■ 研究論文

福島原子力発電所の東日本大震災被害からみた1980年の国土庁によるエコロジカル・プランニング調査の現代的意義

Could Ecological Planning Data Base on Land Agency Report in 1980 Prevent the Actual Disaster of Fukushima Nuclear Plants Caused by the Tohoku Earthquake and Tsunami?

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Abstract：One of advantage in ecological planning method of Ian L. McHarg is synthesis of respective optimal landuse（non optimal landuse). The earthquake and tsunami damage in March 11, 2011 recalled us the importance of the comprehensive optimal landuse evaluation. Especially, damages of the Fukushima nuclear plants were catastrophic. This study focused on the criteria of land evaluation paper data in report of "Land Use Aptitude Evaluation Technique Investigation based on Ecological Planning" by National Land Agency Japan in 1980. We traced 5 paper maps（geological map, landform classification map, slope distribution map, vegetation map, and soil cartography map）for digital map, and inclination in coastal areas in where the two Fukushima nuclear plants exist. In addition, we made risk hazard maps（landslide, earthquake resistant, and flood, tsunami damage estimation）on each disaster with above 5 divisions maps and the table risk scores in the Land Agency Report 1980. Finally, we developed a comprehensive hazard map with overlaid a previous evaluation result and evaluation of optimum area of nuclear plant. An actual nuclear power plant site was selected to the coast for the reasons of barren ground bought easily. However, our results indicate that the nuclear power plant site was relative dangerous location in the sight of overall disasters vulnerability by the overlay analysis in 1980 data.

Keywords：*Ian L. McHarg, Landscape planning, Regional planning team, Site plan of nuclear plant, Disaster hazard map, National Land Agency of Japan*
キーワード：イアン・マクハーグ，地域計画 , リジオナル・プランニング・チーム，原子力発電所の敷地計画，ハザードマップ , 国土庁

1. Introduction

One of advantage of ecological planning methods of Ian McHarg（1969）is synthesis of respective optimal landuse（non optimal landuse). The method for environmental development matching the division of such an environment was proposed with Design with Nature as Ecological Planning. This method was introduced in the landscape planning（Inoue et al（1971)）and the architectural planning（Isobe et al（1971, 1975)）of Japan in beginning 1970's. In 1980, National Land Agency of Japan try to make base data map for ecological planning in Tohoku region. Afterwards, the researcher who is related to the maintenance of basic data of this report（data of 1:500,000 scales）works on a technical improvement. : Maintenance of data of 1:100,000 scales by Isobe（1980), Verification of possibility of satellite image data by Hayakawa et al.（1986), Practical use of ecological planning by personal computer by Kubo（1990).

On the other hand, Irisawa（1986）pointed out the difficulty of the overall judgment by environmental assessment in 1986. He was head of committee of this report. Thus, this ecological planning method has not been used in practical applications. In fact, the environmental administration in Japan was subdivided for top-to-bottom basis and emphasizing economic demands（Kinoshita.（2002)). Nevertheless, an importance of comprehensive environment planning method was above clarified again due to this earthquake and the tsunami damage. Especially, the damage and the compensation problem of Fukushima nuclear plant are serious. Thus, it is necessary to revalue an availability of the ecological planning methods which adapt to the environmental characteristic and locations in the landscape.

2. Method

(1) Digitalization and revaluation of result of the survey of past ecological planning

This report focused on the criteria of land evaluation in the "Land Use Aptitude Evaluation Technique Investigation by Ecological Planning" reported by National Land Agency of Japan in 1980. The Fukushima No.1 nuclear plant（F1）was built from 1971 to 1978, the No.2 nuclear plant（F2）was built from 1979 to 1982. This report was executed for the maintenance of basic information and proposing appropriate range of planning units（alternatives of existing administration region）for the third synthesis development national plan. Five maps of environmental evaluation drawn in A0 size（84.1cm × 118.9cm）were included in this report.

The investigation was conducted on the 6 prefectures in Tohoku district including disaster sites of 2011.3.11. Fig.1 shows towns under analysis of coastal region in Fukushima. First, the paper maps drawn in 1980 were scanned, and locational information was added on the digital maps. Next, the author traced 5 paper maps with table of degree of risk of disaster（geological map, landform classification map, slope distribution map, vegetation map, soil cartography

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map) for digital map, and inclination of coastal area in where Fukushima F1 and F2 nuclear plant were located. In addition, the authors digitalized scores of the risk of evaluation for disaster (landslide, earthquake resistant, and flood and soil maintenance) on the each above 5 division map. These scores of disaster risk were referenced as attributions from tables in the land Agency Report 1980. All these works above were conducted with ArcGIS 9.3.1.

