A city plan should not only focus on areas within its administrative boundaries, because urban lands are always expanding parallel with the growth of its population and activities. In order to anticipate the future pace of development, an inter-governmental coordination is presently expected, viz. the city government itself and the regencies that are located next to the municipal boundaries. Slowly but sure, the existing urban land will overstock the administrative city boundaries. An extra-territorial zoning policies (l'sberg, 1975) can be adopted in order to cope with this problem.

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MONITORING MANGROVE DISAPPEARANCE
BY REMOTE SENSING

A case study in Surabaya, East Java, Indonesia

by Hartono and Bengun Mulyokusumo

ABSTRACT

This study deals with the application of remote sensing in monitoring mangrove disappearance. Color aerial photogram scaled to 1:30,000 of 1985; numerical data of Landsat satellite taken in 1985 and SPOT satellite data of August 30, 1988 were used. The photogram was interpreted manually, while the digital analysis with D-IDACTIM software was applied to the Landsat and SPOT data. Barycentric supervised classification procedure was used in classifying mangrove and land use classes. Key interpretation of mangrove type was obtained by field check in 1989.

Two types of mangrove (Avicenia sp and mixed mangrove) could be identified both on the aerial photograph and on the SPOT data. The extent of mangrove in 1981 was measured manually, while those in 1985 and 1988 were obtained by multiplying the number of pixel (picture element) and the spatial resolution of Landsat and SPOT respectively. During seven years (1981-1988), there were 852 hectares of mangrove in the study area which have been cut.

For mangrove reforestation purposes, two mangrove zonations are presented: one is based on the salinity gradient, while the other is based on the Chaoa formula. It seems that the second zonation is quite good for the study area.

INTRODUCTION

In many parts of the world, destructions of mangrove, an halophyte formation, have been increasing more and more serious. This type of forest

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lies actually in the tropics and the subtropics regions with a surface of about 8 and 15 million hectares. From the economic point of view, most of the mangroves were treated as wasteland to be sweeter (Blasco, 1989). Practically, management of mangrove means to change them into other type of land use, e.g. harbour, airport, residential and industrial areas, agriculture and fishery fields, etc. Actually, as a forest resource, mangroves are very useful. Sanger et al. (1983) stated that they have first some physical function, e.g. stabilization of coastal area, expansion of coastline, and prevention of the coast against abrasion and storm. Secondly, they can be a place of spawning and breeding for fish and shrimp, a nesting sites of sea birds and accommodate the other types of fauna. Thirdly, they have economic values as wood, charcoal, tannin, pulp, etc. An other important advantage of mangrove is probably to prevent the intrusion of salt water to the ground water. It has a great value for groundwater used for domestic purposes. Hence, the destruction of mangrove is really in acceptable.

In Surabaya (East Java, Indonesia), deforestation of mangrove was recently reported by Surabaya Post newspaper issued on March 11, 1989. It was about 50 hectares of mangrove illegally cut by people surrounding the mangrove forest in the last five years. The number is in reality rather small, but for being a conservation forest of Surabaya city with three millions of population and with a very limited extent of mangrove forest, it has a great influence for the local environment.

The study was carried out by the application of remote sensing in monitoring mangrove extent. The objective of this study is to investigate the decrease of Surabaya mangrove since 1981 by aerial and spatial data, and then present the limit of potential region which theoretically might be reforested.

