Mapping of *Mimosa pigra* on Maro River in Wasur National Park, Papua – Indonesia

Barano Siswa Sulistyawan[1] and Dr Hartono[2]

Abstract

The objective of mapping mimosa, *Mimosa pigra* L., was to determine its distribution and rate of spread on the Maro River, Wasur National Park, Indonesia. The methods used were field surveys and remote sensing. Field surveys provided detailed information of mimosa patches, whereas satellite-based remote sensing provided data to predict areas (landforms) where mimosa may grow. Field surveys were conducted along the Maro River from Agrindo village to the international border of the Republic of Indonesia and Papua New Guinea. Mimosa is distributed as 1,259 groups of seedlings and small plants and 62 groups of larger plants. In total, these covered an estimated 1.5 ha. The frequency of mimosa groups was highest downstream. The preferred habitats of mimosa were point bars, oxbow lakes and along the river levees that have a wet and humid microclimate due to frequent flooding.

Keywords: mapping, distribution, Papua, Indonesia.

Introduction

Mimosa, *Mimosa pigra* L., is a native plant of Central America, South America and Mexico. In its native range, mimosa populations are thought to be regulated by natural enemies (Harley and Forno 1992). However, the situation is different when this plant is found outside its native range. For example, in Merauke, Papua, mimosa spreads quickly, and grows up to four metres tall. The first mimosa population in Merauke County was found along the Maro River and since 1995 it has spread along the river. The Maro River functions as a buffer zone and natural border to Wasur National Park. However, mimosa is a noxious exotic species that has potential to invade most of wetland habitat in Wasur National Park.

To determine the distribution and rate of spread of mimosa, the World Wide Fund for Nature (WWF) conducted a land-mapping program along the Maro and Wanggo rivers between Agrindo village and the border between Indonesia and Papua New Guinea (PNG), from 17th to 27th January 1998 (Barano 1998).

The results were not satisfactory because the observations covered a small area. Considering the potential impact of mimosa, we investigated alternative mapping strategies for mimosa. One technique, used in August 2001, was based on landform units and used remote sensing data. In this paper, we discuss this land mapping and habitat-mapping technique for mimosa.

[1] Postgraduate Student of Remote Sensing of Gadjah Mada University, Yogyakarta, Indonesia.
Email: <t_barano@yahoo.com>.
[2] Lecturer of Geography Faculty of Gadjah Mada University, Yogyakarta, Indonesia. Email: <geografi@ugm.ac.id>.

Land mapping and remote-sensing approach

Land mapping

Land surveys are difficult and expensive. However, they are very useful in gathering detailed spatial data (spread and distribution in small areas), especially when prioritizing management techniques. The important components include; collecting field data, developing maps and analyzing the results to determine spread, distribution and to identify threatened areas.

Field data collecting

The equipment used for the land surveys included a GPS (Garmin Nav 75), compass, clinometers, camera and a roll metre. Transport was by canoe or speedboat. Six plots were located along the Maro River using the river as a baseline. Within each plot, mimosa infestations were divided into three classes based on growth. The first comprised seedlings with canopy less than 0.5 m × 0.5 m. The numbers of individuals were counted and their location recorded. The second class comprised small groups of plants that could easily be counted. For each group, the number of individuals was counted, and the lengths of the infestation along the river and distance inland were measured. The river levee slopes were measured and the locations were recorded. The third class was of groups of larger plants that had too many individuals to count. For these groups the areas were measured using GPS and compass and the slopes were also measured.

A map was developed by plotting the coordinate data for each class of mimosa on graph paper. The area of land infested with each size class was then estimated by planimetery. The drafting process was conducted manually and then converted into digital data.

Analysis

The data were processed to determine the frequency of mimosa in each of the six observation plots. Frequency was judged based on the ratio of individual amounts, total number of groups, and then multiplied by 100. The equation was as follows:

$$\text{Frequency of mimosa} = \frac{\text{Individual number}}{\text{Total number of groups}} \times 100$$

Remote sensing

Remote sensing is a data-collection technique using tools such as aerial photography, videography or satellite imagery. Based on spatial resolution level, remote sensing is divided into three groups, high-, medium-, and low-resolution, as described in USGS, EROS Data Center and Clean Lakes Inc. (2000):

a. High-resolution remote sensing are data with ground sample distance (GSD) < 20 m. It can provide high detail but over a narrow area. Techniques are: colouring infrared aerial photography, black and white aerial photography, aerial videography, Ikonos satellite, SPOT satellite data and ERS 1–2.

b. Medium-resolution remote sensing are data with GSD range 20–100 m. They provide improved information about land cover and a wider area. They include Landsat and Radarsat satellite data.

c. Low-resolution remote sensing are data with GSD < 100 m. They cover half or a whole surface of earth in one width. For example: NOAA, AVHRR, Sea WiFs, MODIS.

