Review of Coastal Management Policy and Future in Japan

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Japan experienced serious water pollution during the period of rapid economic growth in the 1960s. In addition, the concentration of population and industry caused large quantities of chemical substances, organic matter, nutrients and so on to flow into the ocean from land areas. This had an adverse impact on the living environment and the fishing industry in the form of health hazards and the occurrence of red tide. Various efforts have been promoted to improve the situation, such as the imposition of legal restrictions through relevant legislation, the construction of sewer systems and the installation of factory wastewater treatment facilities.

One of these efforts is the Total Pollutant Load Control System (TPLCS), put in place to ensure water quality based on the Water Pollution Control Law and the Law Concerning Special Measures for Conservation of the Environment of the Seto Inland Sea. The purpose of this system is to reduce the total pollutant load of chemical oxygen demand (COD), total nitrogen and total phosphorus flowing into the ocean in Tokyo Bay, Ise Bay and the Seto Inland Sea. Efforts have been conducted over a period of 40 years to reduce the total pollutant load and so on in the Seto Inland Sea, the largest enclosed coastal sea in Japan. The benefits from these efforts include the fact that water quality environmental standards for total nitrogen and total phosphorus have been met in almost all water regions in the Seto Inland Sea.

The first half of my presentation will discuss the mechanism of the TPLCS that has been implemented in Japan up to now, as well as the results of these efforts.

Although water quality has improved in some ocean regions, there are others in which red tide and oxygen-deficient water masses still occur frequently. Moreover, it is said that in recent years the reduction of nutrient load has inhibited the production of low-order marine organisms. This has altered the balance of the ecosystem, with the result that nutrients do not circulate to high-order organisms, leading to a reduction in marine resources in some regions.

In order to resolve such problems, it would be effective to clearly identify efficient and effective control policies for each ocean region to ensure the smooth circulation of nutrients in an integrated manner between land areas and sea areas. To this end, beginning in 2010, the Ministry of the Environment (MOE) spent approximately three years studying and formulating an "Action Plan for Healthy Material Circulation in the Ocean" in a model ocean region. In the aftermath of the Great East Japan Earthquake of March 2011, the MOE has also supported environmental regeneration efforts that use "Sato-umi" creation techniques and expertise in areas that were greatly affected by changes in coastal and seafloor topography, water quality, bottom sediment and so on, and the loss of Zostera beds and other habitat environments and the like, in order to aid in the reconstruction of these areas.

The second half of my presentation will discuss the preparation of the Healthy Ocean Plan and efforts relating to “Sato-umi.”

In 2012, a report was issued by the Central Environment Council regarding the “Desirable Future Vision of the Seto Inland Sea”. In response, we are currently working to revise the Master Plan for the Environmental Conservation of the Seto Inland Sea, with the aim of creating a “bountiful sea” that maximizes the diverse functions of the Seto Inland Sea.

As can be seen in the “Sato-umi” efforts and the revision of the Master Plan for the Environmental Conservation of the Seto Inland Sea and so on, measures aimed at conserving water environments in enclosed coastal seas in Japan are entering a new stage as they steer a course toward the achievement of “beautiful, bio-diverse and bountiful oceans bustling-with-people.”

Coastal Zone Management and Causative Mechanism of Red Tide Outbreaks

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Progressive eutrophication in the Seto Inland Sea resulted in frequent red tide Outbreaks. In the summer of 1972, a red tide caused by *Chattonella antiqua* (raphidophyceae) occurred in Harima-nada, located in the eastern part of the Seto Inland Sea. This red tide caused the death of approximately 14 million cultured young yellowtail, resulting in losses of approximately 7.1 billion yen. Initially, however, the causal relationship between eutrophication in the ocean and outbreaks of *C. antiqua* red tide was not clearly understood. Nevertheless, beginning in March 1973, the dumping of night soil into the Inland Sea was banned; also in 1973, the Interim Law for Conservation of the Environment of the Seto Inland Sea was enacted, and in 1978 the Law Concerning Special Measures for Conservation of the Environment of the Seto Inland Sea was enacted as a permanent law that incorporated eutrophication measures. In addition, total pollutant load reduction measures relating to chemical oxygen demand (COD) were introduced. These developments led to load reducing measures that included the establishment of sewage treatment facilities and increased construction of sewage systems. Moreover, in addition to measures to reduce the COD load flowing in from land areas, it was determined that nitrogen and phosphorus measures to control internally produced COD were needed in order to improve water quality in enclosed coastal seas. Accordingly, phosphorus reduction measures and nitrogen reduction measures were introduced in 1980 and 1994, respectively.