LOCATION

The study area is located between 112°48'E to 112°50'E and 7°15'S to 7°21'S, and administratively it belongs to Surabaya city region and Sidoarjo regency in the south which is bordered by Banting river (figure 1). According to the land use map published in 1963 by the Directorate of Land Use, the mangrove of Surabaya lying along the eastern coast of Surabaya varied from 1 to 2 km in width from the coastline. Based on Smith and Fergon climate criteria, the region has C type of climate, with 8 wet months and 4 dry months. In Surabaya meteorological station the annual rainfall is 1762 mm/year and the mean monthly temperature is 27°C. The isothermic diagram of the region is presented in figure 2. Physiographically, the region consists of alluvial plain and partly estuary of the Brantas delta in the north. So the region is annually submerged by tide. Four rivers are found in this region i.e. Wonokromo river...
in the north with 320 cubic metres of maximum depth (90 m of width), Rangkat Melojiy river, Rangkat and Buntung river in the southern part. In fact, the Wonoromo river is a prolongation of Brantas river in the north side, while in the south there is Porong river which is excluded from the study area. The rivers bring materials from the river basin deposited in the estuary. There is a continuous expansion of the coastline in the mouth of the river, especially Wonoromo and Buntung rivers, both with the rate of expansion of 20 m/year. Not too far from the study area, there is a new industrial area in Rangkat subdistrict as a baseline industrial zone for Surabaya city. A reservoir of industrial wastewater is located 6 km landward of mangrove formation. The industrial wastewater is discharged to the rivers in the study area. It seems that physiographic, hydrologic and geologic conditions provide an advantage to the region to be a mangrove forest conservation.

MATERIALS AND METHOD

Infrared color aerial photographs taken in 1981, a magnetic tape of Landsat image of 1985 and numerical data of SPOT satellite image of August 30, 1998 were used as primary data. Topographic, geologic, land use and administrative, and isoline maps were included in this research as supplementary data. Socio-economic conditions were obtained from statistical data. The aerial photograph was manually interpreted with a mirror stereoscope, while the magnetic tape of Landsat and SPOT were digitally analysed with the DIDACTIM software available at the Institut de la Carte Internationale de la Vegetation (ICIV) under the direction of Francois BLASCO, Touslouz, France. In this case, some enhancement techniques and two supervised classification procedures (bayesian and hypercube) have been applied. Field checks in the study area were conducted by authors in 1989.

RESULT

Areal Photographic Interpretation

The aerial photographic interpretation showed that in 1981 the mangrove of Surabaya covered a surface area of about 1120 hectares. It lied administratively in Kepuh village (295 hectares), Wonoerlo (443 hectares), Medokan Ayu (144 hectares), Gunungpayar Tambak (209 hectares), and Tambaksono (389 hectares). It showed a nearly dense mangrove coverage especially in the southern part of the area (Tambaksono territory). The density of the forest is estimated 1000 trees/ha. Based on the color, the density and the

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Figure 2. Ombrothermic diagram of Surabaya
location of the forest which appear on the aerial photograph and on the field check; as well as at least three mangrove zones could be identified. Firstly, near the sea was the mangrove dominated by *Avicennia* sp., about 30 m of width. The second zone was mixed mangrove which consists of *Avicennia*, *Rhizophora* and *Exocoetaria agallocha*. Under the mangrove we found grass and lillsa (dominated by *Derris heterophylla*). Along the river were found some Graminaceae dominated by *Sinoicium spontaneum* ("flagat") and *Imperata cylindrica* ("sling-ling"). Lastly, the third zone was a mixed mangrove dominated by *Exocoetaria agallocha* mixed with *Hypnea siliquosa*, *Pachyseris spicata* and *Acrostichum dilleinѳ* ("jerup") under the trees. Map resulting from the aerial photographic interpretation is presented in figure 3.

Comparing the aerial photographs and the topographic land use maps, we can identify that a rapid expansion of the land to the north occurred in the south of Buntang river. It is probably due to the wave action from the south when the sediment was deposited in the sea. The accretion modified the estuary of Buntang river to the north and it was wholly occupied by *Avicennia* sp.

**Digital Analysis of Landsat MSS Data**

A supervised classification needs some training areas. In this case, we chose from the Landsat imagery nine training areas of mangrove and land use types that represent nine classes. The classes are: (1) *Avicennia*, (2) mixed mangrove, (3) grass, (4) fishery 1, (5) fishery 2, (6) dry field, (7) wet rice field, (8) bare land (abandoned fishery pond) and (9) village/temple. There was a different phenologic stage between the two rice fields classes. Dry rice field means a rice field in which the rice is ready to be harvested or after harvested, while the other one is a rice field where the rice is maturing. The difference between fishery 1 and 2 is the existence of mangrove vegetation in the fishery field. In the fishery 1 the trees cover more or less 10 percent of the area, while in the fishery 2 are 50 percent.