In this project, medium-resolution using Landsat TM was used to assess areas suitable as mimosa habitat.

Habitat

Mimosa prefers humid and wet habitats, and grows in river levees and point bars or shoals of rivers and in oxbow lakes in Wasur National Park. Knowing preferred habitats of mimosa and understanding landforms along the Maro River helped identify potential mimosa habitats in the Maro River. The Maro River meanders through lowlands, has few tributaries and has formed oxbow lakes. Based on landform classification guidelines of Jordens and Marsoedi (1996), suitable habitats for mimosa include alluvial lands, floodplains, meandering river floodplain, river levees, point bars or shoals, and oxbow lakes.

Mimosa seed is transported into oxbow lakes and can reach river levees during floods. When waters recede, mimosa seed is left in the river levee. Drifting seed is trapped in aquatic grass on point bars of the Maro River.

Through Landsat data, landform information was obtained for a wide area and, coupled with knowledge of the habitats used by mimosa, helped determine the distribution of mimosa by directing field surveys.

The levels of salinity in the Maro River were measured at 16 sites between the border with Papua New Guinea and the Marauke harbour.

Landsat TM data processing

A Landsat TM data image recorded on May 1997 was used to make a digital base map with geometric correction using a topographic map as the reference. The output included a landform map and land-covering map. This required use of appropriate computer hardware and the software

ENVI 3.1 to process raster data, and ArcView and ArcInfo to process vector data. GIS tools were then used to predict potential habitat invaded by mimosa (see Figure 5).

Results

The mapping models mentioned above were used to complement each other. Remote-sensing data were used to map habitat and landscape of Maro River (Figure 1). Field observation data were used to give detailed information about mimosa populations.

Mimosa distribution

It was found that the total area covered by mimosa on the Maro riverbank was 1.5 ha, consisting of 1,259 groups of seedlings and small plants and 62 groups larger plants. These were spread along 98 km of the Maro River from Agrindo village to the Indonesia–PNG border. Based on average area per group it was predicted that the potential area that could be invaded by mimosa along the Wasur National Park side of the river was about 35 ha. This would double if both banks were invaded.
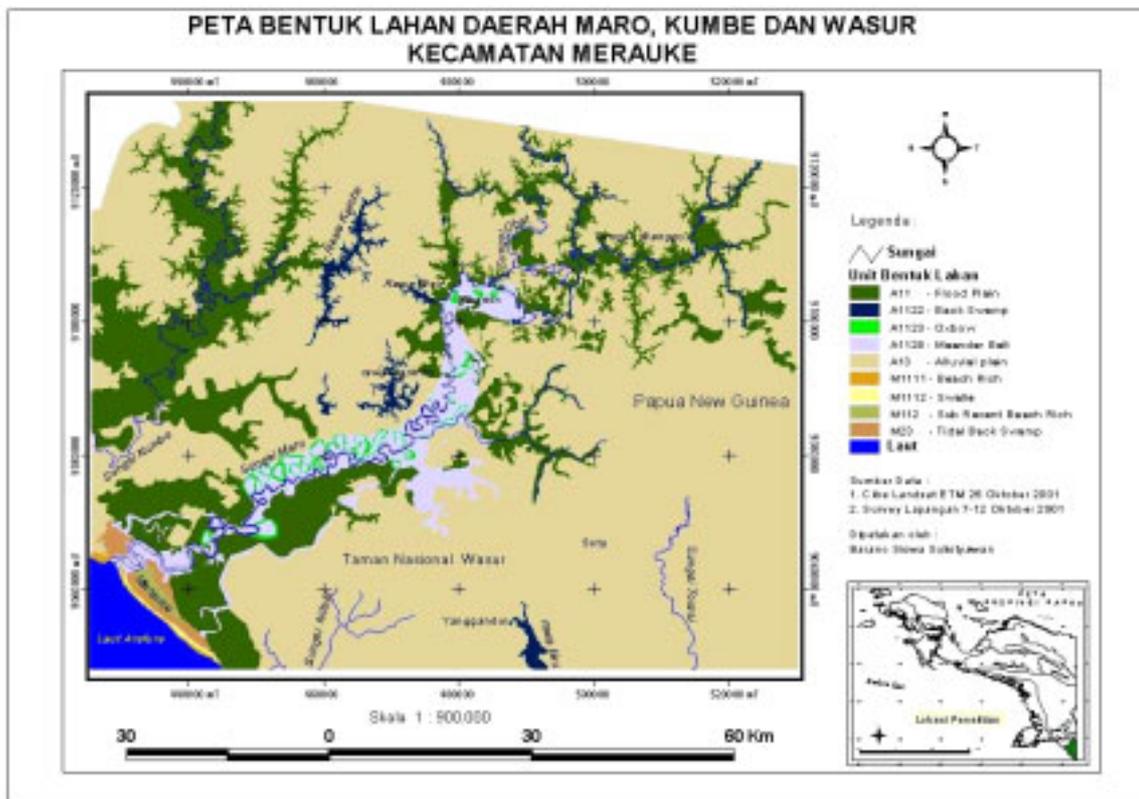