In this paper, we used only evaluation points of vulnerability to the disaster among the rank points at each environmental division. For example, the vegetation map has other three rank points beyond that of a vulnerability to the disaster (the rank points of retention capability of ground)： 1. Degree of human disturbance on vegetation, 2 Rarity value of vegetation, 3 Water retentivity of land).

Moreover, two months were needed only for the data input though it was an area of the 0.36% of Tohoku 6 prefecture (each report data). It might be excessive information at the time of 1980, because there was not high performed personal computer and GIS software like nowdays. Hence, we supposed that is one of the reasons for the unutilized data in an actual regional planning in the past.

(2) Evaluation of optimum site of nuclear plant by danger of disaster

A synthetic disaster hazard map was generated with results from overlapped previous disaster evaluation. Moreover, a tsunami damage map estimated in 2007 by Fukushima Prefecture was overlaid to the map. The range of tsunami of the maximum flood forecast was assumed with two situations. 1) Earthquake of about M8 taken placed from a hypocenter located in off shore of the Pacific Ocean. 2) In the case of functional destruction of breakwaters. Finally, we analyszed the optimum sites for nuclear plants based on the scores of risk for disaster to consider relationship between environmental evaluation by ecological planning method in 1980 and actual damages on Fukushima nuclear plants caused by 2011.3.11 earthquake tsunami catastrophe.

3. Result and Discussion

(1) Revaluation of the past ecological planning based on digitalized synthesized maps.

This report focused on the "Land Use Aptitude Evaluation Technique Investigation by Ecological Planning" in 1980. This was a valuable case study that an ecological planning method was applied to regional planning of Japan. However, the data cannot be found now and the results have not been open to the public, neither available as old book data. This abandonment schedule report was personally kept in our University. This discard report was collected by retired Professor Rei Itoga.

Fig.2-Fig.6 show the ranked scores of the risk of the disaster at the each 5 division map (landslide, earthquake resistant, and flood and soil maintenance).

Fig.2 is a map of the rank scores of quake resistance for each geological division. The rank score of quake resistance: Rank1 (low quake resistance) with Al (Sand・Pebble・Clay), Rank2 (middle quake resistance) with Tn (Sandstone, Mudstone, Gravel), Tr (Terrace deosit, Diluvial gravel),

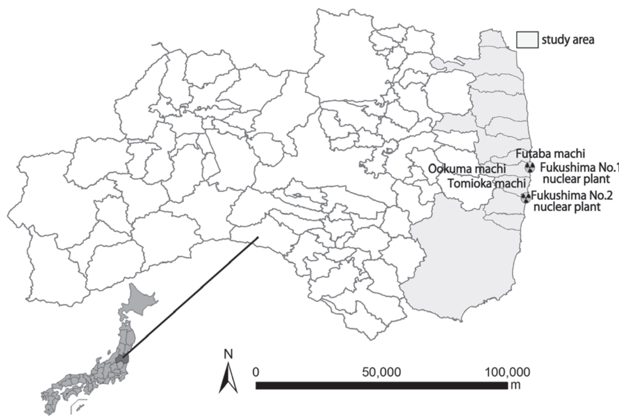

Fig.1　Map of the study area and towns & Fukushima No.1&2 nuclear plants

Sch (Crystalline schist) or M (Sandstone, Shale, Gravel), Rank3 (high quake resistance) with An (Andesit), Gr (Granite), P (Slate・Schalstein), Gd (Gabbro・Diabase) or Sp (Serpentine).

Fig.3 exhibits the rank score of risk (predisposition) of land slide each geological division. The rank score of risk of land slide: Rank1 (High risk of land slide) with Tn (Sandstone, Mudstone, Gravel), Rank2 (Rather high risk of land slide) with An (Andesit), Rank3 (Little low risk of land slide) with Gr (Granite) or Tr (Terrace deosit, Diluvial gravel), Rank4 (Low risk of land slide) with Al (Sand・Pebble・Clay), Sch (Crystalline schist), M (Sandstone, Shale, Gravel), P (Slate・Schalstein) or Gd (Gabbro・Diabase).

