Abstract for IGARSS 2010, O1: Ocean Biology (Color) and Water Quality

THE POSSIBILITY ON ESTIMATION OF CONCENTRATION OF HEAVY METAL IN COASTAL WATERS FROM REMOTE SENSING DATA*

Chuqun CHEN, Fenfen LIU
(LED, South China Sea Institute of Oceanography, Chinese Academy of Sciences, Guangzhou, 510300, cqchen@scsio.ac.cn)

With the increase of population and industrial production, a great deal of industrial and household wastes with heavy metals are discharged directly to the ocean or via rivers. The heavy metals cannot be decomposed but can be transferred and accumulated with food chains [1,2]. Many heavy metals are toxic to human beings. It is very important to measure the heavy metal concentration in coastal waters for water quality investigation and environmental management. The remote sensing technology has been successfully applied for estimation of many parameters of water quality, such as the suspended sediments [3], chlorophyll_a, [4-6], CDOM (colored dissolved organic matter) [7-8], eutrophication [9-10], salinity[11], and water quality grades [12]. The remote sensing technology has many advantages over the conventional investigation of water quality for its high spatial and temporal resolution, low cost, big coverage of data and synchronization. With its development, the remote sensing technique is expected to retrieve more parameters of water quality.

According to the geochemistry behaviors of heavy metals in coastal waters, the heavy metals in water will exist in three forms [13-14]: a) the particle form, which is absorbed by suspended particles, b) the dissolved form, which is chelated by dissolved organic matters; and c) the biological form, which is utilized by phytoplanktons. It means that the distribution of heavy metal concentration in waters is controlled by the three kinds of water components, i.e. the suspended sediments, phytoplankton and dissolved organic matters. On the other hand, the optical property of waters is also determined by the three kinds of water components. In order to verify the possiblity of remotely-sensed estimation of heavy metal concentration, three cruises were conducted for in-situ data collection in the Pearl River estuary in Augest, October and November, 2009, respectively. An above-water method was used for the measurement of remote sensing reflectance (Rrs). The water-leaving radiance, the radiance reflected by a reference panel with 25% reflectance and the sky radiance were measured in turn for 3 times using the Ocean Optics USB4000 spectrometer (wavelength range from 346 to 1037 nm with a spectral resolution of 0.22 nm) at 48 sampling points, where the water samples were synchronously collected for lab analysis of concentration for three heavy metals (Cu,

Pb and Zn) and other water components (suspended sediments, chlorophyll-a and CDOM). The in-situ measured remote sensing reflectance data were calculated by integrating the spectral resolution to 10 nm. The relationships between the concentration of the three heavy metals (Cu, Pb and Zn) and the remote sensing reflectance were analysed. The results showed that all the three heavy metals have good correlative relation with the remote sensing reflectance data. The Zinc has the highest correlative relation (R^2=0.73) and the copper has lowest correlative relation (R^2=0.45). It showed that there is a possibility to retrieve the concentration of heavy metals in coastal waters from remote sensing data. Seven more cruises will be conducted in 2010 for in-situ data collection with the support of two undergoing projects and an algorithm for estimation of heavy metal (e.g. Zinc) concentration in the coastal water of Pearl River estuary is expected to be developed with more in-situ data (totally 160 samples).

Keywords: Ocean color, Remote sensing, Heavy metal (Cu, Pb, Zn), Water quality.

*This research is supported by China National 863 Programme (2009AA12Z135) and National Natural Science Foundation of China (40976106).

Main Reference

[1]. Bryan GW and Langston WJ. (1992). Bioavailability, accumulation and effects of heavy metals in sediments with special reference to United Kingdom estuaries. A review. Environ Pollut 76:89-131.

[2]. Chapman PM and Wang F. (2000). Issues in ecological risk assessment of inorganic metals and metalloids. Human Ecol Risk Assess 6:965-88.

[3.] LI X. (1993). A united model for quantitative remote sensing of suspended sediment concentration. International Journal of Remote Sensing, 14(14): 2665-2675.

[4].Gordon H. R., Clark, D.K., Brown, J.W., Brown, O.B., Evans, R.H. and Broenkow, W.W., (1983). Phytoplankton pigment concentrations in the Middle Atlantic Bight: comparison of ship determinations and CZCS estimates. Applied Optics, 22: 20-36.

[5]. Chen C. Q., Shi P., Larson M., Jonsson L., (2002). Estimation of chlorophyll_a concentration in the Zhujiang Estuary from SeaWiFS data. Acta Oceanologica Sinica, 21(1):55-65.

[6]. Gitelson A., (1992). The peak near 700 nm on reflectance spectra of algae and water: relationships of its magnitude and position with chlorophyll concentration. International Journal of Remote Sensing, 13 (17): 3367-3373.

[7].Doerffer R. and Schiller H., (1997). Pigment index, sediment and gelbstoff retrieval from directional water leaving radiance reflectances using inverse modelling technique, Algorithm Theoretical Basis Document ATBD 2.12.

[8].Chen C. Q. and Shi P., (2003). A local algorithm for retrieval of yellow substance (gelbstoff) in coastal waters from SeaWiFS data: Pearl River estuary, China. International Journal of Remote Sensing, 24(5): 1171-1176,

[9]. Chen C.Q. and Li X.B. (2006). Application of ocean colour remote sensing data for retrieval of Nutrients concentration in Pearl River Estuary. Key research findings to harmful algal blooms in the South China Sea (edited by Kin-Chung Ho et al). pp.33-38.

[10].Zhang X.Y.; Lin Y.A.; He X.Q. et al. (2007). Remote sensing of sea surface nutrient in the frontal zone of Changjiang diluted water and the Taiwan Warm Current. Acta Oceanologica Sinica, 26(3):22-32.

[11].BINDING C. E.; BOWERS D. G. (2003). Measuring the salinity of the Clyde Sea from remotely sensed ocean colour. Estuarine, Coastal and Shelf Science. 57(4): 605-611.

[12]. Chen C.Q., Tang S.L., Pan Z.L.et al. (2007). Remotely-sensed assessment of water quality levels in the Pearl River Estuary, China. Marine pollution bulletin. 54(8): 1267-1272.

[13]. Zheng J.L.; Wang Z.D. Lin Z.Q. et al. (1982a). A study of estuarine chemistry in the Zhujiang River I. Trace metal species in water phase. Oceanologia et Limnologia Sinica. 13(1): 19-25

[14]. Zheng J.L.; Wang Z.D. Lin Z.Q. et al. (1982b). A study of estuarine chemistry in the Zhujiang River II. Chemical forms of heavy metals in the suspended particulate. Oceanologia et Limnologia Sinica. 13(6): 523-530