Estimation of environmental damage assessment in the shoreline after the NAKHODKA oil-spill using Geo-informatics

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Abstract:

The investigation of the amount of the ecosystem damage on the shoreline due to the NAHODKA oil-spill accident, which occurred in the Sea of Japan, was attempted by using geoinformatics. At first, it was assumed that symbolical vegetation's distribution could be specified in the coast in Ishikawa Pref. where the heavy oil was washed, and surveyed the regional distribution. Then, the presumption result of those environmental capacities was arranged by GIS. In addition, the amount of the ecosystem damage was presumed as cost necessary though a symbolical living thing for the retreat because of the base line by the heavy oil drifting ashore was recovered.

By comparing the vegetation line and the surveying data which shows environmental capacity, the retreat areas of the vegetation were 1100-1200 m^2. When the amount of damage on the ecosystem of the NAHODKA oil-spill accident was presumed based on the retreat area of this vegetation and the restoration cost, the amount of damage within Shioya beach which 150m in the surveying range became 2 to 2.5 million Yen. Because the extension distance from the Shioya beach to the Katano beach was about 3,500m, the amount of damage became about 46 to 65 million Yen. As a result of calculation for the amount of damage on the ecosystem of the NAHODKA oil-spill accident, it was estimated approximately 1,400 to 2,000 million Yen in the shoreline of Ishikawa Pref., because the total extension of beaches in Ishikawa Pref. is about 110km.

1. Introduction

On January 2, 1997, the Russian tanker NAHODKA sank off Oki Island, and spilled approximately 8,660 kiloliters of oil (Sao, 1998). The oil contaminated more than 2,000 kilometers of coastline along the Sea of Japan has been affected. There were some factors causing wider spread of pollution and a longer impacted shoreline; these factors included strong wind, rough winter weather, and, the worst of them, delay of the commencement of the response. In the NAHODKA oil-spill incident, the amount of damage exerted the influence on the ecosystem of the coast region by the drifting ashore oil is zero assessments. The reason is that the victim is not specified in the system and the presumption technique is not established. However, the system for the environmental damage scales presumption by which it is assumed that an environmental disaster same as the NAHODKA oil-spill incident will occur in the future is needed.

As a method of presuming the damage calculation due to an environmental disaster, there are CVM (Contingent Valuation Method) and TCM (Travel Cost Method). In the NAHODKA oil-spill incident though it is applied, to say nothing of the problem of the technique, the distribution of the value of the environment cannot be specified. Therefore, the verification considerably will be needed by the time the reliability of the presumed amount of environmental damage is obtained by using these. In addition, there are HEP (Habitat Evaluation Procedure) and WET (Wetland Evaluation Technique) and BEST (Biological Evaluation Standardized Technique) as an evaluation technique of environmental capacity. However, it is not easy to say the model which can be applied as it is when applying to the coast region which all these techniques are the one intended for the marsh and the ocean, and is struck regions of the NAHODKA oil-spill incident.

In this study, at First, using GIS based on these backgrounds in normal circumstances controls environmental capacity. Then, the objective of this paper is to explore the construction of the presumption model of the environmental damage scale to which the struck level can be presumed according to the amount of the retreat of environmental capacity at environmental

damage.

2. Data and Methods

2.1 Flow of environmental damage amount presumption

In this study, the change in symbolical vegetation's line at passing year's change and the season was first extracted from the aerial photograph and the surveying result, and then arranged by GIS. Moreover, the logistic curve was applied to those changes, and environmental capacity was presumed. It is also attempted to surveying the amount of the retreat of vegetation's line after the incident of the NAHODKA oil-spill, and to presume the amount of environmental damage according to the restoration cost of the vegetation. The following discussions are developed assuming that a symbolical vegetation is specified the thing to specify a symbolical vegetation is not a purpose in this study but now.

2.2 Surveying of interannual change of vegetation line

(1) Use data

i) Kaga City jurisdiction chart (map number 19, 26, 27, and 34)
ii) Kaga City making (Katano and Shioya beaches) an aerial photograph (July, 1984 and November, 1992)
iii) Geographical Survey Institute making Kaga City (Katano and Shioya beaches) an aerial photograph (June, 1974 and September, 1980)
iv) Surveying data of vegetation line

(2) Vegetation's reference point

The coordinates of starting point and ending point in a reference line were surveyed, by GPS, by using a triangular point in the vicinity of the coastline on November 3, 1998.