It is well known that field for shrimp and fishery are usually developed in mangrove land. The exploitation of the mangrove land in Surabaya and the vicinity (Cirebon and Sidoarjo regencies) is primarily destined to fishery and salt production. There is a unique system of mangrove exploitation for fishery in Java called "pantai forest" (mixed forest and fishery). It war in Citarum and Cimunuk delta (especially in Tejajang Krawang and Cemara) that the system was initiated. The system regulated both the development of mangrove and fishery in one place, with a maximum 10 percent of exploited land and for fishery (Harun Al Rasyid, 1971). Mangrove forest in this system must be developed, while at the same time fishery can be applied by fishermen in the mangrove vicinity. The fishermen have also a duty for conserving the mangrove. In some regions (e.g. Cangkring, Cemara, and Jogok-Sejara Arakan) the system is running quite well.
but there is a trend that the fishermen prefer to get more space and land for their fishery. So we found in many parts of Java that mangrove is more and more destructed. This phenomenon can be found in Tanjung Krawang, Palabean Hilir, Purwa, Bodi delta, Pemali delta, and Cisanggarung delta in the northern coast of Java and also in the study area (east coast of Java). Fishery product here is usually shrimp (primarily Penaeus monodon) and milk fish (Chaetos chanos).

Landuse 1985 analysis of Surabaya's mangrove was started by extracting some statistical values for each class. In this case values of the mean and the standard deviation of every class in four original bands were taken. From the values, a scattergram of classes in two bands (bands 5 and 7) was made to show the separation of classes. The scattergram is presented in figure 4. It seems that the separation of class is quite good, especially between class number 3, 5, 6, and 7. But there is a little confusion between class number 1 and 2; 4 and 5 as well. In order to avoid the confusion, the class 1 and 2 were regrouped and also class number 4 and 5. This classification procedure produced a good result. The mangrove is well classified and it is separated from the other objects. Here, the accuracy of classification was 88 percent. Mangrove here covered more or less 943 hectares.

Digital Analysis of SPOT Data

SPOT image used in this study is a scene of multispectral mode which consists of 512 x 512 pixels in three bands (XS1, XS2 and XS3). The spatial resolution is 20 m.

Analysis of the image was firstly done by a display of enhanced Color Compositve image (CC). In the CC image four mangroves and six land use features are identified. They are mixed mangrove 1, mixed mangrove 2, dense Avicennia, degraded Avicennia, new fishery, active fishery, old fishery, village, bare land and grass. Secondly, one training area of each feature is selected. Statistical values (mean and standard deviation) are then obtained (table 1).

Thirdly, backscattering classification procedure is applied to the scene by using the statistical values. Mangrove and land use are well classified into ten classes. The accuracy of classification is 99 percent, which is obtained from a confusion matrix. A map derived from the SPOT image analysis is presented in figure 5, where for the presentation, the classes are generalized into seven classes.
TABLE 1. STATISTICAL VALUES OF TRAINING AREA

