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Research/Technical Note

Inference on the Surveying Methods at the 8th Century in Japan

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Abstract: Ancient regional records on geography named Fudoki were compiled in Japan at the 8th century. There were about 60 provinces at that time, but only 5 Fudoki (transcripts) have remained at present. Among them, Izumo Fudoki (edited in 733) is not only almost complete, but also contains detailed geographic data (surveying data) not found in the others. The surveying data are distances between major points, heights and sizes of mountains, sizes of lakes and isles etc. However, there are many differences when comparing these surveying data with actual sites. The Fudoki researchers had tried many times to interpret the relationships between the two, but many unclear points have remained. During the time, we civil engineers had little interest in the Fudoki. In this paper, we estimated the surveying methods by comparing the Fudoki data with map data and confirming the sites, then obtained the following conclusions. The distances were almost correct, the heights of the mountains were converted using the number of steps, the perimeters of the mountains were calculated with the trails as diameters, and the sizes of the lakes and isles were the lengths of the waterways. The surveying methods at that time were simple, but the results obtained were practical. We think that these ancient surveying methods were widely used, not in one region or one period.

Keywords: Izumo Fudoki, Ancient Surveying, Mountain Heights, Sizes of Lakes, Sizes of Isles

1. Introduction

At the beginning of the 8th century, the Emperor of Japan ordered each province to report the circumstances. The records, called Fudoki, contained names of counties, fertilities of lands, origins of place names, and legends.

At present, transcripts of 5 provinces and fragmentary articles of about 50 provinces are remained. Izumonokuni-Fudoki (edited in 733, abbreviation: Izumo Fudoki, the Fudoki) among them is the only one almost complete book remained, that contains detailed geographical information (surveying data). The surveying data includes the distances from the county offices to the boundaries, and to the major mountains, the sizes (lengths) and heights of mountains, lakes, isles, etc., [1].

Izumo Fudoki has more than 150 transcripts belonging to several different groups in details. The oldest transcript whose year can be confirmed is in 1597.

The earliest research book on the Fudoki is "Izumo Fudokisho" in 1683 by Tokiteru Kishizaki, a samurai of the province, which has focused on the estimation of sites by place names [2].

Since then, many researchers have succeeded or criticized the previous studies. In recent years, the Shimane Prefectural Board of Education, which is a public institution, aggregated all transcripts and promising views, then published "Commentary on Izumonokuni-Fudoki (CIF)" [1]. This paper is mostly based on this book.

However, this aggregation does not mean solving the problems as follows. When trying to match the numerical data described in CIF with the site map, we still face some problems. Because most of locations of county offices and the traffic routes are unknown. In addition, it is not understood how the sizes and heights of them were measured.

This paper aims to clarify the grounds for the numerical values in the Fudoki, comparing with the site maps and photographs, under the assumption that most of the values are correct. These detailed contents were/will be made clear

individually in Japanese papers [3-7]. This paper covers various surveying methods.

2. Izumo Province

Izumo Taisha, one of the biggest shrines in Japan, is located at Izumo province. The deity of this shrine is enshrined at all over Japan.

Many myths on Kojiki that attracted Lafcadio Hearn (1850-1904) and brought him to Japan are related to this province. For example, there is a story about killing of a dragon with eight heads. The Fudoki describes that the peninsula on the Japan Seaside was pulled out from the Korean Peninsula etc., which are several hundred kilometers away, to make the country (this province) larger.

Figure 1. *Izumo Taisha (one of the biggest shrines in Japan).*

Archaeologically, Izumo province facing Japan Sea is considered to have transacted direct/indirect exchanges and trades with the Korean Peninsula and China since ancient time, because of evidence such as relics and earthenware [8]. This is supported by the rice cultivation that came from southern China.

Figure 2. *Location of Izumo Province.*

At the end of the 20th century, a lot of bronze wares most in Japan were excavated from two adjacent ruins of the 1st century. The bronze wares consist of 358 swords, 16 halberds, 45 dongs, can be seen at the museum in this province [8].

These facts, mentioned above, show the prosperity of this province.