Fig.4 is a map of the rank score of probability for land slide on the degree of slope.; The rank score of risk of land slide : Rank1 (High probability of land slide) with 8° to 20°, Rank2 (Rather high probability of land slide) with 20° to 30°, Rank3 (Little Low probability of land slide) with 3° to 8°, 30° to 40°, 40° or more, Rank4 (Low probability of land slide) with 0° to 3°

The map of Fig.5 demonstrates the rank scores of capability for land retention on each vegetation and land use division. The rank score of land retention capability: Rank1 (Low land retention capability) with Paddy field, Dry field, Logged forest or Urban area, Rank2 (Middle land retention capability) with Pinus, Rank3 (High land retention capability) with *Quercus serrata, Thuja standishii-Pinus parviflora, Castanea crenata-Quercus crispula, Pinus thunbergii's plantaion, Cryptomeria japonica's plantaion or Larix kaempferi's* plantaion.

Fig.6 is a rank score of potential flooding on each physiographic division.: The rank score of potential flooding : Rank1 (High potential flooding) with Delta, Tidal flat, Castal plain or Lower peatbog land, Rank2 (Rather high potential flooding) with Fan, Valley bottom lowland, Rank3 (Little low potential flooding) with Sand dune Beach ridge, Mud flow landforms or Lava flow landforms, Rank4 (Low potential flooding) with Steep slope of mountains or Gentle slope of mountains

Fig.7 is a map of the tsunami damage estimation that had been announced in 2007 by Fukushima Prefecture.