<table>
<thead>
<tr>
<th>Classes</th>
<th>X1</th>
<th>SD</th>
<th>X2</th>
<th>SD</th>
<th>X3</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed mangrove*</td>
<td>87.67</td>
<td>2.96</td>
<td>22.53</td>
<td>0.72</td>
<td>37.87</td>
<td>0.62</td>
</tr>
<tr>
<td>Durian Aviscens (12)</td>
<td>87.67</td>
<td>2.97</td>
<td>24.30</td>
<td>0.50</td>
<td>38.97</td>
<td>0.67</td>
</tr>
<tr>
<td>Degraded Aviscens(2)</td>
<td>84.00</td>
<td>2.98</td>
<td>31.78</td>
<td>1.02</td>
<td>14.00</td>
<td>0.77</td>
</tr>
<tr>
<td>Mixed mangrove*</td>
<td>60.11</td>
<td>2.84</td>
<td>27.35</td>
<td>0.82</td>
<td>39.89</td>
<td>0.59</td>
</tr>
<tr>
<td>New Fishery (12)</td>
<td>14.66</td>
<td>1.19</td>
<td>35.08</td>
<td>0.28</td>
<td>47.00</td>
<td>0.53</td>
</tr>
<tr>
<td>Active Fishery (12)</td>
<td>35.67</td>
<td>2.81</td>
<td>30.50</td>
<td>0.56</td>
<td>49.17</td>
<td>0.53</td>
</tr>
<tr>
<td>Old Fishery (14)</td>
<td>0.64</td>
<td>2.99</td>
<td>25.25</td>
<td>1.57</td>
<td>34.93</td>
<td>2.05</td>
</tr>
<tr>
<td>Village (13)</td>
<td>42.64</td>
<td>1.04</td>
<td>43.42</td>
<td>1.60</td>
<td>45.74</td>
<td>1.76</td>
</tr>
<tr>
<td>Bare land (12)</td>
<td>45.98</td>
<td>1.76</td>
<td>58.50</td>
<td>2.40</td>
<td>65.58</td>
<td>2.63</td>
</tr>
<tr>
<td>Grass (17)</td>
<td>49.71</td>
<td>1.75</td>
<td>35.76</td>
<td>0.81</td>
<td>42.41</td>
<td>1.03</td>
</tr>
</tbody>
</table>

Note: * = number of pixel; SD = standard deviation.

Mangrove extent in five coastal villages in the study area for 1981, 1985 and 1988 is given in Table 2, while the mangrove disappearance in those periods is presented in Table 3.

TABLE 2. MANGROVE AREA OF SURABAYA

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Keputh</td>
<td>295</td>
<td>299</td>
<td>51</td>
</tr>
<tr>
<td>Wonorejo</td>
<td>263</td>
<td>246</td>
<td>70</td>
</tr>
<tr>
<td>Medokan Ayu</td>
<td>144</td>
<td>127</td>
<td>64</td>
</tr>
<tr>
<td>Gununganyar Tambak</td>
<td>109</td>
<td>78</td>
<td>92</td>
</tr>
<tr>
<td>Tambakano</td>
<td>309</td>
<td>223</td>
<td>51</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1120</td>
<td>943</td>
<td>260</td>
</tr>
</tbody>
</table>

The mangrove extent in 1983 was 15.8 percent smaller than those in 1981. Mangrove degradation was found especially in the new accretion land in the northern part of the study area. The existing mangrove were found in the southern part of Wonokromo river. In the period between 1981 and 1985, 171 Ha mangrove was cleared. They were in Keputh (26 Ha), Wonorejo (17 Ha), Medokan Ayu (17 Ha), Gununganyar Tambak (31 Ha), and in Tambakano (66 Ha). The rate of clearing is 44.2%.
### Table 3. Mangrove Disappearance in Surabaya (1981, 1985, 1988)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Kepith</td>
<td>26</td>
<td>8.6</td>
<td>6.5</td>
<td>216</td>
<td>81</td>
<td>244</td>
<td>62.7</td>
<td>34.8</td>
<td>31.6</td>
</tr>
<tr>
<td>Wonorejo</td>
<td>17</td>
<td>5.6</td>
<td>4.25</td>
<td>176</td>
<td>71.5</td>
<td>193</td>
<td>73.4</td>
<td>27.5</td>
<td>33.4</td>
</tr>
<tr>
<td>Medanay Ayu</td>
<td>17</td>
<td>5.6</td>
<td>4.25</td>
<td>83</td>
<td>65.4</td>
<td>100</td>
<td>69.4</td>
<td>14.3</td>
<td>27.5</td>
</tr>
<tr>
<td>Gg. Anuy Tambak</td>
<td>31</td>
<td>9.4</td>
<td>7.75</td>
<td>26</td>
<td>33.3</td>
<td>57</td>
<td>52.3</td>
<td>8.1</td>
<td>27.5</td>
</tr>
<tr>
<td>Tambakoso</td>
<td>86</td>
<td>27.8</td>
<td>21.5</td>
<td>172</td>
<td>77.1</td>
<td>258</td>
<td>83.5</td>
<td>36.8</td>
<td>31.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>177</strong></td>
<td><strong>15.8</strong></td>
<td><strong>44.25</strong></td>
<td><strong>675</strong></td>
<td><strong>71.5</strong></td>
<td><strong>234.7</strong></td>
<td><strong>482</strong></td>
<td><strong>76.1</strong></td>
<td><strong>121.5</strong></td>
</tr>
</tbody>
</table>