(3) Vegetation line in a surveying point

The Shioya beach installs the surveying point of A-Z on a reference line and a reference line 150m at intervals of 10m. The situation of vegetation's breeding and decline based on it. The situation of the geographical features change in beach was surveyed at the total station (The observation day: on November 14, September 27, July 1, and May 31, 1998). The outline of the

surveying is shown in Fig. 1 and the results are shown in Table 1 and Fig. 2.

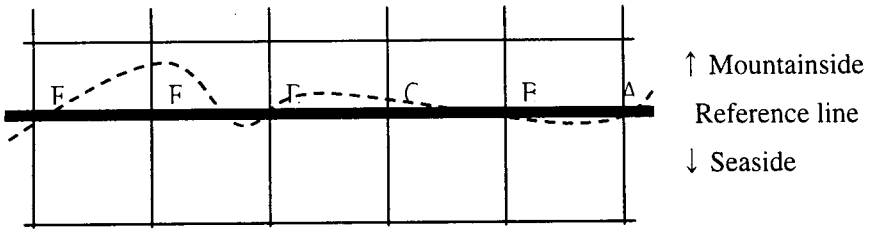

Fig. 1 The outline of the surveying

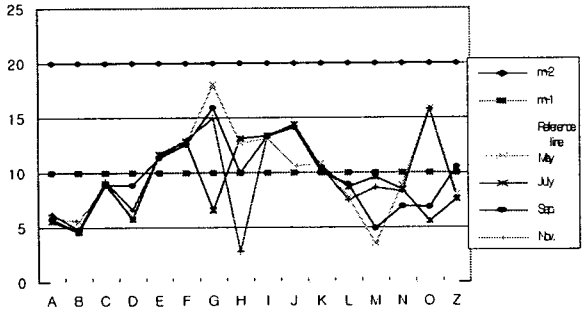

Fig. 2 Change of time series of vegetation line in Shioya beach

S.P	m-2	m-1	R.L	May	July	Sep.	Nov.
A	20	10	0	5.907	5.567	5.780	6.276
B	20	10	0	5.540	4.597	4.578	4.788
C	20	10	0	8.821	9.030	8.893	9.206
D	20	10	0	5.938	5.760	8.853	6.603
E	20	10	0	11.426	11.689	11.357	11.542
F	20	10	0	12.717	12.883	12.554	12.967
G	20	10	0	18.032	6.564	15.919	14.998
H	20	10	0	12.707	13.115	9.974	2.801
I	20	10	0	13.122	13.385	13.312	13.391
J	20	10	0	10.574	14.402	14.159	14.294
K	20	10	0	10.851	10.434	10.002	10.464
L	20	10	0	7.735	8.676	8.944	7.483
M	20	10	0	3.487	9.573	4.900	8.635
N	20	10	0	8.900	8.445	6.919	8.274
O	20	10	0	15.857	5.567	6.861	15.805
Z	20	10	0	8.000	7.586	10.514	7.642

Table 1. Surveying result of Shioya beach

2.3 Presumption of environmental capacity

Environmental capacity (K) is based on the concepts of "Maximum number where the species can exist." (Iwaki, 1990). Can presume the vegetation line by using the logistic curve from approaching to the position which becomes be the maximum so that may break out originally as become be old the age the vegetation line based on this concept. In addition, it was assumed the one that environmental capacity could be shown as follows by the amount of distribution. Vegetation's line grows thickly to the seaside in summer, and retreats to the mountainside in winter. However, the aerial photograph, which has been taken a picture by now, become the spot data. Presume the maximum value of the vegetation line and the minimum value from the time series data of the vegetation line statistically to solve this respect, and distribute the vegetation line between the maximum value of each a surveying point's vegetation line and the minimum value.

Based on the above-mentioned assumption, the presumption flow of environmental capacity

is summarized schematically in Fig. 3.

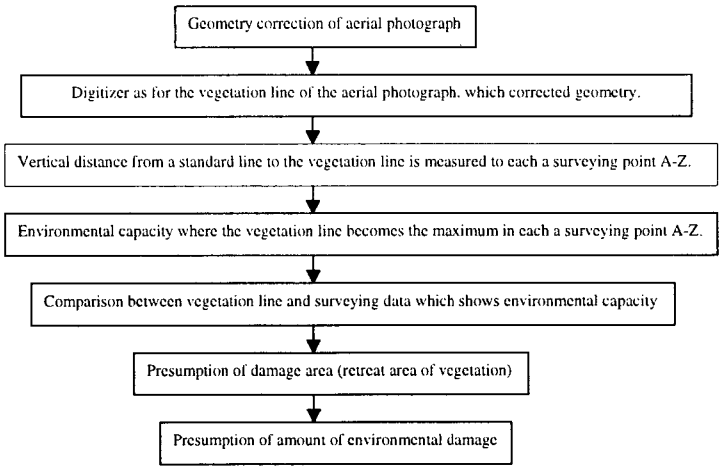

Fig. 3. Flow of environmental capacity presumption

The correction of an aerial photograph's geometry is done to compare data and the digitizer does an aerial photograph's vegetation line by using Micro station95-DCARTES –