The characteristic oceanic structure where *C. antiqua* red tides occurred had a stable nutricline at a comparatively shallow depth (5 - 7 m), with nutrients depletion in the surface layer but with a large quantity of nutrients in the bottom layer. Through microcosm experiments (indoor bacteria-free culture tank with height 1.5 m and diameter 1 m), it was demonstrated that *C. antiqua* displayed diurnal vertical migration under nitrogen and phosphorus nutricline and uptake nutrients in the bottom layer at night. In addition, through mesocosm experiments (in situ ocean enclosure with a water depth 20 m and a diameter 5 m, obtained by enclosing the natural ecosystem as is), in which a shallow nutricline was maintained through artificial eutrophication and environmental control, it was demonstrated that *C. antiqua* showed diurnal vertical migration with reaching approximately 7.5 m depth during night, uptaking nutrients and caused the outbreaks of *C.antiqua* red tides. Subsequently, the Environment Agency determined the prevention of eutrophication as an effective means of preventing the outbreaks of red tides, and this also helped to achieve arbitrated settlements in court case relating to red tides.

Household and industrial wastewater measures have dramatically improved the water quality in the Seto Inland Sea, and the combination of improved feed and cultivation technologies and increased awareness of the need for environmental conservation on the part of fishery operators and coastal residents has played a major role in preventing the outbreaks of red tides in the Seto Inland Sea. In some ocean areas, however, the continued presence of high nutrients concentrations and oxygen-depleted water masses in bottom layers has been confirmed. Following a rapid increase in the outbreaks of red tides from 44 in 1965 to 326 in 1976, since 1989 the number has been reduced to approximately 100 outbreaks. However, red tides caused by *Gymnodinium* and other dinoflagellates are still seen to occur.

A medium- to long-term scenario was prepared for coastal management of the Seto Inland Sea with FY 2004 (the year that the 6th Total Pollutant Load Control Standards were enacted) as the baseline year and 2035 as the target year. The median estimates for "Future Estimated Population of Each Prefecture in Japan," as determined by the Institute of Population Problems, were used as the future population scenario. The experimental results for the previous period in the "Innovative Program of Climate Change Forecasts for the 21st Century," as determined by the Meteorological Research Institute, were used as the future climate scenario. The Comprehensive Sewer System Construction Plan for Individual Watersheds (Osaka Bay), Sewage Treatment Vision (individual prefectures) and Bay Regeneration Plan (Osaka Bay and Hiroshima Bay) were used as references for policy option scenarios. As a policy option scenario for reducing discharge loads in land areas and ocean areas, the Seto Inland Sea environment in FY 2034 was predicted to be one in which the inflow load would be reduced by 44% for COD, 21% for total nitrogen (TN) and 30% for total phosphorus (TP) in comparison to FY 2004. The distribution of minimum values of DO in the bottom layer for the year predicts that there will still be oxygen-depleted water masses in Osaka Bay, the western part of Harima-nada, the eastern part of Hiuchi-nada, Hiroshima Bay and the western coast of Suo-nada. Even if the surface layer is in an oligotrophic state, the oxygen-depleted water masses in the bottom layer will cause nutrients to be eluted from the bottom sediment, so abundant nutrients will continue to be present. Large quantities of cysts are still present in the bottom sediment in a dormant state, and even if the reduction of the nutrients load continues in the future, the outbreaks of red tides is expected to continue at the same level. These results suggest that this factor should be fully taken into consideration in coastal zone management in the future.

Coastal Management and Climate Change in the United States

Jane Nishida

Climate change is affecting the coastal areas of the United States in a variety of ways and the impacts of climate change are likely to worsen many existing problems that coastal areas are facing. Coastal areas are particularly impacted by sea level rise, changes in the frequency and intensity of storms, increases in precipitation, and warmer ocean temperatures.

Some of the fastest rates of relative sea level rise in the United States are occurring in areas where the land is subsiding. For example, coastal Louisiana has seen its relative sea level rise by eight inches or more in the last 50 years, which is slightly faster than twice the global rate. Subsiding land in the Chesapeake Bay area is also projected to worsen the effects of relative sea level rise, increasing the risk of flooding in cities, inhabited islands, and tidal wetlands.

Growing populations and development along the coasts increase the vulnerability of coastal ecosystems to sea level rise. Development can change the amount of sediment delivered to coastal areas, worsen erosion, and damage wetlands. Coastal Louisiana lost 1,900 square miles of wetlands in recent decades due to human alterations of the Mississippi River's sediment system and natural resources extraction has further caused the land to sink. In addition, coastal areas are vulnerable to increases in the intensity of storm surge and heavy precipitation. Coastal areas in the Northeast, including New Jersey and New York, were devastated by heavy flooding during strong storm surges caused by Hurricane Sandy.