Izumo province located in the western part of Japan, the area is about 70 km east-west and about 60 km north-south. In the Nara period, it was divided into 9 counties, each with a county office.

Figure 3. *Restored remains and bronze wares.*

3. Scale and Maps etc.

The unit scale using in the Fudoki is 1 shaku=29.7 cm (in Tenpyo Scale). Length:1 bu=6 shaku=1.782m, 1 ri=300 bu=534.6m. Height:1 jo=10 shaku=2.97m.

The data used for the consideration are based on CIF, the values converted into meters are collated with the site maps.

The Chinese characters used in the Fudoki are shown in Table 1. As a result, it was found that one Chinese character

was used for two meanings (perimeter, size).

Table 1. *Chinese characters and its meanings.*

Item	Chinese character	Japanese reading	meaning	Chinese character	Japanese reading	meaning
Mountain	zhōu	meguri	perimeter	gāo	takasa	height
Lake	zhōu	meguri	size (length)	-	-	-
Isle	zhōu	meguri	size (length)	gāo	takasa	height

Note: Same Chinese characters may not be same meanings (as a result).

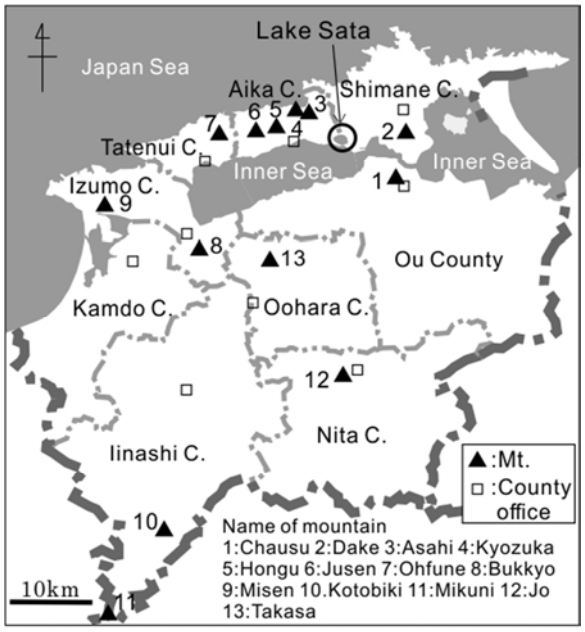

Figure 4. *Map of Izumo Province.*

We use the oldest detail map (S=1/25,000) of this area surveyed at 1914. This map shows many paths used for walking that are not on the present map. Prior to this, there is a map of 1899, but the scale is 1/50,000. The present map is too different from the old due to development and new roads. However, for the shapes of coastal isles, the map of 1914 is not accurate and is not suitable for consideration, therefore we use the present one.

In sentences, regarding the names of mountains, lakes, isles etc., the one in the Fudoki and the present one in () are written.

4. The Locations of the County Office and Major Mountains in Aika County

In the existing literatures, it has been presumed that the distances from the county office to the mountains are to the trailheads, and the mountain heights are from the trailheads to the summits [9, 10].

In this province, there are 13 mountains whose perimeters and heights are described. The reason for choosing Aika county is that 4 mountains are existing, therefore the location of the county office can be examined in multiple ways.

The descriptions about the mountains in the county are as follows [1].

1) Mt. Kamnabi (Mt. Asahi)

It is 9ri 40 bu (4880m) to the northeast from the county office to the mountain, the height is 230 jo (683m) and the perimeter is 14 ri (7480m).

2) Mt. Taruhi (Mt. Kyozuka)

It is 7 ri (3740m) to the north from the county office to the mountain, the height is 170 jo (505m) and the perimeter is 10ri 200 bu (5700m).

3) Mt. Asimuno-takano (Mt. Hongu)

It is 10ri 20 bu (5380m) to the west from the county office to the mountain, the height is 180 jo (535m) and the perimeter is 6 ri (3210m).

4) Mt. Tsuseno (Mt. Juzen)

It is 10ri 20 bu (5380m) to the west from the county office to the mountain, the height is 110 jo (327m) and the perimeter is 5 ri (2670m).

