

# Monitoring the distribution of floating macrophytes in Lake Limboto using Landsat images

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**Abstract:** The expansion of macrophytes, especially floating macrophyte, has become a social problem in Indonesian lakes. The excessive growth of the macrophytes causes the reduction or disappearance of the water area, and may alter the aquatic ecosystem. Lake Limboto, located in the northern part of Sulawesi Island, is one of the areas concerning of this problem. The water area is reduced due to massive growth of water hyacinth (*Eichornia crassipes*). Since the lake has been used for agriculture and fishing, this changes may influence the livelihood of local peoples.

We investigated long-term changes in distribution of floating macrophytes using Landsat images. The Landsat/TM and ETM+ images in this region (Path:113, Row:60) were obtained from the USGS Earth Explorer site (<http://earthexplorer.usgs.gov/>). The data were collected from 1991 to 2012 with no cloud cover on the lake. The noise due to the SLC (Scan Line Collector) failure in Landsat/ETM+ images from 2003 to 2012 were modified by a simple image synthesis method using 2 or 3 images taken within 2 months. The data were converted Digital Number (DN) to Top-of-Atmosphere (TOA) reflectance, and used to calculate the Normalized Difference Water Index (NDWI). The water and macrophyte areas were then divided by a threshold of the NDWI. The lake area was first determined using the oldest Landsat/TM image (10 January, 1991) because it differs among images. Finally, the macrophyte and water areas were calculated for all images after clipping the lake area.

The estimated area of Lake Limboto from Landsat/TM image in 1991 is about 30 km<sup>2</sup>. The macrophyte area is 1.1 km<sup>2</sup>, which is the smallest one during the survey periods. The area drastically increases to 9.4 km<sup>2</sup> in 1994, and continues to increase

until 1997 (11.4 km<sup>2</sup>). After that, the area decrease to 6.6 km<sup>2</sup> in 2000, and the minimum peak is found in 2001 (3.8 km<sup>2</sup>). The Landsat images show that the inundation of the lake occurred in this periods. The area increases again from 2001 to 2011, and reaches about 12.2 km<sup>2</sup> in 2011. Although the macrophyte areas are similar between 1997 and 2011, the distribution pattern is different. In 1997, the macrophyte densely distributed along with the coastal area, and almost did not find in the offshore area. However, in 2011, the macrophyte sparsely distributed not only the coastal area but also the offshore area. The macrophyte at the offshore area increases significantly from 2007. It may be related with the number of cage culture for fisheries.

Keywords: Water hyacinth, Landsat, inland waters