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REVIEW ON A NATIONAL MANGROVE MAPPING : Case Study on the Indonesia Mangrove Mapping by BAKOSURTANAL

(Review Pemetaan Mangrove Nasional: Studi Kasus pada Pemetaan Mangrove Indonesia oleh BAKOSURTANAL)

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ABSTRACT

Indonesia is the largest archipelagic country in the world with coastline span about 95,181 km. With such long coastline, coastal resources continuously support to the live of most Indonesian people. Mangroves are among the important coastal resources in terms of its economical and ecological functions. The mangroves have been severely deteriorated mostly due to the increasing exploitation as a result from the growing number of the population. Moreover, mangroves considered as a fragile ecosystem since it only grows in a unique area, which is in the tidal plain area. These problems have been discussed widely particularly to address how to preserve the functions of the mangroves. Planners and decision makers that concern on coastal resources and developments want to evaluate their changes overtime. Therefore, current data of the status of the mangroves nationally is highly demanded. This paper describes and evaluates the experience of the Center for Marine Resources Survey, Bakosurtanal in mapping mangroves Indonesia in 2009. Remote sensing approach had been used on the mangroves mapping. Remote sensing technique was considered as the most useful approach particularly due to the area that should be covered was very large. Besides that, mangroves can be easily recognized and delineated from most of satellite imageries.However, there are also some limitations on the application of remote sensing technology for mangroves mapping.

***Keywords**: Mangrove, Remote Sensing, Mapping, Indonesia*

Indonesia adalah Negara kepulauan terbesar di dunia, dengan panjang garis pantai mencapai lebih dari 95.181 km. Dengan garis pantai sepanjang itu, sumberdaya pesisir secara terus menerus menyokong kehidupan sebagian besar penduduk Indonesia. Mangrove merupakan salah satu sumberdaya pesisir yang penting baik dinilai secara ekonomi maupun secara ekologi. Sebagian dari mangrove tersebut mengalami kerusakan karena eksploitasi yang berlebihan seiring dengan pertambahan jumlah penduduk. Disamping itu, mangrove juga merupakan ekosistem yang rapuh karena mangrove hanya bisa tumbuh di lingkungan yang khusus, yaitu sepanjang area pasang surut saja. Permasalahan ini telah banyak dibahas, khususnya untuk mencari solusi guna melindunginya. Para perencana dan pengambil keputusan selalu ingin mengevaluasi perubahannya dari waktu ke waktu. Dengan demikian, data mengenai keberadaan

mangrove terkini selalu diharapkan ketersediaannya. Tulisan ini memaparkan dan mengulas tentang pemetaan mangrove Indonesia yang dilakukan oleh Pusat Survei Sumber Daya Alam Laut, Bakosurtanal pada tahun 2009. Teknik penginderaan jauh telah digunakan sebagai pendekatan dalam pemetaan mangrove tersebut. Pendekatan ini dianggap sebagai alat yang sangat berguna karena mangrove dapat dengan mudah dikenali dan didelineasi dari citra satelit penginderaan jauh. Namun demikian, dalam aplikasi teknologi penginderaan jauh untuk pemetaan mangrove ini juga terdapat keterbatasan atau kekurangan.

***Kata kunci**: Mangrove, Penginderaan Jauh, Pemetaan, Indonesia*

INTRODUCTION

Mangroves can be found along the most coastal area in Indonesia. Indonesian environment is a suitable location for mangroves' growth which in a tropical-equatorial area with constant tropical temperature, high rainfall (more than 1,500 mm annually) and salinities ranges from 29-33%o in the inshore waters.Those are important factors to support mangroves development in the coastal areas (Saputro, *et al*, 2009).

Mangroves ecosystem has important functions in terms of ecological and economical functions, beside issues and controversy in managing these resources. As subsistence resources, mangrove forests have important role for social-cultural interaction in the local society for a long time in Indonesia. Therefore, concern about this type of ecosystemsis high particularly because of the decreasing trend in mangroves forests around the world.