At first, in figure 5 (surveyed at 1914), we assume that the trailhead of Mt. Kyozuka is the village entrance. Following the road shown in the map, we take the distance of 3740m from the trailhead so that the direction from the summit is to the south (⇔ the north), then estimate the county office.

Next, following the road in the opposite direction from the county office to Mt. Asahi, we can find an actual trailhead at 4910m. It is 100.6% of the described value. The direction of the summit of Mt. Asahi is northeast, as described in the Fudoki (table 3) [4]. We can see the same roads in the illustration (like a picture) drawn at 1830 in the Edo period [11].

The reliability is confirmed, as independent descriptions of Mt. Kyozuka and Mt. Asahi are matched.

The values from the county office to Mt. Asimuno-takano (Mt. Hongu) and Mt. Tuseno (Mt. Juzen) in table 3, are also matched with the distances on the map, but these routes are in high degree of estimation.

Although the Fudoki does not describe the surveying methods, we presume that the east-west and north-south directions are based on the moving of the sun, and the distance measurements are used with poles, ropes, or pacing. These methods depend on general literatures.

Figure 6. *Mountains in Aika county. (Hearn loved this landscape).*

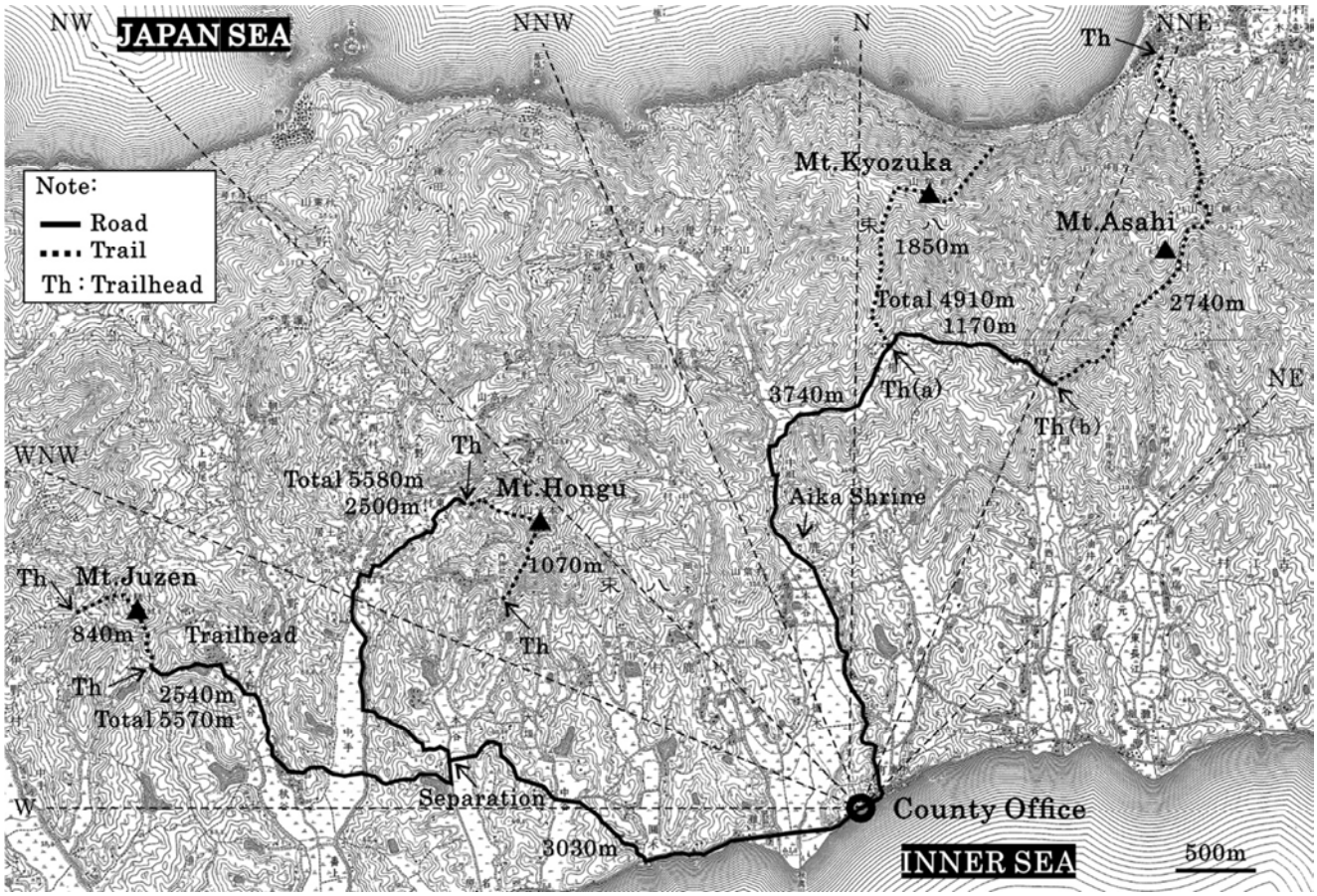

Figure 5. *Map of Aika county.*

5. Mountain Heights

Table 2 shows the heights of 13 mountains. The ratios of the numerical values described in the Fudoki to the actual elevations are 1.39 to 2.42 excluding in the colored columns, the described values are apparently higher than the actual values. Besides, the elevations of the trailheads are not taken into the consideration.