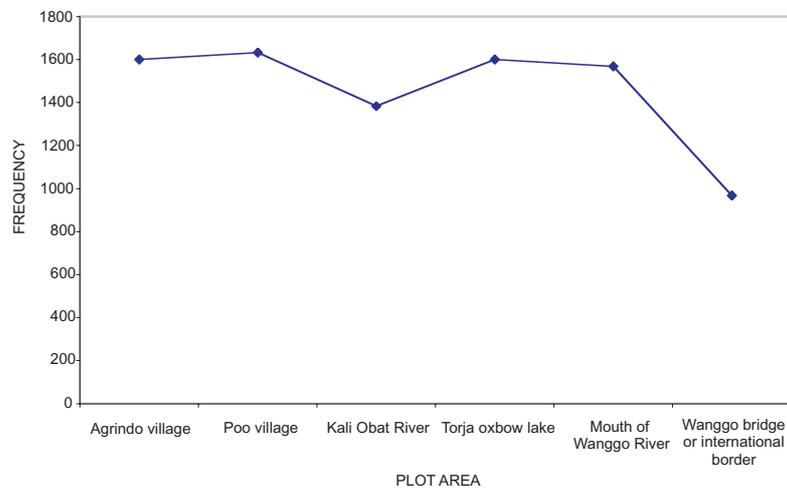**Figure 1.**   Habitats and landforms along the Maro River catchment.

Figure 2.   Frequency of mimosa presence along the Maro River.

Mimosa presence frequency

Observations at the six locations along the Maro River indicated little variation except near the international border where fewer populations were noted (Figure 2).

Salinity increase downstream from 1 ppt at Agrindo village to sea water levels at Marauke harbour. Mimosa was not present below Agrindo village indicating that mimosa prefers freshwater.

Factors that suppress mimosa growth and spread

Fire, high water level and undisturbed riparian primary forest are natural and important barriers to the growth and spread of mimosa. Fire can decrease the number of seeds that are produced by the parent plant. Death or suppression of growth depends on heat intensity, duration of fire and fire frequency. In the dry season of 1997, fires killed many mimosa plants (Figure 3). Seed germination may be suppressed by floodwater though this may not affect mature plants.

Figure 3.   Burning mimosa along the Maro River.

Another factor suppressing mimosa may be lack of disturbance. Where the dense riparian primary forest remains undisturbed, mimosa is rare. Where landslides, erosion or sedimentation caused openings in the forest, colonization by grasses occurred quickly and mimosa was found growing in all stages from seedlings to mature plants. Once mimosa was established in these situations it competed with other vegetation.

Factors that support mimosa growth and spread

There appear to be a number of factors that support the growth and spread of mimosa such as movement of water, land clearing and the lack of natural enemies. The movement of water due to tidal changes and seasonal flooding transports mimosa seeds from one place to another. We predict the spread of mimosa seeds from upstream to downstream along the Maro River and an increase in the size of the infestation, limited downstream by salinity levels. Seasonal influences that determine the levels of flooding in the wet seasons and the ability for the floodplains to burn in the dry season affects the amount of viable seed remaining and rates of germination. Landslides, sedimentation and silting-up in the river contributes to new habitats suitable for mimosa establishment and growth (Figure 4). Finally, there is a lack of natural enemies to suppress growth and reproduction of mimosa.