Warmer temperatures in mountain areas have led to more spring runoff due to melting of snow which in turn threatens the health of coastal waters. The Gulf of Mexico and the Chesapeake Bay are already experiencing "dead zones" where bottom water is depleted of oxygen and increases in spring runoff bring more nitrogen, phosphorus, and other pollutants into these waters. Warming temperatures may also cause habitats of temperature-sensitive species to shift northward and some areas have already seen shifts in both warm and cold water fish species in Alaska. Invasive species that had not been able to establish populations in colder environments may now be able to survive and start competing with native species. The rising concentration of carbon dioxide in the atmosphere has also increased ocean acidification which may adversely affect the health of many marine species and coral reefs in the Florida Keys, Hawaii, Puerto Rico, and other U.S. territories.

The U.S. Environmental Protection Agency has established a Climate Ready Estuaries program to address climate change in coastal areas. The purpose of Climate Ready Estuaries is to assist National Estuaries Programs and coastal communities in becoming "climate ready" by providing tools and assistance to assess climate change vulnerability and plan for adaptation. The Climate Ready Estuaries program has successfully helped coastal communities to complete vulnerability assessments, identify climate change indicators, develop adaptation plans, and educate and engage stakeholders to better prepare them for the affects of climate change.

Leadership of Chesapeake Bay Restoration: Citizen Responsibility and Engagement

Michael Hardesty

Chesapeake Bay environmental restoration first became organized in the signing of the original Chesapeake Bay Agreement in 1983. Since then four more Bay Agreements have been declared in 1987, 2000, 2010, and most recently in 2014. Each has sought to include more participation and set stricter, clearer, and more up-to-date goals for pollution reduction. With a watershed that spans 64,000 square miles and includes six states and the District of Columbia, the Chesapeake Bay restoration effort has an abundance of citizens, elected officials, scholars, and professional stewards invested in the resurgence of its health. For purposes of this presentation, I will focus on the cultivation of citizen leadership in higher education and the efforts of citizen organizations that underline the Chesapeake Bay cleanup effort. I will highlight the links along the leadership chain that connect engaged citizens to the institutional leaders such as the Chesapeake Bay Program and the international of conference of the Environmental Management of Closed Coastal Seas.

ENVIRONMENTAL POLICY ON GUANABARA BAY IN BRAZIL / CHESAPEAKE BAY–GUANABARA BAY PARTNERSHIP PROJECT

Gelson Serva

The Guanabara Bay, a geographical landmark of great natural beauty and environmental wealth, is the heart of Rio de Janeiro. The bay, with two billion m3 of water, covers an area of 384 km2, where 55 rivers contribute with an average annual flow of 350 m3/s.

There are serious urban infra-structure problems and social/cultural shortages around the GB, where 8.4 million people live. The irregular occupation housing along the watershed, with a deficient sewage collection and treatment, and also a deficient solid waste collection, causes the inappropriate water quality in several areas of the bay.

The first major program toward reversing the lack of sanitation in the metropolitan region of Rio de Janeiro was launched by the State Government twenty years ago, in the wake of Rio de Janeiro Eco92 Conference. Unfortunately, the actions didn't have continuity to a long-term program and the financial institutions ceased their participation in the beginning of last decade.

In 2008, a commitment with the International Olympic Committee for holding the 2016 Olympic Games, established new requirements to reduce the organic load discharged by collecting and properly treating the wastewater in order to achieve the environmental recovery of Guanabara Bay.

The new program "Environmental Sanitation Program of Municipalities Surrounding Guanabara Bay" – PSAM, financed by Inter-American Development Bank – IADB, has focused the partnerships with the fifteen municipalities that comprise the watershed, supporting them with the development of The Municipal Sanitation Plans.

Around GB, the level of sewage treatment increased from 15% in 2007 to 35% in 2013, but to carry out the sewage works to achieve universal sanitation in the watershed of GB, it is necessary to get more resources than the current PSAM budget and in this aim, the State Government is detailing the projects to seek financial and fiscal resolution.

The environmental restoration challenge is beyond this huge sewage and solid waste program, connected with urban infra-structure works. The surrounding GB has been impacted by development projects in different activities such as petrochemical, refinery, petroleum offshore bases, shipyards and the expansion of the harbor. We shall mitigate those intensive uses of the bay and prevent the potential risks.

In order to promote the health of the bay, it is mandatory to engage the population and to involve all local stakeholders, establishing a management model for the bay. In order to create a new governance structure for the Guanabara Bay and to share the best practices in recovering and keeping the bay healthy and sustainable, the Government of Rio de Janeiro State signed last December a partnership with the Government of Maryland, USA. The experience in restoring the Chesapeake Bay, can be very important for the challenges of Rio de Janeiro. The partnership is supported by a technical cooperation, facilitated by Environmental Protection Agency – USEPA, with Maryland University participation and the grant of IADB.