NUMERICAL ANALYSIS OF CLIMATE CHANGE IMPACT ON REGION OF FRESHWATER INFLUENCE IN THE ARIAKE SEA,JAPAN

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論 文 名　：NUMERICAL ANALYSIS OF CLIMATE CHANGE IMPACT ON REGION OF FRESHWATER INFLUENCE IN THE ARIAKE SEA, JAPAN
（気候変動が有明海の淡水影響域に与える影響の数値解析）

区　　分　：甲

論 文 内 容 の 要 旨

The climate research has been begun since in the early 19th century, according to Intergovernmental Panel on Climate Change (IPCC) report 2008. The anomaly phenomena caused by extreme events as primary climate change indicator in nature such: extreme temperatures, heat waves, precipitation extreme, droughts, change in tropical cyclone activity, and sea level rise in extreme are some of the impacts of climate change.

In the global environments, aquatic ecosystems are the critical component to determine the quality of the environment. In addition to being vital contributors to biodiversity and productivity, they also provide a variety of services for the human. Aquatic ecosystems have a limited ability to adapt with climate change effect. However, aquatic systems have been increasingly threatened directly and indirectly by climate change. Alteration of water temperatures will alter water ecosystem significantly. At the marine ecosystem, increased water temperature, precipitation intensity, and longer periods of low flows are projected to exacerbate many forms of water pollution including sediments, nutrients, dissolved organic carbon, pathogens, pesticides, salt and thermal pollution.

The aquatic ecosystem consists of seawater ecosystem and freshwater one. The region of freshwater influences (ROFI) that was proposed for the first time by Simpson is an interfacial area of water between seawater and freshwater. ROFI plays an important role in determining the condition of the marine environment and ecosystem in coastal regions. Related to climate change phenomena, this region becomes a vulnerable area to degradation of water quality due to alteration effects from both sides of seawater and freshwater. In natural of water activity, the physical parameters of water such density and temperature are two components that can play a significant role to determine water quality level in an aquatic environment. Therefore alteration of water density and water temperature are used as the primary parameter in this study.

In the environmental fluid dynamics, the baroclinic is the motion of fluid in ocean or atmosphere that is measured how misaligned the density/temperature gradient from its gradient of pressure. In the sea, baroclinic plays various roles related to the alteration of water quality condition such as developing of water nutrition components, water stratification, and adjustment on it causes distribution pattern of chemical and physical components will change vertically and horizontally due to the sensitivity of them caused by fluctuation of water density and water temperature. Therefore, to see the climate change impact on ROFI, the alteration of baroclinic assessment was used to obtain climate change impact by using several numerical experiment cases relate to climate change indicators.

In the present study, to see the climate change impact on the Ariake Sea ROFI, the study was divided in some chapter in this thesis, and described as follows:

Chapter 1 explains about research background, research problem, research objectives, the scope of the study, and also the overview of the thesis as an introduction.

Chapter 2 shows several previous research related to our study. How the impact of climate change on the aquatic system was showed from some research results that have been conducted by some experts, more than that, the study about ROFI as the primary object of this study was discussed to shows how its vulnerary and potential threat due to climate change impact.

Chapter 3 indicates the numerical analysis conducted to compare an effect of runoff pattern on the baroclinic flow for 20 days in July, 2012. We modify river discharge data by using multiplier factor α (0.8-2.0) to make several case conditions. A comparison among numerical experiments for several extreme floods is considered as a projection of climate change. The result from this study can show that the change of rainfall pattern can change the baroclinic structure in a coastal region of the Ariake Sea.

In **Chapter 4**, numerical experiments are conducted with the observation data of river discharge and river water temperature to investigate the baroclinic structure in ROFIs due to both of salinity stratification and thermal one in several cases that show the actual water temperature difference (ΔT) between seawater temperature and riverine freshwater temperature from −0.29°C to 9.27°C. Results from this research assessed the effects of the water temperature different in the Ariake Sea ROFIs on the baroclinic structure. The results can be used for considering adaptation for aquatic environment and marine ecosystem in a coastal region to the global warming.

In **Chapter 5**, an assessment of the climate change effects on thermal stratification in coastal waters is carried out by using data from the Ariake Sea – a semi-enclosed bay in the island of Kyushu, Japan. The river water temperature data after August 2015 at the discharge observation stations of Class-A rivers that feed the bay is used. Numerical simulations are performed on the density stratification in the Ariake Sea to assess the effects of temporal changes in river water temperature on thermal stratification. It is shown that during a summer flood, river water temperature can influence the reproducibility of the development of thermal stratification depending on the river water temperature used, and the reproducibility of the base water temperature differed during the transition to the mixing period. Effects of river water temperature on the water temperature structure of the sea are indicated.

In **Chapter 6**, an assessment of potential threat of water temperature alteration effect on the aquatic ecosystem is done. In the following climate change issue, the region of freshwater influences (ROFI) is vulnerable area to degradation of water quality. In this chapter, differences of water temperature in ROFI associated with the global warming effect is conducted by some numerical experimental conditions on water temperature simulation that has an extreme different temperature (ΔT_{sr} = 10 °C to −8 °C) in the Ariake Sea. The results show how the global warming can be a problem in aquatic environments and how the distribution pattern of potential threats of water temperature change in seawater–freshwater mixing related to water temperature in aquatic ecosystems. This is important because changes in water temperature have implications for aquatic biota such as seaweed (Nori: *Porphyra yezoensis*), fish and other organisms, especially in the ROFI. The results can be utilized to determine some methods to mitigate the effects of global warming on aquatic environments and marine ecosystems in coastal regions.

Chapter 7 concludes all chapters in this thesis and also proposes some recommendation for future works.