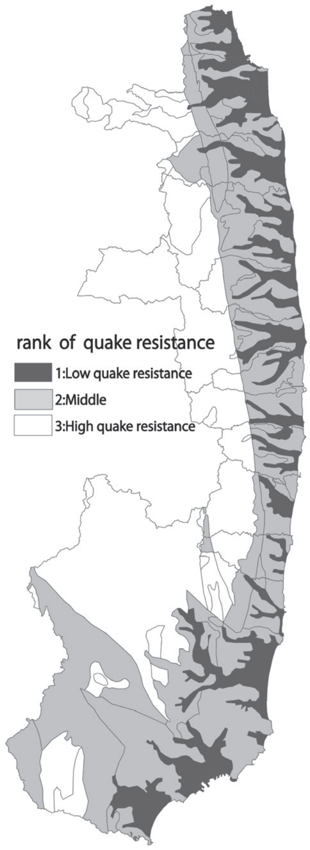

Fig.2 The rank of quake resistance on each geological division

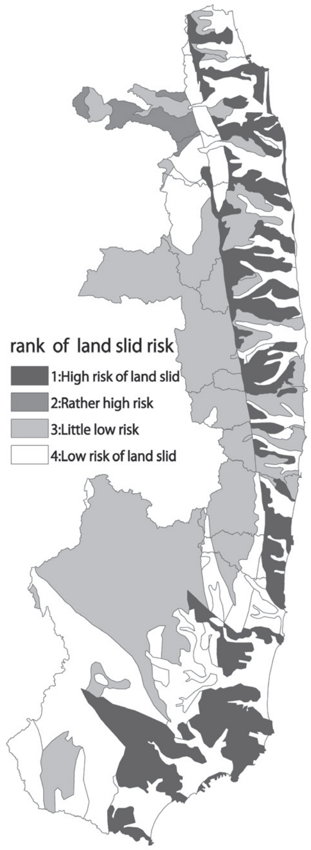

Fig.3 The rank of landslide risk on each geological division

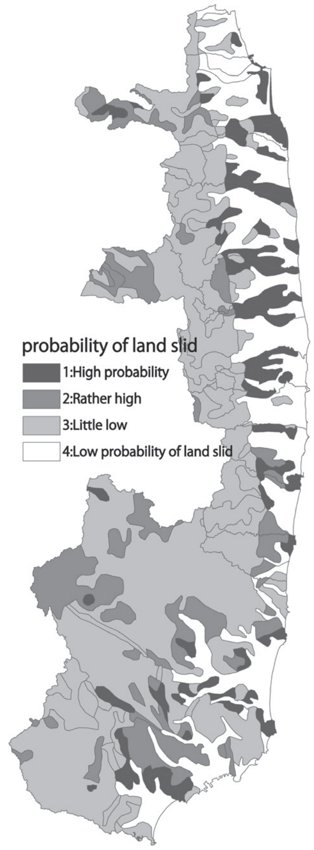

Fig.4 The rank of landslide probability on the degree of each slope

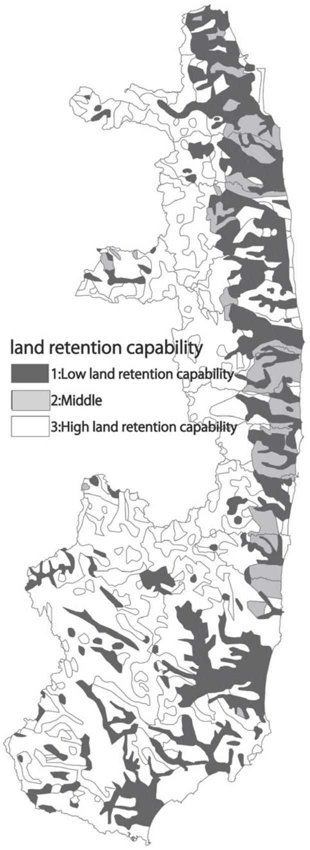

Fig.5 The rank of capability for land retention on each vegetation type

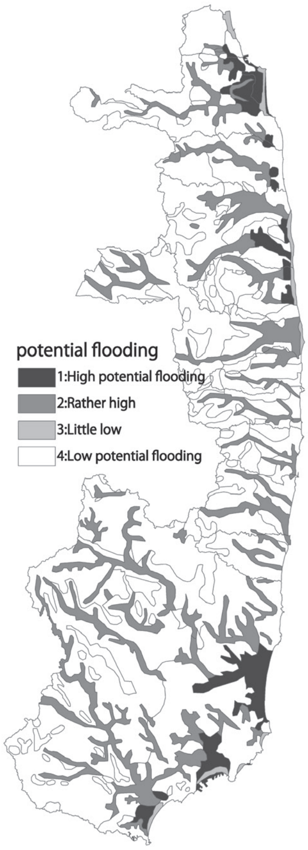

Fig.6 The rank of potential flooding on each physiographic division

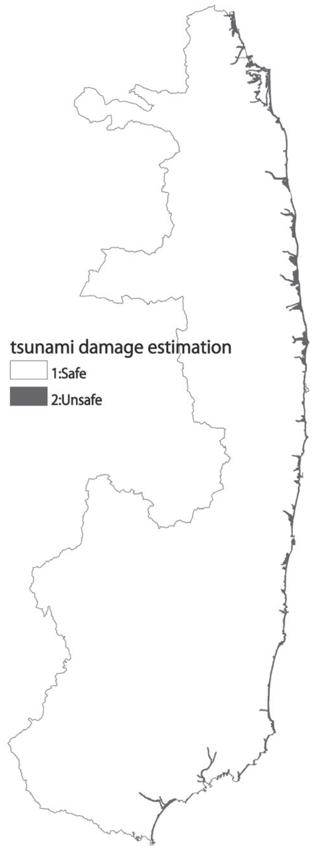

Fig.7 Map of the tsunami damage estimation

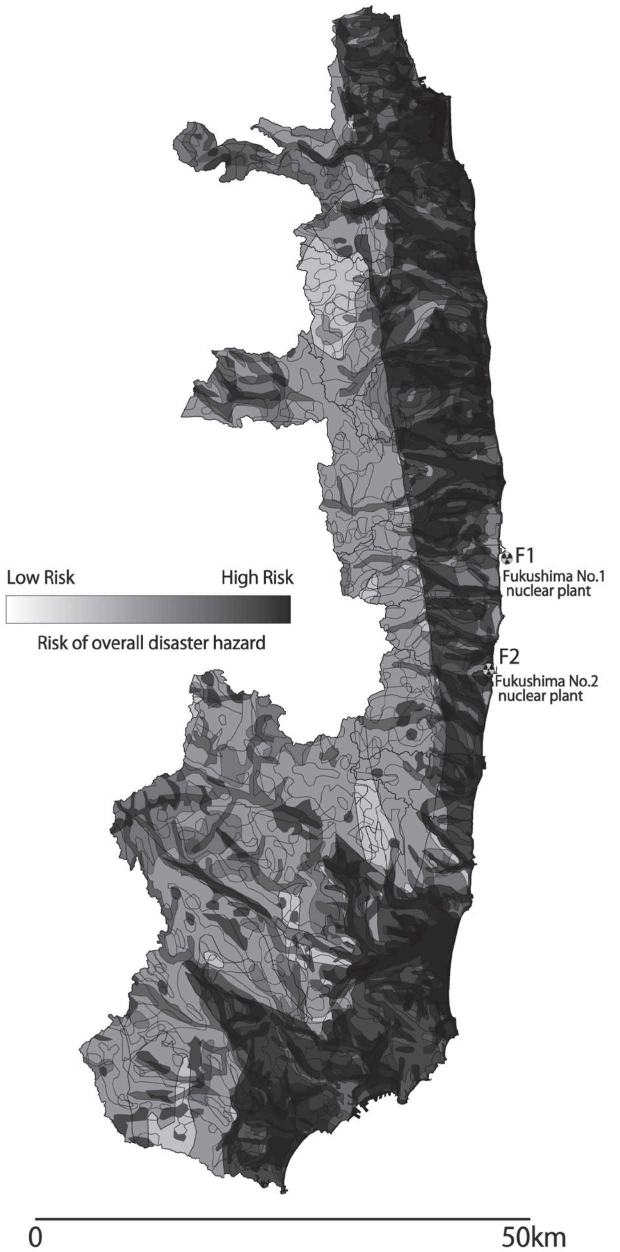

Fig.8　The distribution of risk of overall disaster hazard and predicted value of cumulative contamination of radioactive as 1year

(2) Evaluation of optimum site for nuclear plant estimated by danger of disaster

According to Kainuma (2011), the site selection of the Fukushima first nuclear power plant (F1) from 1961 had progressed smoothly without troubles, and it was due to easeful decisions to purchase lands where the Nation Force already had compellingly purchased for an airport (salt farm afterwards) in World War II.

On the other hand, land purchase of the Fukushima second nuclear power plant (F2) announced in 1968 had hampered leading a lawsuit after development.

Moreover, Kainuma (2011) introduced a statement by Kimura Morie as Fukushima Prefectural governor in 1960's: "The construction of a nuclear power plant will be built based on safety standards. It has been constructed in urban areas in the United States and the United Kingdom." From the fact above-mentioned, it is understandable that the location selection of Fukushima nuclear power plant (F1, F2) was implemented with the extremely simple reason in wherever a vast terrain can be easily purchased.

Finally, we overlay respective result of five disaster hazard evaluations as comprehensive disaster hazard map.

Moreover, we overlapped the tsunami damage estimation map (Fig.7) in 2007 estimated by government of Fukushima Prefecture. Fig.8 shows a resulted synthesis disaster hazard map and estimation value of cumulative does from Fukushima F1 and F2 nuclear plants. The density of gray color increase proportionally as increased of the risk of disaster.