Considering the elevations of the trailheads, the numerical values of the two mountains, Asahi and Kyozuka in table 3, are more than 2 times than the actual heights.

Table 2. *Relations between mountain heights and steps.*

No.	Name of Mountain	a) Eleva-tion (m)	Records			Ratio (b/a)
			H (jo)	Steps	b) H (m)	
1	Chausu	171	80	1600	238	1.39
2	Dake	331	270	5400	802	2.42
3	Asahi	344	230	4600	683	1.99
4	Kyozuka	316	170	3400	505	1.6
5	Hongu	279	180	3600	535	1.92
6	Juzen	194	110	2200	327	1.69
7	Ohfune	327	120.5	2410	358	1.09
8	Bukyo	366	175	3500	520	1.42
9	Misen	506	360	7200	1069	2.11
10	Kotobiki	1013	300	6000	※891	0.88
11	Mikuni	795	50	1000	※149	0.19
12	Jo	578	125	2500	※371	0.64
13	Takasa	195	100	2000	297	1.52

Note: 1) Records are from "Commentary on Izumonokuni-Fudoki".
2) The hight of Mt. Ohfune seem to be a mistake.
3) ※ means the trailheads are high elevations.

Table 3. *Mountains in Aika county.*

Name of Mountain			Asahi	Kyozu.	Hongu	Juzen
	Direction from the office		NE	N	NW	NW
			○	○	×	○
Records	Distance from the office	ri	9	7	10	10
		bu	40	0	20	20
		meter	4880	3740	5380	5380
Road (measured, m)			4910	3740	5530	5570
Ratio (%)			100.6	100.0	102.8	103.5
Records	Height	jo	230	170	180	110
		a) meter	683	505	535	327
		steps	4600	3400	3600	2200
Summit (m)			344	316	279	194
Trail head (m)			40	75	-	-
b) Relative Height (m)			304	241	-	-
Ratio (a/b)			2.25	2.10	-	-
Records	Perimeter	ri	14	10	6	5
		bu	0	200	0	0
		shaku	25200	19200	10800	9000
		meter	7480	5700	3210	2670
Diameter (1/3 of Perimeter)		ri	4	3	2	1
		bu	200	167	0	200
		shaku	8400	6400	3600	3000
		a) meter	2490	1900	1070	890
Trail (measured)		Types	trail	ridge	ridge	both
		b) meter	2740	1850	1070	840
Ratio (b/a, %)			110.0	97.4	100.0	94.4

Note: 1) Records are from "Commentary on Izumonokuni-Fudoki".
2) Ridges when there are no mountain trails.