Figure 4.   Mimosa growing on slumped banks of the Maro River.

The area threatened by mimosa along the Maro River and in Wasur National Park is shown in Figure 5. The blue-shaded area shows the zero-growth probability areas. These areas are stable riparian forest, which are relatively high and dry. In comparison, the red-shaded areas represent locations with conditions suitable for mimosa and have a very high probability of invasion. The red-shaded areas include oxbow lakes and low-lying, flood-prone areas that have wet and humid microclimates.

Summary

Mapping the spread of mimosa populations was done at two scales, land mapping and remote sensing. Field observation during land mapping provided a detailed population estimate. To achieve a spatial habitat estimates, remote sensing data with high or medium resolution was used. By combining the results for field survey with remote-sensing data, the potential for spread of mimosa was estimated.
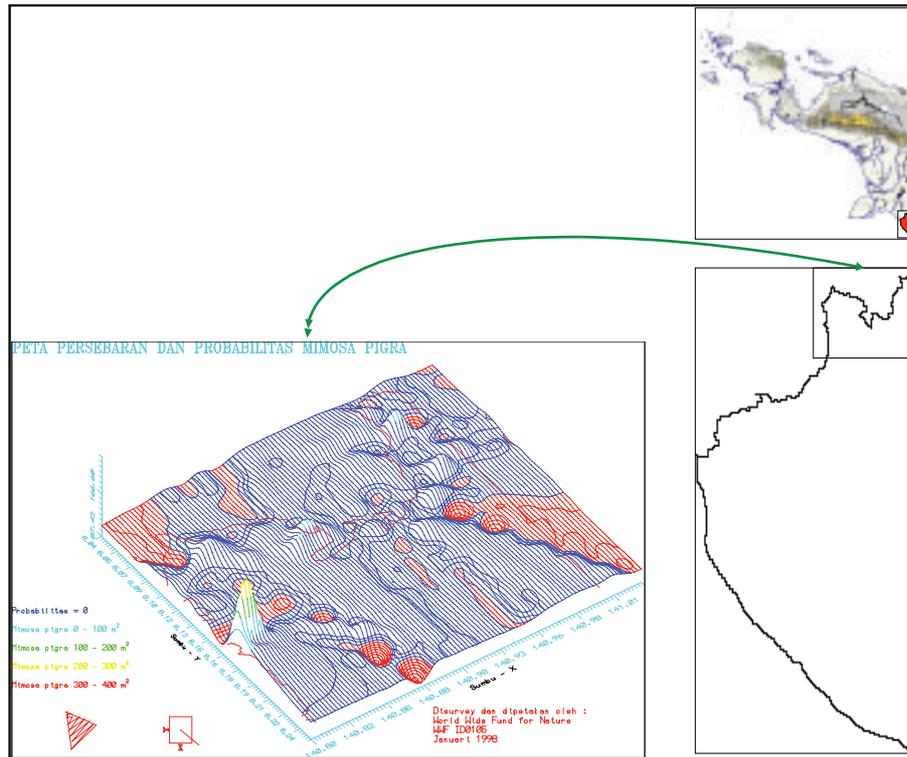
Acknowledgements

Figure 5. A growth probability map for mimosa for the area around the Maro River. Blue is primary forest and has low probability. Red is lowland, swamp and lagoons and has high probability.

References

Barano, S.S. 1998. *Penyebaran dan Pengendalian Mimosa pigra di Taman Nasional Wasur*. WWF Report, Merauke.

Harley, K.L.S. and Forno, I.W. 1992. *Biological Control of Weeds, a Handbook for Practitioners and Students*. Inkata Press, Melbourne, 14.

Jorden, E.R. and Marsoedi, D.S. 1996. *Guidelines for Landform Classification* (two languages version). Technical report, Center for Soil and Agroclimate Research, Bogor.

US Geological Survey, EROS Data Centre and Clean Lake Inc. 2000. *Systems for Monitoring Water Hyacinth in the Lake Victoria Basin, East Africa*. US Agency for International Development.