This result indicates that the nuclear power plant site was relative dangerous location in the sight of overall disasters vulnerability. Even if the site of nuclear plants had already been determined, comprehensive disaster measures must have been enforced based on results from this ecological planning investigation.

4. Conclusion

This report focused ecological planning paper data base on Land Agency report in 1980. The author digitalizes 5 division maps of vegetation, geological divisions, geographical divisions, the soil, and the inclination of coastal area which has Fukushima F1 & F2 nuclear plant from paper data of 30years ago. We also digitalize the score of the risk characterization evaluation of the disaster at the each environmental division (landslide, earthquake resistant, and flood and soil maintenance) with ArcGIS9.3.1.

An actual nuclear power plant site was selected to the coast for the reasons of barren ground bought easily. However, our results indicate the nuclear power plant site was relative dangerous location in the sight of overall disasters vulnerability by the overlay analysis in 1980 data.

If ecological planning methods in 30 years ago was possible to apply site planning, the planning method could contribute to prevent the accident of Fukushima nuclear plants caused by the Tohoku earthquake & Tsunami.

On the other hand, this result has revealed that ecological planning land evaluation data in 1980 were too huge, and the data accuracy was low. In spite of this, alternatives site from combined viewpoint can be planned besides the site decided by one aspect. The some researcher points out that the nuclear power plant was located in the coast for getting water and the drain of seawater. Nevertheless, suitable for getting water and the drain of seawater is synonymous with it is fragile land for the tsunami. This paper suggests the importance of combined environmental evaluation.

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