Generally, it had been thought that the heights of a mountains were measured by using triangles, as found in the ancient Chinese records [12].

In this method, the height H of the mountain is calculated using the angles (θ1, θ2) to looking up the mountain peak from the 2 points of a and b, with the distance ℓ between a and b (figure 7). If in this method, the values would be closer to the actual heights.

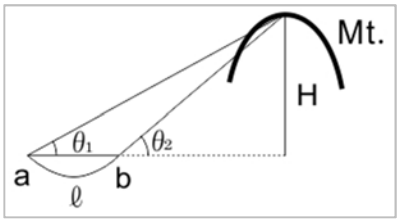

Figure 7. *Estimation of mountain height using triangles.*

Existing literatures do not provide satisfactory surveying methods [9, 10, 13, 14].

We infer that mountain heights are based on steps by climbing. Pacing is usually used to measure planar distances, but also can be used to measure heights. Although not accurate, the number of steps can be converted into the climbed height. If 1 step is 0.5 shaku (15 cm), 20 steps are 1jo (3m) [3].

In table 2, if every 1jo (3m) is 20 steps, 100 steps are the measurement unit except for one example (Mt. Ohfune) of mistake [15]. In the case of Mt. Chausu, the height is 171m in elevation, but it is 80 jo (238m) in the Fudoki. The number of steps is 20 x 80 jo=1600. The mountain takes 20 minutes to climb from the trailheads of 3 directions except the east side (40 minutes) [16]. Then, it means 80 steps per minute, which is reasonable walking speed.

Although the height calculated by this method is inaccurate, the climbing times can be easily calculated to make a travel schedule. It is a practical method of displaying mountain heights.

Figure 8. *Mt. Chausu from the southeast.*

6. Mountain Perimeters

Regarding mountain perimeters, there are some doubts of where the surveying lines were set, how to measure on steep cliffs and among deep bushes. Furthermore, there is a question

of whether the mountain perimeter is an important index for deserving difficult works or not. In table 3, assuming that the mountains are circles, the numerical values of 1/3 of the perimeters were compared with the distances of the trails. To take Mt. Asahi as an example, 1/3 of 7480 m of the perimeter is 2490 m, on the other hand, the measured value of the mountain trail is 2740 m (110.0%, figure 5, table 3).

For Mt. Kyozuka, there is no trail at present, so we follow the ridge. One third of 5700 m of the perimeter is 1900 m, and the distance of the mountain trail is 1850 m (97.4%).

Similar results are obtained for the other two mountains.

It can be said that they are individually matched, considering bad condition that they are mountain trails with slopes and turns.

Surveying works are not difficult if mountain trails are used, it is the same about the other mountains. In other words, the perimeters were calculated by assuming the mountains to be circles and multiplying the lengths of the trails by 3 times, as the diameters [4].

This method is convenient to show the approximate sizes (perimeters) of mountains.

7. Lake Sizes (Lengths)

Sizes of two lakes are described in the Fudoki. Usually, they are thought as the perimeters of the lakes. However, they do not match the perimeters based on geological estimation.

This paper deals with Lake Sata. The descriptions of the lake are as follows [1].

The perimeter of the lake is 7ri (3740m). Crucian carps are there. The lake connects to the inner sea. The waterway is 150bu (267m) long and 10bu (18m) wide.

As shown in figure 9, when Lake Sata is drawn with a surrounding area of 7ri (3740m), the elliptical shape shown by the dotted line (long axis is about 1500m).

However, extremely flat lowlands spread in this area, and there are no private houses except around the hilly areas. This situation is the same on the map of 1914 (figure 9) and the photograph at present (figure 10).

After all, the part within the dotted line is not much lower than the surroundings, and no reason can be found for dividing the lowlands. Therefore, we must estimate the range of the lake in the 8th century under the following conditions.

1) The water area spread to the vicinities of the hills.

2) There was a waterway with 150 bu (267m) long and 10 bu (18m) wide connecting with the Inner sea.

Thus estimated, the perimeter of the lake is 24ri (12800m).

