USE OF SATELLITE REMOTE SENSING DATA IN SHORELINE ANALYSIS

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1.0 INTRODUCTION

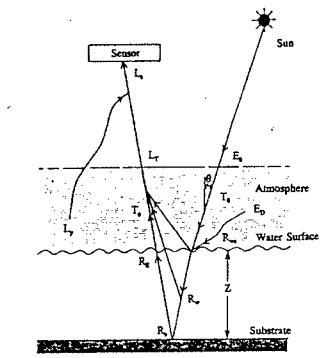
Passive sensors such as SPOT HRV which measure reflected radiation from visible ranges of the solar spectrum particularly carry useful water depth information. Light energy entering a water column is subjected to absorption and scattering from the water body and the substrate as shown in fig.1. In this study the attenuation coefficient of Miyazaki Port area to SPOT HRV data is estimated and used in a model to estimate water depth at Nobeoka Osee River mouth area. These results are then compared with water depths derived from level slice method. The applicability of the estimated water depths in shoreline change model analysis is discussed.

2.0 Water Depth Estimation

The attenuation of light energy may be described by equation (1).

$$T_r=e^{-\alpha z} \quad \text{.....(1)}$$

Here T_r is the fraction of the radiant flux, and α is the volume attenuation constant assuming a homogeneous medium (Jerlov,1976).



R_w:Solar illumination; E_D:diffuse sky irradiance R_{ws}:water surface reflectance; R_b:substrate reflectance: R_E:effective reflectance of water body; R_{ws}:water column molecules reflectance

Fig.1 Radiance amount reaching a sensor.

To allow for substrate reflectance effects a generalized version (Jupp,1988) of equation (1) was adopted.L_E:Radiance emerging from water

$$L_E=e^{-2kz}L_b+(1-e^{-2kz})L_W \quad \text{.....(2)}$$

mass L_b:radiance of wet substrate material for no water cover, L_w:radiance of deep water and k is the effective attenuation coefficient for the water body. Since reflectance is proportional to radiance equation (2) can be normalized to reflectance (Bierwirth et al,1993).

$$R_E=e^{-2kz}R_{bi}+(1-e^{-2kz})R_w \quad \text{.....(3)}$$

Symbols are as defined below fig.1. After the necessary corrections for instrument gain and deep water effect, equation (3) becomes;

$$R_{Ei}-R_{wi}=R_i=R_{bi}e^{-2kz} \quad \text{.....(4)}$$

i=1,N where N is the number of bands. In this analysis bands 1 and 2 of SPOT HRV were used. R_i can be estimated from the digital value(C) by the relation $CG/I=R_i$, where G is the instrument gain and I is the average solar irradiance. Hence equation (4) becomes

$$lnC=A-2kiz \quad \text{.....(5)}$$

where $A=lnR_{bi}-lnG+lnI$

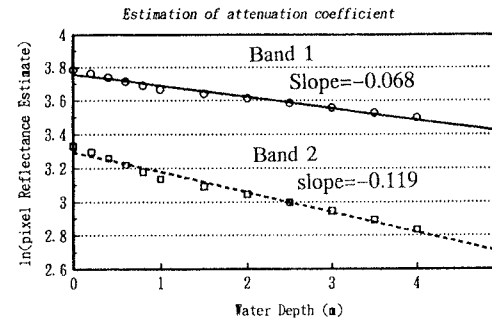


Fig.2 Water attenuation coefficient estimation

From equation (5) the slope of a plot of $\log_e$ pixel reflectance versus water depth as shown in fig.2 gives an estimate for the attenuation coefficients to the bands.

Now summing equation (4) over N bands gives;

$$z=\sum_{i=1}^{W}\frac{lnR_i}{(-2kiN)}-\sum_{i=1}^{W}\frac{lnR_{bi}}{(-2kiN)}$$

Assuming hundred percent reflectance (R_{bi}=1)(Bierwirth) then the above equation becomes ;

$$z=\sum_{i=1}^{W}\frac{lnR_i}{-(2kiN)} \quad \text{.....(6)}$$

Fig.3 shows a plot of water depth estimated from equation (6) and from level slice method versus digital values.

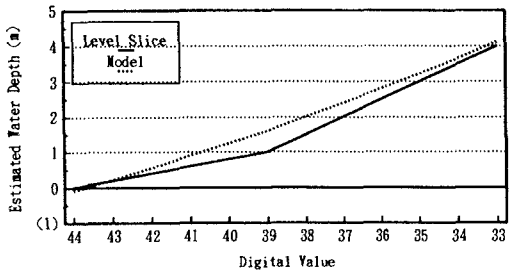


Fig.3 Estimated water depth and digital value

As shown in fig.4, the linear correlation coefficient(0.98) shows a very good linear agreement between the two estimates.

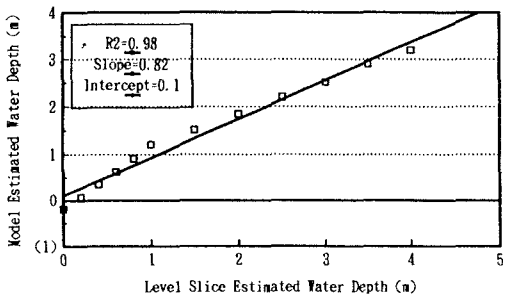


Fig.4. Model estimated water depth versus estimate from level slice method.

3.0 Shoreline Monitoring

Remote sensing data used in conjunction with topographic maps, a section of the shoreline was taken for the study. Fig.5 compares the results of the shoreline positions of the selected study area captured between 1988 and 1990 by SPOT HRV and aerial photography. The linear correlation coefficient shows a very good correlation between these results. The intercept indicates the average error caused by the slight difference in observation dates.

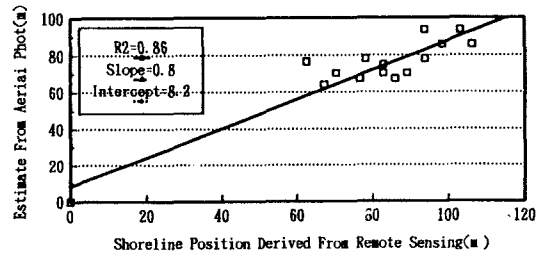


Fig.5 Shoreline position estimated from R/S and Aerial Photograph

4.0 Simulation of Shoreline Change

Water depth data in the surf zone (4m depth limit) was estimated from R/S data and beyond this zone 1979 bathmetric data (fig.6) were used in the shoreline change model to predict shoreline variation.

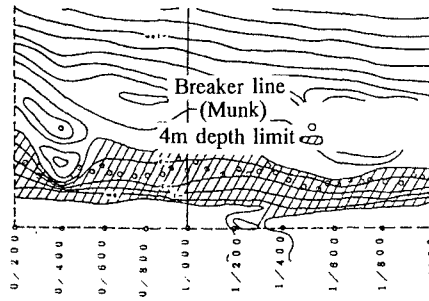


Fig.6 Osee River Mouth Bathymetry

5.0 Conclusion

1. R/S data can be used to monitor shoreline change
2. R/S data may provide useful surf zone depth data for shoreline change model.
3. Water depth up to the 4m depth limit can be reasonably extracted from SPOT HRV data.

6.0 Acknoledgement

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7.0 Reference

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