Analysis of Medium to Long Term Variation of Water Quality in the Seto Inland Sea

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ABSTRACT

The Seto Inland Sea is the largest enclosed coastal sea in Japan. This sea is greatly influenced by incoming rivers and nutrient concentration sometimes makes the area susceptible to unusual events, such as red tide. In this paper, to clarify the contributing factors for the variation of water quality in the Seto Inland Sea, EOF (Empirical Orthogonal Function) analysis was applied to the monitoring data of COD (Chemical Oxygen Demand), TN (Total Nitrogen) and TP (Total Phosphorous), which obtained form 1982 to 2001. Main results are as follows: 1) The first principal component which is obtained by EOF analysis reflect the effect of load form incoming rivers. 2) The second principal component may have some connection to the variation in main channel area (Bisan-seto area). 3) The variation of water quality in the Seto Inland Sea can be described by using top three principal components.

KEY WORDS: Seto Inland Sea, water quality, Empirical Orthogonal Function analysis

INTRODUCTION

During the period of high economic growth after World War II, the Seto Inland Sea, were heavily eutrophicated because large quantities of industrial effluent, as such as domestic sewage, were released into the sea (International EMECS Center, 2007). The former environment agency (the current environment ministry) enacted “Law Concerning Special Measures for Conservation of the Environment of the Seto Inland Sea” in 1973, which aimed to improve water quality, and has continued to effort to improve water quality such as COD (Chemical Oxygen Demand), TN(Total Nitrogen), TP(Total Phosphorus) since the law was enacted. The effort of government services, the total amount of COD, TN, TP loaded into the Seto Inland Sea has continued to decrease (Sasakura et. al., 2004). Meanwhile, current study indicates that the inflow load from the Pacific Ocean may exist in addition to land origin load (Fujwara et al. 2006). To get a clear grasp of the effects of measure for land origin load reduction or influence on the open sea, it is important to look at the water quality variation from a long-term perspective. In this study, we use a statistical method to estimate the characteristic of the water quality variation in each water area such as a bay or nada in the Seto Inland Sea. Moreover, using eigenfunction for time and space, we tried to examine the reproducibility of the water quality variation in the Seto Inland Sea.

MATERIALS & METHODS

Water quality Data

The ministry of Land, Infrastructure, Transport and Tourism has conducted integrated investigation in conjunction with their regional bureaus and the local governments since 1982. This investigation is part of marine environmental improvement project all over the Seto Inland Sea and it has an important part to play in collecting the basic data for their conservation program.

In this investigation, the measurement of water quality and sediment one is carried out quarterly and semiyearly, respectively. In the water quality measurement, spot measurement of water condition (salinity, pH, dissolved oxygen (DO), transparency, color phase etc) and sampling water (for water quality analysis in the laboratory; SS (suspended solids), COD and so on) are examined both at the surface layer (at 2 m below water surface) and bottom layer (2m meters above the seabed).

The investigation spots are be placed 8 km apart due to grasp the characteristic of water variation in each water area (Figure 1). It started with 142 investigation spots (Kii channel 28; Osaka bay 21; Harima nada 37; Bisan-seto 13; Hiuchi nada 21; Hiroshima bay 14; Aki nada 5; Iyo nada 3), however, the number of them has been increased and it reaches 229 in 2005. In this study, the data of COD (Chemical Oxygen Demand), TN (Total Nitrogen) and TP (Total Phosphorus), which obtained form 1982 to 2001, were used.

EOF (Empirical Orthogonal Function) analysis

The brief of the Empirical Orthogonal Function analysis is as follows. In the case of COD, we express the value of COD concentration at x water area in t year as $\text{COD}(x,t)$.

The variation of the period average value of COD concentration at x water area $\overline{\text{COD}}(x)$ is written as follows.