Note: * = Ha/year.

In 1988, the mangrove covered 268 Ha only. It means that 71.5 percent of mangrove have been deforested since 1985. The most intensive deforestation of mangrove in the study area went on between 1985 and 1988. There were 675 Ha of mangrove deforested for only three years. More than 50 percent of mangrove deforestation occurred in four villages, i.e.: Kepith (81 percent), Wonorejo (71.5 percent), Medanay Ayu (65.4 percent) and Tambakoso (77.1 percent). This phenomena can perhaps be related to the increase of fishery exploitation (especially shrimps) in that period.

In seven years (1981-1988), the total decrease of mangrove is 852 Ha (76.1 percent of those in 1981). The rate of deforestation is 121.5 Ha/year. In all of the five coastal villages, more than 50 percent of mangrove was cleared and changed into fishery fields. From the image analysis, one can identify that mangrove in the area, as a mangrove forest, lives poorly. In the accretion land, there is no more mangrove. Pure stand of mangrove in a good condition as used to be in 1981 can not be found. Only two relatively big communities of mangrove are found in Medanay Ayu and Gununganyar Tambak villages. They are mixed mangroves (Exocoetia agallocha, Avicennia, Rhizophora). The others are Avicennia along the coast and on the artificial dykes which separates fish or shrimps ponds.

The estimation of Surabaya mangrove in 1981 and in 1988 are presented in figure 6a and 6b. It was extracted from the overlay of aerial photograph, SPOT image and field check. The figure were traced from the sea to landward in figure 3 and 5.

In figure 6a, the area can be divided in more detail into two parts i.e.: the accretion zone in the front part with active mangrove and fishery zone and the remaining mangrove in the rear. On the accretion zone, Avicennia in pure stand (number 10), Avicennia trees with drainage canals in side (number 9) and seeding of mangrove (number 8) can be found. The pure stand of Avicennia is
estimated 25 trees/ha. This natural formation is pioneer mangrove in the
region. The drainage canal are artificial as a man made action that might be a
state of preparation for fishery. Seedlings of Avicenna dominated the
undergrowth of Avicenna mangrove. The accretion zone is extending to the sea
with the rate of 20 m/year. It is due to the sediments transported by Brantas
river. Avicenna spp and Sonneratia spp are pioneers mangrove trees as in
Segara Anakan, Central Java. In the study area, only the Avicenna sp. is found.

In the fishery zone, we could identify successively mixed mangrove (6),
fishery field (5), dyke of fishery (4), drainage system (2), rice field (3), and
village (1). The mixed mangrove consists of Rhizophora apiculata and
Exocarica agallocha (dominant). Inside of the fishery field, we have no tree
anymore. According to the regulation of "tambak-forest", mangrove trees must
be left in the centre of fishery field, and the surface of fishery field, surrounding
the mangrove trees may not exceed 10 percent of the exploited land. On the
dike, it is usually found Avicenna sp. as remaining mangrove. Behind the
fishery field there are drainage system, rice field, and village that the influenced
by inland climate. Sap-caprice formation is situated between the mangrove
formation and the village. Associated with the village, one find coconut, acacia,
jackfruit, hibiscus tiliaceus, and pohon teka around the house. The drainage
system is used for precipitation and waste water sewage, and for traditional
transportation by canoes and small boats.