As natural resources, mangroves forests continuously give benefits for the people in Indonesia. Mangroves have been exploited both commercially and traditionally. It is well known that the increasing demand for timber products and conversion to fish/shrimp ponds have led to degradation of the forest in many areas of the country. Those exploitations actually have been deteriorating the environment such as coastal abrasions and declining fish productions. Therefore, understanding on the ecological functions of the mangroves should be promoted for preserving the mangroves forests.

Along with the growing interest in preserving mangroves forests, people starting to ask about the state of the mangroves in Indonesia. Several institutions such as the Ministry of Forestry (MOF), Ministry of Fisheries and Marine Affair (MFMA) and Ministry of Environment (MOE) have provided maps for mangroves. Unfortunately, those institutions have different mangroves data particularly in terms of the state of the area of the mangroves (see Saputro *et al*, 2009). This could happen probably because those institutions used different mapping methods and the mappings were dedicated for particular purposes (Hartini, *et al*, 2010).

The recent mangroves mapping done by Bakosurtanal aims to provide existing mangroves stand in Indonesia. Bakosurtanal is the Coordinating Agency for Surveys and Mapping in Indonesia. Remote sensing technology has been used as the mapping approach by Bakosurtanal. Landsat satellite image has been used as a main source for delineating the mangroves stand throughout the Indonesia. This paper aims to evaluate the mangroves mapping process.

THE NATIONAL MANGROVES MAPPING METHOD

Summarize the mangroves mapping approach conducted by Bakosurtanal, the mangroves mapping Indonesia used Landsat satellite images as the main source for delineating the existing mangroves stand in Indonesia. **Figure 1** shows the mangroves stand on Landsat

imageries. Some 190 scenes Landsat satellite imageries acquired along the year 2006 – 2009, were used in this mapping. The existing mangroves cover was delineated visually from the Landsat image using on screen digitization. The image interpretation of mangroves cover was conducted using 3 approaches i.e. photo-guided approach, photo-key approach and landscape-ecological approach.

The mangroves identification and interpretation on Landsat imageries were also assisted by using the available mangroves maps and/or high spatial resolution images i.e Quickbird satellite images where the mangroves feature appear in more detailed (**Figure 2**).

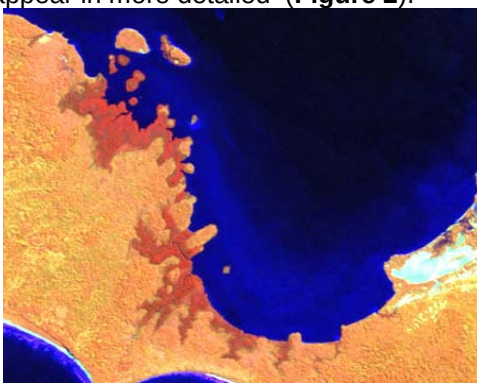

Figure 1. Mangroves on Landsat TM image with combination band of 452 (RGB) appear in reddish color (USGS, 2009).

Figure 2. Mangroves cover on Quickbird satellite image, (Google Earth, 2009).

THE NATIONAL MANGROVE MAPPING RESULT

Result of the mangroves mapping conducted by Bakosurtanal was presented in three different formats i.e. a seamless digital format, sheet-wise format at the scale of 1:1.000.000 and in provincial-base boundaries. Since the mapping were carried out digitally, generalization in terms of reducing the detailed of the result of the mangroves delineations were not performed, so that all the existing mangroves that can be delineated from the imageries were completely counted. The mapping shows that the area of existing mangroves Indonesia was 3,244,018.46 hectares, whereas the mangroves map produced by the Ministry of Forestry (MOF) in 2007 shows that the area of mangroves was 7,758,410.595 hectares. The main reason for the significant differences in the result of the two mapping was because the MOF mapping considered the area of the mangroves based on its forest status whereas the Bakosurtanal's mapping only considered the existing stands of the mangroves Hartini *et al*, 2010 discussed the result of the mapping.

REVIEW ON THE NATIONAL MANGROVES MAPPING

Accuracy is the main issues in this mapping. The mapping method that was mainly based on visual interpretation of Landsat satellite images is considered not sufficient, even though the operators were well-trained, and sufficient knowledge with background in geography of the object identified i.e mangrove vegetation. To enhance the accuracy of the map, the method should be improved, for example by combining supervised and unsupervised classification.

