RISK ASSESSMENT OF AGGREGATE LOSS BY STORM SURGE INUNDATION IN ISE AND MIKAWA BAY

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INTRODUCTION
In the event of disaster, the risk of disaster are intertwined, and there is an occurrence possibility of simultaneous damage in multiple areas. Nationwide companies have more risks of simultaneous damage in multiple areas by one disaster. For example, factories in Osaka and in Nagoya, can be damaged by one typhoon. In this case, company will need more money when damage happened and better to make special insurance contract, e.g. Catastrophe bond. On the other hand, insurance company has to assess amount of insurance payout because to pay it for contracted companies quickly. Insurance company may have difficulty to estimate total amount since there are few researches assessing aggregate loss caused by coastal disasters. This research proposes a procedure of assessment of aggregate loss by storm surges in Ise and Mikawa Bay located in Aichi prefecture, Japan.

METHODS
Typhoon data which passed only Ise Bay and both Ise and Mikawa Bay are extracted from the stochastic typhoon model (Nakajo, et al., 2014). Number of typhoons are 192 and 805 in 1000 years, respectively. Storm surge by the typhoons passed only in Ise Bay was calculated by an empirical formula which was used by the Japan Meteorological Agency till 1998 (CASE 1) while storm surges by the typhoons passed both Ise and Mikawa Bay are simulated by the nonlinear shallow water equation model, SuWAT (Kim, et al., 2008) (CASE 2), because there is no empirical formula for Mikawa Bay. Inundation area and depth are calculated by the floodplain inundation simulation model, LISFLOOD-FP (Bates, et al., 2005). Asset maps are made using the digital national land information. Loss function which is a relationship between inundation depth and damage is estimated according to the flood control and the economic research manual. Loss are calculated by the inundation depth, the asset map, and the loss function.

RESULTS
Event curve which is a relationship between an exceedance probability of aggregate loss and return period was estimated as shown in Fig. 1. Event curves considering existence of seawalls were also estimated, which loss becomes zero if storm surge height are smaller than seawall height. Expected loss which is represented by the area of lower side of the event curve can be calculated because the expected loss equals the sum of expected loss multiply occurrence probability. Expected loss calculated by CASE 1 was overall lower than CASE 2. Although estimation of storm surge by the empirical formula needs little computational cost, storm surge heights by the empirical formula were tend to be underestimated.
Figure 2 shows the aggregate loss in two bays and individual losses in Ise and Mikawa Bay. Typhoon which caused the fifth highest loss in Ise Bay also caused the damage in Mikawa Bay, and the aggregate loss became the third highest. Since these two bays are close, large typhoon can cause simultaneous damage.

CONCLUSIONS
Process to calculate the aggregate loss by storm surge inundation in the multiple area is proposed and the expected aggregate loss was estimated. To estimate losses in the Ise and Mikawa Bay aggregate loss is necessary to be considered rather than Individual losses.
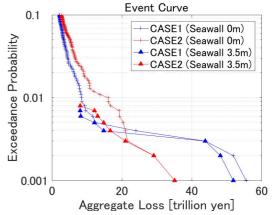

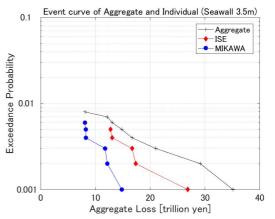Figure 1 - Event curve (Exceedance probability of loss) by storm surges

Figure 2 - Aggregate loss of two areas and individual losses in each area against exceedance probability

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