(II－31) ON TECHNOLOGY DEVELOPMENT FOR THE GRAVEL BEHAVIOR CLARIFICATION

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1. Introduction

In order to clearly evaluate sand and soil movements, a survey of changes in the river-bed (using sand level meters) has been continuing in the Abe River since 1996. This document reports on the results of the survey gathered during the period between 20th August 1998 and 30th September 1998.

2. Survey Method

As can be seen in Figure 1, the aforementioned survey is taking place in two specific areas: transversely at three points (4 sand level meters at each point) at Ushizuma check point (17.1 km), which has a water level survey station, and at one point (2 sand level meters in the center of the river) at Kadoya check point (14.25 km).

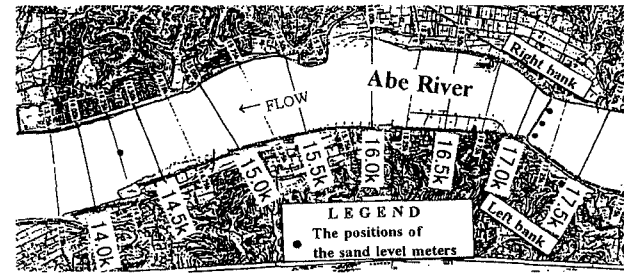

Figure 1 : Map showing the positions of the sand level meters

Two types of sand level meters exist, comprising of either a 6 meter- long or 3 meter -long stainless steel pole, and as can be seen from Photograph 1, each meter has been placed vertically in the hollow of an upright H-shaped base.

Photograph1 : Sand level meter

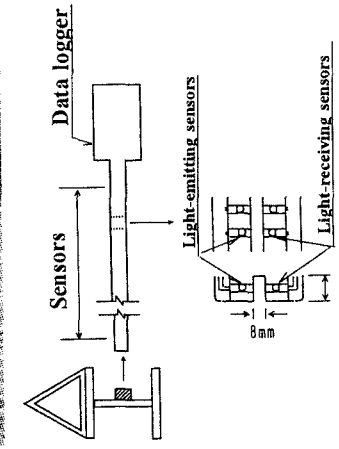

Figure 2 : Survey device

The sensors are embedded in the stainless steel pole, and comprise a pair of light-emitting sensors and light-receiving sensors, at intervals of 10 cm on the 6 meter-long poles, and at intervals of 2.5 cm on the 3 meter-long poles. When the river-bed rises and the optical axis between the light-emitting sensors and light-receiving sensors becomes cut off by sand, that position is discerned as the level of the river-bed (Figure 2), and is recorded as such in the data logger at regular intervals.

3. Survey Results

Flooding occurred on 4 occasions during the period between 20th August 1998 and 30th September 1998. None of the floods exceeded the average yearly maximum flux of Q=1,100^3/s. The changes in 'flux' and 'height of the river-bed' (measured by a 6 meter-long sand level meter) during this period at the left side of Ushizuma check point can be seen in Figure 3.

From the results taken at times of flooding during this period, it has become clear that the biggest change in the river-bed was a sandbar wave height of 1.9m, recorded on 28th August.

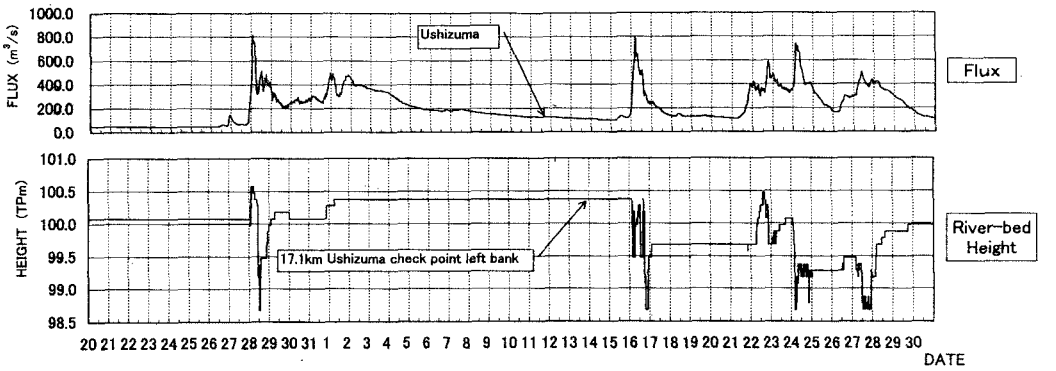

Figure 3 : Values for the survey of flux and river-bed height (20th August 1998 ~ 30th September 1998) (17.1km Ushizuma check point left bank 6 metre-long sand level meter)

4. An Examination of the Survey Results

In Segment 1, on a section of linear stream, 'the depth in the maximum scour section (Hmax.s)' and 'the scour depth in the maximum scour section (Δ Z)' (i.e. the difference between the average river-bed level and the deepest river-bed level) is evaluated as:

Hmax.s/Hn=1+0.8Hs/Hn ----- expression (1) Δ Z/Hm=0.8Hs/Hm ----- expression (2)

Hmax.s : Depth in the maximum scour section (m) **Hn** : Channel depth (m)

Hs : Sandbar wave height (m) **Δ Z** : Scour depth in the maximum scour section

Hm : Average depth during average yearly maximum flux (m) **Hs** : Sandbar wave height (m)

Furthermore, when the survey results are applied to the formula comprising "the relationship between 'the ratios of sandbar wave height to water depth (Hs/Hn)' and 'main channel breadth to water depth (B/Hn)'" obtained through waterway model experiments, the results correspond to "multiple sandbars and sandbar rows less than H/d <100". Therefore, considering the fact that there are multiple sandbars in the Abe River, it can be deduced that the ratio is in the range of Hs/Hm=2.

Here, the result of a river-bed data survey is defined as d, and if "average depth during average yearly maximum flux Hm" is calculated from unequal flow calculations, the Abe River may be computed as in Table 1.

Table 1: The Relationship between Hs/Hn and B/Hn in the Abe River

The present condition of the stream (surveyed in February 1998) During average yearly maximum flux

Stream point (km)	Average particle diameter *1) dm (mm)	Average water depth Hm (m)	Width of water surface B (m)	B/Hm	Hs/Hm	Hs = (Hs/Hm) Hm	Δ Z= 0.8 Hs
8.0 ~ 15.0	45	1.08	447	414	2.0	2.2m	1.7m
15.0 ~ 20.0	40	1.15	380	330	2.0	2.3m	1.8m

*1) Average particle diameter used results from a survey in 1975

The value of 2.3m for "sandbar wave height Hs" is a little larger than the biggest sandbar wave height of 1.9m surveyed on 28th August. However, if one takes into account the fact that the flux on that date was a little lower than the average yearly maximum flux, then the value seems reasonable.

5. Conclusion

The survey using sand level meters succeeded in measuring changes in the river-bed.

Moreover, when evaluating revetments, the calculated value of the "local scour depth" was verified to be more or less in harmony with the survey value for depth in the maximum scour section taken during this survey.

We plan to continue the survey of changes in the river-bed during flooding, so that the relationship between flux and sand and soil movements may be better understood.