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Article / Book Information

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論 文 要 旨

THESIS SUMMARY

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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

A cascading event which led to a huge earthquake occurred off of the East coast of Honshu Island in Northeastern Japan on March 11, 2011 (hereinafter referred to as 3/11). Followed by a tsunami which cut off all power to the Fukushima Daiichi Nuclear Power Plant (1F), therefore causing a hydrogen explosion. After the explosion a radioactive plume spread across Eastern Japan, resulting in evacuations of areas within 10-km of 1F. Some of the evacuation orders were delayed, and in some cases harmful because they led people into highly contaminated area. Local authorities and the national government struggled to make sense of the situation when it first occurred. Only 20% of residents close to 1F knew something was wrong in the nuclear power plant. According the official report of Executive summary, the Fukushima Nuclear Accident Independent Investigation Commission, the disaster that occurred at 1F is a "man-made disaster".

In Chapter 2, an integrated and intuitive user interface has been developed by utilizing a large database containing atmospheric dispersion simulations of radioactive nuclides. In this study, the interface has been named IRONS (Interface for Radiation Observation for Nuclear Safety). Development of IRONS takes into consideration two main users, monitoring posts experts and evacuation experts. Due to the differing needs of the users, IRONS was designed for various output functionalities. The database used in IRONS contains an output of large quantities of simulations with 1 Bq/h release with the source point of the release being 1F. The user interface accesses the large database and acquires the spatiotemporal distribution output based on the user's input. For example, the user can change the release rate, source terms and release date. As a result, IRONS will swiftly output data in the form of comprehensible tables highlighting important values, such as maximum dose levels, its locations and distance from source, and insightful figures of plume horizontal dispersion and distribution. As a unique function, IRONS can produce outputs at a rate of 97 - 99% faster compared to the general atmospheric dispersion simulator. In addition, IRONS can be used on any machine running Linux or Linux environment and outputs can be generated using any number of parallel machines for an even faster output speed.

Based on the outcome from chapter 2, chapter 3 uses a weight-distance methodology which was applied for the function of monitoring post installations for emergency preparedness. In chapter 3, output from chapter 2 was utilized to compare and distinguish the different dose patterns by separating into four different cases; high air dose rate (> 20 μSv/h), high fluctuation or rate of change in air dose (> 300 %), and low air dose rate (<20 μSv/h), low fluctuation (< 300%). This study considered the methodology with the experts of monitoring posts in mind by setting up an area of 20 x 20 km with: 1) Four monitoring posts, 2) Nine monitoring posts and finally 3) 25 monitoring posts. In each of the three cases listed, a weight-distance formula was applied to each monitoring posts, then summed up to give an assumed air dose rate based on each of the cases. The plume analyses have shown that areas within the 30 km radius of 1F require 25 monitoring posts with 95% accuracy in order to sufficiently assume the proper air dose rate. However, in areas outside the 30 km zone require between four to nine monitoring posts with 95 – 99 % confidence levels to sufficiently assume proper air dose rates.

Evacuation experts preplanning for evacuation preparedness require to look ahead and predict if certain areas will exceed the air dose evacuation criteria, in case of a plume dispersion. IRONS output from chapter 2 along with areas analyzed in chapter 3 were utilized for evacuation preplanning in chapter 4. The methodology used considers the two levels of evacuation. Firstly, any air dose rate exceeding or equal to 500 μSv/h requires immediate evacuation, and secondly, any air dose rate exceeding or equal to 20 μSv/h requires evacuation within one week. At first, air dose rates were taken from locations of 20 x 20 km in a certain time. Then the air dose rates were compared to the same areas but, 24 hours later. This will result in quantitative results displaying the difference in air dose rate. Afterwards, the results are used show the dose increase ratio, per hour, day and week. Consequently, this will show the user how fast evacuation air dose rates level will reach, hence better preparing for evacuation.

After analyzing the results from chapter 2 – 4, in the final chapter 5, this study proposes the use of the IRONS system to create outputs according to each users' needs hence assisting experts in the field of monitoring posts installations and evacuation preparedness. With large data analysis IRONS can generate an infinite amount of cases, but with only the fraction of the time. Outputs of IRONS are tailored to specific users which could help in dose and plume distribution analysis, and determination of dose increases.