(1) The vegetation line is extracted from the aerial photograph by watching, and the digitizer does (Fig. 4). (2) The surveying point A on a reference line - A vertical distance to the vegetation line to which the digitizer is done from Z by (1) is surveyed, and each a surveying point brings the distance together. (3) Because it is not the one taken at the same season, the aerial photograph cannot be compared as they are. And so, the annual range of the vegetation line shift is considered using the surveying result in 1998.

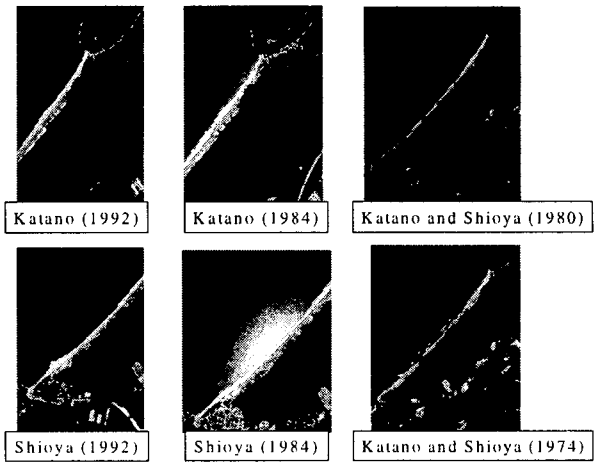

Fig. 4 Seasonal variation of vegetation line

2.4 Presumption of amount of damage using the environmental capacity

Cost necessary though the vegetation was recovered to the limit value of the vegetation line

was assumed to be amount of environmental damage. However, it estimates as an example of the unit of the field of the restoration cost of the lawn (1700-2300 yen/m^2) because there is no estimation material of the vegetation collection which exists in beaches at this time. The line of environmental capacity and the line of the measurement result are shown on the coordinates map, the unit of the field of the restoration cost is put on it for the area to which the vegetation line retreats, and it is assumed the amount of environmental damage.

3. Presumption result of environmental capacity and amount of environmental damage

3.1 Environment capacity distribution

The distribution chart of environmental capacity of each the presumed surveying point is shown in Fig.5.

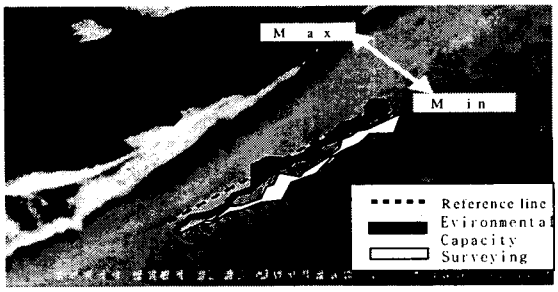

Fig. 5 Vegetation line by which environmental capacity

3.2 Environment damage amount distribution

By comparing the vegetation line and the surveying data which shows environmental capacity, the retreat areas of the vegetation were 1100-1200 m^2. When the amount of damage on the ecosystem of the NAHODKA oil-spill incident was presumed based on the retreat area of this vegetation and the restoration cost, the amount of damage within Shioya beach which 150m in the surveying range became 2 to 2.5 million Yen. Because the extension distance from the Shioya beach to the Katano beach was about 3,500m, the amount of damage became about 46 to 65 million Yen. As a result of calculation for the amount of damage on the ecosystem of the NAHODKA oil-spill incident, it was estimated approximately 1,400 to 2,000 million Yen in the shoreline of Ishikawa Pref., because the total extension of beaches in Ishikawa Pref. is about 110km.

4. Conclusion

Ohno and Hayashi (1999) calculated the damage of the NAHODKA oil-spill incident by using the Contingent Valuation Method (CVM) investigation analysis in the same investigation region. However, there was a problem that the point whether main feeling mixed to use the questionnaire, and how much damage was received of where was indefinite though the amount of damage was presumed in the evaluation by CVM like this. The technique used by this research uses as an index and is presumption of the environmental capacity presumed based on the observation to overcome those problems. The presumption of the amount of environmental amends due to the NAHODKA oil-spill could be attempted by using the measurement data with which main feeling did not mix.

Acknowledgements

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