Inundation area estimation of Bengawan Solo river basin: Analysis study using MODIS spatiotemporal data

ブンガワンソロ流域における浸水域推定：MODIS 時空間データを用いた解析研究

Atiqotun Fitriyah*, Tasuku Kato**

○フィトリヤー アティコトゥン*、加藤 亮**

1. Introduction

Around 99% of total disaster occured in Indonesia was due to hydro-meteorological conditions and flood occurred the most frequently. With the increasing frequency and intensity of flood in recent years, it is necessary to improve the current infrastructure of the flood prone area so that when heavy rainfall occurs flood damage can be reduced to the minimum. Conversion of floodplain areas over the years into agricultural and residential areas are increasing while the capacity of existing stream channels remains. This led to the reduction of the existing stream capacity on channeling the excess rain.

It is undeniable that grey infrastructure is necessary; however, simply continuing to increase the capacity of grey infrastructure is considered unsustainable due to the pressure associated with ongoing climate change and urbanization. Additionally, the multi-functionality aspect of paddy fields needs to be reintroduced to society as some part of paddy fields have taken up spaces of what should be the floodplain/wetland in the riverine area. Not only focusing on the provision function but also considering other ecosystem services for a more sustainable ecosystem management.

Here we intended to study the potential capacity of existing paddy field areas to be integrated as green infrastructure in flood control mechanisms to be utilized along with the existing grey infrastructure. Thus area mapping of such potential need to be conducted to assist management planning in the future. While there are many remote sensing products available to be utilized in mapping the inundation, MODIS has the advantage in terms of temporal resolution though with coarser spatial resolution. By mapping the spatial and temporal distribution of inundation over the study area then can we analyze the potential of paddy fields during flood and zoning the area as part of the green infrastructure.

2 Study area and methods

A watershed of the longest river in Java Island Indonesia, Bengawan Solo, is decided to be the current study area. Bengawan Solo flows through twenty regencies/cities of two provinces and has the length of 600 km and a catchment area of 16100 km^2. As the lowland area is quite large (nearly 60%), paddy fields distribution in the area is significantly abundant.

Rice-fish farm area which is located in the downstream of the watershed has the land elevation up to 5 m below sea level. That is why this area is mostly inundated in the rainy season but very dry in the dry season. This area along with paddy fields located in the riparian zone is very likely to be the primary target as green infrastructure for the flood control.

* グローバルイノベーション研究院 Global Innovation Research, Tokyo University of Agriculture and Technology.
** Institute of Agriculture, Tokyo University of Agriculture and Technology
Keywords: 浸水，水田、リモートセンシング，inundation, paddy fields, remote sensing

Data used in this study are derived from MODIS surface reflectance daily data (MOD09GA) with 500 m spatial resolution for flood extent monitoring and retaining capacity analysis of paddy field area, rainfall and river flow data for flood frequency analysis, and data of paddy field area from Indonesian Agricultural Ministry for ground calibration. Remote sensing analysis here was conducted using indices such as difference value of red and NIR band, modified LSWI (MSLWI), and Normalized difference water index (NDWI) while flood frequency analysis using Log Pearson III distribution frequency to determine recurrence interval of flood.

3. Ongoing Result and discussion

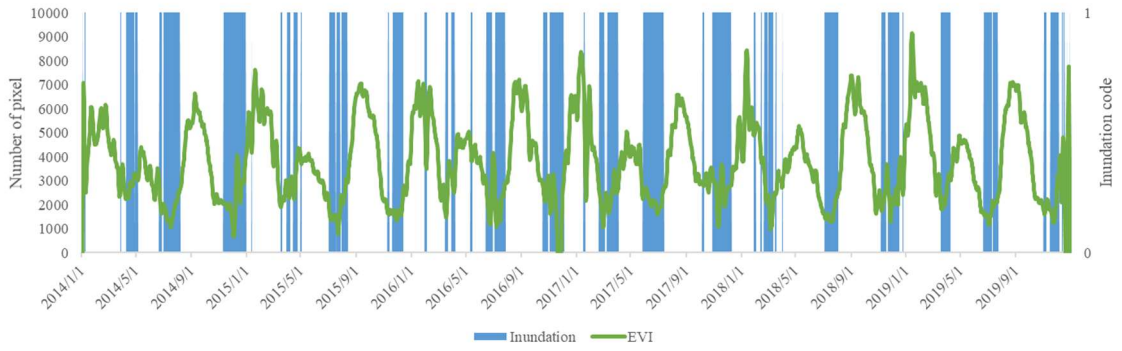

Fig. 1 Detected inundation extent and vegetation/biomass index (EVI) in a part of downstream area

Due to the large share of paddy fields in the watershed area, inundation extent mapping results did not only reflect flood occurrences but also reflected the influence of inundation on paddy field water management(Fig.1). Though the inundation frequency showed a positive correlation with the governmental produced flood risk map (see Fig.2), inundation period due to small frequency flood in the local area still showed some setbacks.

Frequently inundated area in the upstream and middle stream of the river basin mainly located in the riverine area while the downstream has broader extent. This was in accordance with the area morphology where the inundated area in the upper area located near the river junctions while inundation in the downstream occurred due to the spreading lowland so that the area tended to receive large amounts of water during the rainy season.

Stepwise regression was also used to study variables related to inundation characteristic of the area so that it can be utilized to propose green infrastructure management in time of flood occurrence.

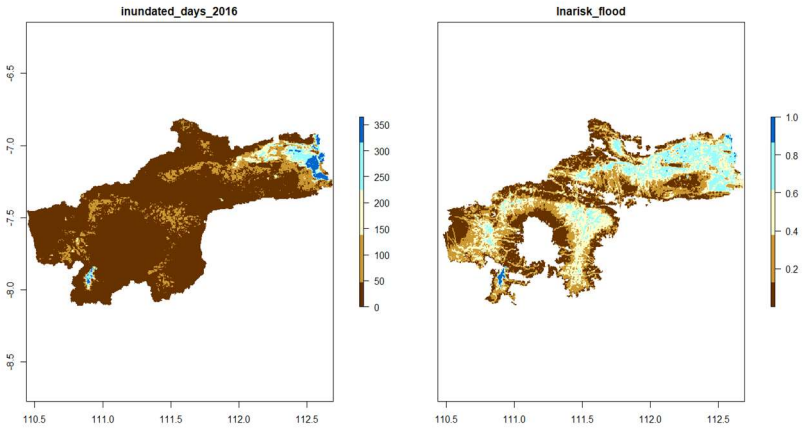

Fig. 2 Inundation frequency map for 2016 from MODIS data analysis (left) and flood risk map from Indonesian Board for Disaster Management (BNPB, 2016) ($R^2 = 0.7$)