Procedure of the mapping by using hybrid approach should be explored and formulated. There are limitations in digital classification that merely rely on the

spectral number of the pixel. By nature, the digital number of the pixel is actually depicted by several ground objects within the size of the pixel, that not always homogenous. This problem can be fixed by using satellite image with higher spatial and spatial resolution. Hyperspectral imageries have been used for mangroves mapping (Vaiphasa, 2005). In terms of spatial resolution, satellite image with very high resolution such as Quickbird (0.6 centimeter) and IKONOS (1 meter) also used for mangroves mapping (Wang, 2004).

The image classification can also be improved by adding spatial information related to the mangroves habitat. As already mentioned above, the digital classification is only relied on the pixel number. Here, any objects with same digital number are considered the same object even though the fact is not always the same. This means that mangroves vegetation may have similar pixel with non mangrove vegetation. The reason is that the pixel is not pure and even there are many objects that have similar spectral signature–the digital number of mangroves. By adding spatial context information, the non mangroves pixel can be excluded from the mangroves. As an example, a tidal range map can be used to exclude the non mangrove vegetation from the mangroves class, since mangroves is only grows within the tidal range area. Therefore, all vegetation with similar pixel number with mangroves that located outside the tidal range area can be assured as non mangroves. When this approach performed, GIS is a useful tool for conducting such operation.

Problem due to cloud cover was highlighted in the original report by Saputro *et al*, 2009 and discussed further by Hartini *et al*, 2010. Here we suggest for exploring the combination used with remotely sensed imageries recorded with active sensor. Even though the mangroves class would not be able to be distinguished clearly, however the area of the mangroves stand will still be able to be identified and delineated. Therefore, there would reduce the missing of the existing mangroves counting. Moreover, inaccuracy of the delineation was also the result of image striping of the Landsat images used. Performing de-striping process would be attempted, however the result might significantly increase the accuracy of the delineation and/or interprettation. For this respect, we suggest to use other satellite images.

Some comments also addressed to the classification of the mangroves. The map is considered too general since the map basically only presents the mangroves' stand with no more detail such as the condition of the mangroves or the types of the mangroves. Without providing detail information, this map would not be useful particularly for institutions who responsible for rehabilitation or monitoring the dynamic of biodiversity of the mangroves. The author considered that fulfilling the detailed information on the condition and the type of the mangroves required changing the method of the mapping. Visual interpretation of a coarse spatial resolution of satellite image like satellite data is not sufficient to obtain detailed information of the mangroves.

Condition of the mangroves that usually classified as good, fair, or damage, cannot be derived from Landsat data. Moreover, the definition about the classification of the mangroves' condition is still in debate when the condition is only defined based on the number of tree per hectare as stated on Minister of Environment Decree No. 2001 Year 2004 about standard criteria and guideline for determining mangroves damages. A better definition is required to define the classification of mangroves' conditions. We consider that the definition is too simple and may not sufficient to picture the real condition of the mangroves. Therefore, a comprehensive measurable factors need to be explored.

Considering the used of remotely sensed data for mapping mangroves' condition, image with finer spatial

resolution is required particularly when the condition is defined based on the number of mangroves trees. Individual mangroves trees can be identified only on imageries with a very high spatial resolution such as Quickbird. Besides that, a field work is also required because mangrove condition should be reflecting the summary of the actual quality of the mangroves that need a clear and thorough description.

CONCLUSION

Despite some weaknesses of the mapping processes of the mangroves mapping, this effort deserved to be acknowledged particularly in providing baseine for existing mangroves Indonesia. However, thorough improvement on the mapping methods must be carried out to achieve accurate and standard mangroves map suitable for respective institutions and stakeholder of mangroves Indonesia.

Better methods on image processing and interpretation must be explored so that a high accuracy of the mangroves mapping could be achieved. Besides that, the used of other type of remotely sensed imageries could be explored and field work to check the accuracy of the mapping must be performed to give confidence when using the mangroves map in general.

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