HISTORICAL CHANGES OF STORM SURGE DISASTERS IN OSAKA

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Abstract. Changes in storm surge disasters in the Osaka area were studied from reports in old documents, in which descriptions of disasters have been given for about 1200 yr. Storm surge disasters have occurred 53 times in the Osaka area since 700, seven of them major ones that killed 1000 or more people. The risk to life therefore, of these disasters is the order of $10^{-3}$. This value is the potential risk when no countermeasures are taken against storm surge disasters. After the Muroto typhoon (1934) risk to life in storm surge disasters has been reduced remarkably by the soft and hard countermeasures taken. The mean interval between major storm surge disasters is about 150 yr, which corresponds nearly to the return period of the storm surge accompanied the Muroto Typhoon.

1. Introduction

In Japan, we have had few large storm surge disasters since 1961 when storm surges that accompanied the Daini Muroto Typhoon struck Osaka. This is mainly because of the decrease in the number of large typhoons that have directly hit the islands of Japan. Soft and hard countermeasures against storm surge disasters such as typhoon warning systems and lock gates, also have contributed to the prevention and reduction of major disasters [1]. In the early 1960s, coastal areas in and around Japanese cities were reclaimed for the construction of modern industrial complexes and public facilities. Urbanization advanced greatly in the hinterlands of these reclaimed areas in the 1970s. Consequently, the probability of catastrophic storm surge disasters occurring has increased in areas such as Tokyo, Nagoya and Osaka.

Osaka was developed on the site of the old capital of Naniwa (645) on the top of Uemachi Hill. The first storm surge disaster was recorded in 753. Mitsuura Village at the bottom of the west slope of the hill was devastated by storm surges in which some 560 persons were killed. Since 753, many other storm surge disasters have occurred [2]. The city of Osaka is unfavorably located to withstand storm surges. Typhoons frequently move northeastward just before hitting the Japanese archipelago, and unfortunately the shape of Osaka Bay is elliptical with its major axis running northeast (Figure 1). When a typhoon passes over western Osaka, a large amount of water is piled up at the northeast end of the bay as the storm surges. During spring tides, the tidal range is about 1.85 m. Therefore, a meteorological tide due to a storm surge added to the astronomical tide can produce an extremely high sea level.

Many old documents describe historical storm surge disasters in the Osaka area. We have studied historical changes in the risk to life due to storm surge disaster caused by changes in various social and environmental circumstances. The results of the occurrence frequency of major storm surge disasters is verified by the statistical data on high tides which we have reported previously [3].

2. Topographical Background of the Osaka Hinterland

The hinterland of Osaka can be divided into three areas; the Kawachi Lowland,
Fig. 1. Map of the area studied and the paths of the three biggest typhoons to strike Osaka since 1900.

Uemachi Hill and a coastal lowland (Figure 2). In these areas, many people have lived since ancient times, therefore, the topography inevitably has been modified by human activities, as well as by natural phenomena such as river flooding and reclamation of