The mangrove zonation in 1958 in general was much smaller than in
1981, especially in the accretation zone. Pure Avicenna stand existing in 1981
was largely cleared and the resulted bare land was developed for fishery. We
could identify some new canals of drainage system in this zone. Avicenna was
situated only along the coast for about 30 m width. Similarly, some trees in the
mixed mangrove zone have been cleared. Rhizophora sp and Exocarica
agallocha might only be found sparsely in many parts as remaining mangrove.
Almost the whole area has been transferred into fishery field. Some degraded
stands of mangrove were only found around the cost and in Medokanau and
Gununganyar villages.

Some parts of old shrimp fish field abandoned. This parts transferred
into bare land which might be allocated for residential area e.g. BTN (Bank
Tabungan Negara). This phenomenon occurs especially near the residential
area of Medokanau Aya village which has been drained. We can find many
porets (preparation for settlements) on the old shrimp and fish fields. It is
understandable because Surabaya city with 2 percent annual population
increase needs more land and space for agglomeration of the city. In the city
itself, space is not enough for residential area because the density of population
is very high (7878 person/ha,km, in 1987).

DISCUSSION

In the Master Plan of Surabaya City for the twenty first century (Number
23/1978), Surabaya mangrove was determined as a "conservation forest". The
region consists of Medokan Aya, Gununganyar Tambak and Wonorejo villages
which are naturally bordered by Wonokromo river in the north and Rungkut
river in the south.

In this study, before 1981 the decrease of mangrove could not be traced
because of the lack of data. If mangrove deforestation did occur, it might be
due to the boom of shrimp fishery exploitation introduced since PELITA (Five
Years Development of Indonesia Government) started in 1959. At the time,
shrimp export was encouraged so that people were stimulated to open new
fishery along the northern coast of Java, e.g.: Tanjung Krawang, Indramayu,
Kendal, Gresik, Sidorejo, Banyuwangi, and also Surabaya. The new fisheries
were usually established in mangrove land. Between 1981 and 1985, the
mangrove deforestation in Surabaya continued, even on the accretion lands in
the mouth of Buntung and Wonokromo rivers. Mangrove forest of 177 hectares
(Table 2) have been cleared in that period. It means the rate of deforestation
was 44.25 hectares/year. Until 1988, mangrove forest in the region kept on
decreasing. The existing mangrove is only 26 Ha, with the mean rate of
decrease of 121.5 Halyear. Suppose the deforestation goes on with the same
speed, we can predict that in the next five years the mangrove will completely
disappear, unless there is real effort to stop them. In order to analysis the case,
two questions can be raised; first, are there any physical causes for the mangrove
deforestation; and second, why did people cleared the mangrove until 30 m from
the coast line?

From the ecological point of view, the existing mangrove in one area
must be supported by specific condition of safety, tide, temperature, regular
discharge, and protected coast. A good mangrove formation can be found in an
area where the salinity varies between 0.5 per cent - 2.5 per cent. For the salinity
between 2.5 per cent - 4 percent, the mangrove starts decreasing, for 4 percent
- 9 per cent the mangrove decrease and for more than 9 per cent there is no
mangrove anymore (Blasco, 1984). Certain species of mangrove, e.g. Avicenna
marina can resist to the salinity around 9 percent (Mason, 1968). Mangrove
can be developed well in regions with a mean temperature of around 27°C.
Protected coast against storm and wave action is preferable for developing
mangrove (Champagnon, 1976). Watson (1928) classified mangrove in detail
based on the period of inundation. The classification is as follows: inundated
by high tide56-62 times a month (Rhizophora mucronata, on the stream bank);
by medium high tide 45-56 times a month (Avicennia, Sonneratia, Rhizophora
mucronata); by normal high tide 20-45 times a month (Rhizophora mucronata,
Rhizophora conjuga, Ceriops candollei, Carapa obovata); by spring tide 2-20
mangrove zonation in Surabaya is given as follows: first 30 m - 50 m for Avicennia sp., followed by Rhizophora for 50 m - 80 m, and finally by the mixed mangrove for the rest of the land. Along the fishery dyke, Avicennia and Rhizophora can be planted for stabilizing it.

