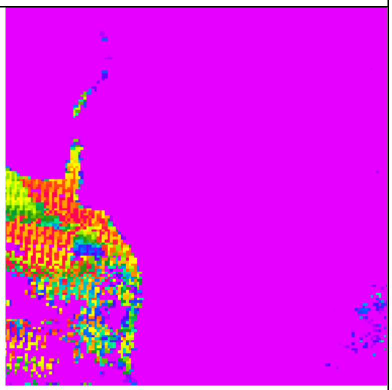


Figure 2. Floodwaters appearance on MODIS infrared channels (2, 5, 6 and 7)

Figure 1 and 2 show 621 RGB MODIS imagery and MODIS reflectance per band (1-7) in the period before the disaster, during disaster (floods) and after a disaster. Floodwaters location indicated by the red circle. The data used is the 8 daily composite MODIS reflectance (MOD09). Data pre-disaster period selected in 2011 on 217 Julian Date (5 to 12 August 2011), the period during selected events in 2011 on 361 Julian Date (27 to 31 December 2011), and the period after the events selected in 2012 on 177 Julian Date (2 June to 2 July 2012). Based on these data it can be seen that the reflectance MODIS band 2 (NIR), 5 and 6 (SWIR) provide better results in detecting floodwaters as compared to other bands, especially the channel appears (visible).

	BEFORE THE FLOOD (August 2011)	IN THE FLOOD (December 2011)	AFTER THE FLOOD (June 2012)
RGB 621			
NDVI			
EVI			
NDWI			

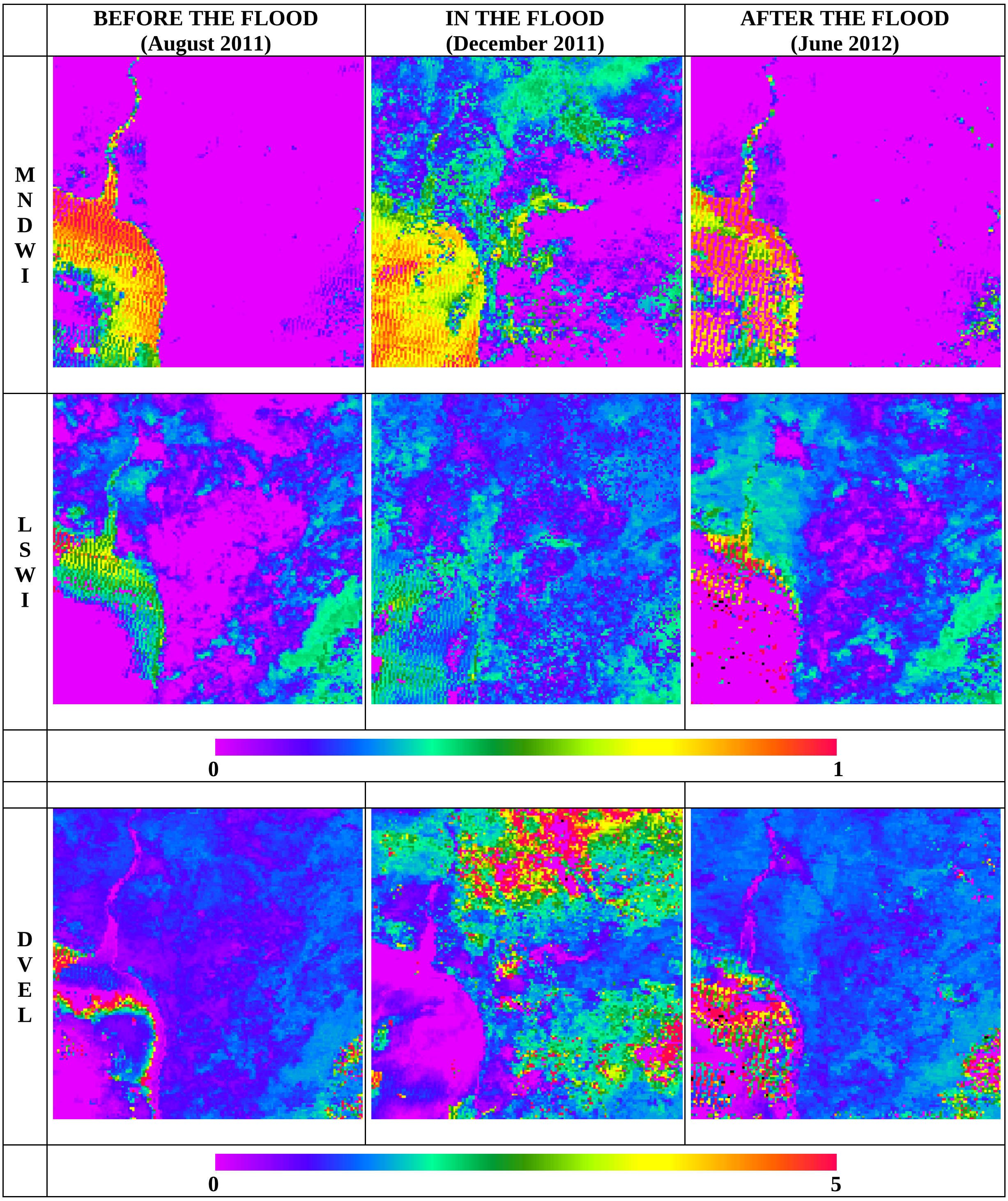


Figure 3. Floodwaters appearance on MODIS NDVI, EVI, NDWI, MNDWI, LSWI, and DVEL

While Figure 3 shows the MODIS RGB image 621 and the calculation of the value of the index (NDVI, EVI, NDWI, MNDWI, LSWI, and DVEL) are expected to be used for the identification of flood inundation. Based on the results of the analysis can be seen that all variables except LSWI can be used to detect the floodwaters.

V. CONCLUSIONS AND RECOMMENDATIONS

The study concluded that the MODIS optical images can be used to identify a pool of water caused by floods. Physical parameters that can be extracted for identification of the floodwaters is reflectance value channel 2, 5 and 6 and the index values are calculated from the reflectance values, such as NDVI, EVI, NDWI, MNDWI, and DVEL.Based on the results of this study should be followed up with a more focused research, namely by applying models based on physical parameters of MODIS imagery for identification of flood inundation, particularly for rapid mapping purposes (rapid mapping) flood affected areas.

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