The northern side of Wonsokromo river (the coast of Keputih village) is also suitable for mangrove development, especially on the cap, northern part of the Wonsokromo estuary (see figure 3 and figure 5). Farther from the area, the salinity is higher (around 4.5 percent) and soil texture is coarser than in the cape and its vicinity.

The mangrove zonation in the second proposal is smaller than that in the first one. Looking at the actual condition of Surabaya's mangrove, it is more reliable, because the land up to 150 m away from the coastline might be owned by government. New land produced by natural process is owned by the government (Sandy, 1987). In practice, ownership status of the new land will not be clear if there is no strict control and inventory in the terrain. We need to be worry to individual proprietor of the new land. Keeping in one coordination, the reforestation is easier to be realized. On the contrary, for developing an ideal mangrove forest as a conservation forest, the first proposal is better. But, it is more difficult in clearing the land that is now occupied by some private fisheries.

By and large, for answering the questions above, it seems that there is no problem on salinity, temperature, deposited material, and coastal physiographic condition factors for mangrove’s deforestation in Surabaya. One thing should be taken into consideration in this respect; it is that influences the width of the submerged area. The fact that there were some fishery fields abandoned and changed into other types of land use, is an indication that the highest tide did not reach the area anymore. Hence, people were stimulated to open new fishery field in the submerged region which is used to be occupied by mangrove. It can be the reason why Surabaya mangrove disappears recently. As stated by Bianco (1982); in the humid regions of the Third World, the primary responsibility of mangrove decline lies with deforestation and aquaculture. The other causes are probably socio-economic condition and rapid population increase in Surabaya (Java, in general). In this case, the government role is very important, especially to improve the society awareness on the environmental conservation. Without cooperation between the government and the people, the effort in mangrove reforestation seems likely to fail.

CONCLUSION

In conclusion, it can be said that the disappearance of mangrove in Surabaya can be monitored by color aerial photograph MSS Landsat and SPOT data, with an accuracy of image classification about 90 percent. In this study, it is
obvious that SPOT data can be used for identifying mangrove and land use objects as nearly similar as those obtained by medium scale aerial photographs.

The rate of mangrove disappearance in the area is 121.5 hectares/year. The mangrove will totally disappear in five years, if the deforestation goes on just as what happens now. For realizing a mangrove reforestation in Sundayas, two proposals of mangrove zonation are given with some trade-off between both. Considering the actual mangrove condition of the area, the second proposal, i.e.: 150 m of mangrove landward from the coastline, is more suitable than the first one.

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REFERENCE


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POPULATION AND ENVIRONMENT IN INDONESIA

by Ida Bagus Manta

ABSTRACT

The present environmental situation is not compatible with our expectations. Pollution, erosion, floods and droughts have hit many parts of the world, and these disasters give us reflections on how serious are the environmental problems that beset this planet of ours. In meeting its needs, mankind has exploited the environment to the utmost without caring about environmental conservation. Moreover, with the population explosion after the 1950s and the dependency of life upon the natural processes, the cultivated land to be inherited by future generations has gradually become increasingly barren and fertile.

Esters are absolutely necessary to check increasing population growth rate, to raise the standard of living for all people and to arouse and awareness of sustainable development policies so that a compatibility between development activities and environment can be achieved.

INTRODUCTION

Since the 1970s many countries in the world, particularly the industrialised nations, have been confronted with environmental problems. News about pollution, erosion, floods and droughts can always be found in the newspaper, on the radios and television, reflecting how serious are the environmental problems that beset nations. So grave is the problem that the United Nations held a special conference on environment (the 1st World Environment Conference in Stockholm) on June 5, 1972, the day which later was established as the Environment Day (Salim, 1979).

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