In our previous paper [5], we interpreted the waterway on Lake Sata was one section of one of the main traffic routes in Izumo province, and the length was 6ri (3200m).

Since it is necessary to avoid shallows and wind waves on the actual route, there is no problem caused even if the distance is 7 ri (3740m).

If the size of the lake shows the length of the waterway, the values in the Fudoki and in the map will be matched [6]. It is a convenient display to make the tour schedules.

Note that the Sada River shown in figure 9 is an artificial river that was excavated in 1787 (Edo period) to drain the water from the inner sea to the Japan Sea, and it did not exist in the time.

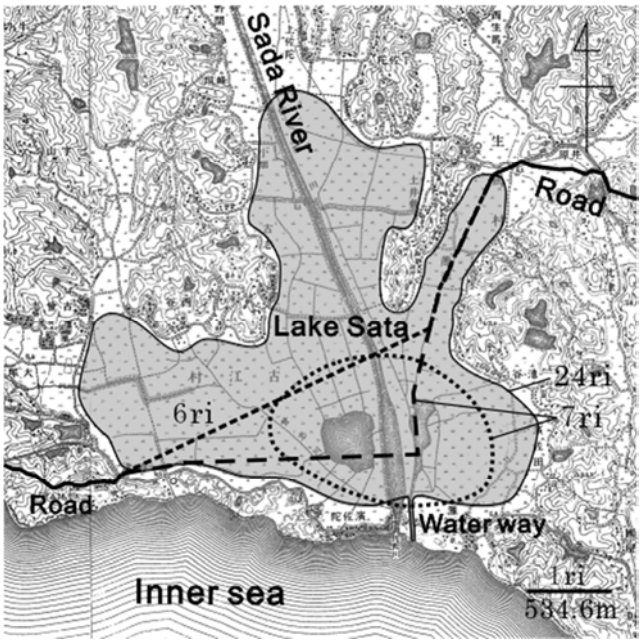

Figure 9. *Map of Lake Sata area (estimated).*

Figure 10. *Lake Sata: The height difference between the water surface and the surrounding paddy fields is small.*

8. Sizes (Lengths) and Heights of Isles

Figure 11 and table 4 show the isles whose sizes (lengths) and heights are described in the Fudoki. These values greatly differ from them of the actual isles.

8.1. Mistakes in Transcription

The Fudoki is extremely old and has been transcribed many times. First, it is necessary to understand the possibility of mistakes on numerical values in the transcriptions.

There are some groups in the transcripts, the representative books are shown in table 4 [17].

If assuming that the values of CIF are correct, the ratio of

mistakes excluding duplication is about 3% (8/279). The reason why excluding the duplication is that they were guessed mistakes in the source book. This is an approximation.

The contents of them are confusions of "30 and 40" of Chinese characters, mistakes of units, and so on.

In addition, we must consider that there are accumulated mistakes in all four books. The Hosokawa-book transcribed in 1597 is the oldest of them, but more than 860 years had passed since the original editing.

However, we cannot doubt that most of values are not wrong based on table 4.

Next, figure 12 shows the numerical notation of the Fudoki (in 1793) from the National Diet Library Digital [18]. The following patterns are likely to cause mistakes in transcription.

a) “1, 2, 3” of Chinese characters
The strokes are simple (number of horizontal lines).
b) “20, 30, 40” of Chinese characters
The strokes are simple (number of vertical lines).
c) “7 and 20” of Chinese characters
The fonts are similar.
d) The others
It is possible for missing numbers or mis-correction etc.

Table 4. *Numerical values about isles described in various Izumo Fudoki.*

No.	Records		Hosokawa-book			Kurano-book			Hinomisaki-book			Manyo-i-book					
	Name of Isle		Size		H	Size		H	Size		H	Size		H	Size		H
	Ancient	Present	ri	bu	jo	ri	bu	jo	ri	bu	jo	ri	bu	jo	ri	bu	jo
Ou county																	
1	Tokami	Mt. Tokami	3	180	60	3	180	60	3	180	60	3	180	60	3	180	60
Shimane county																	
2	Tako	Daikon	18	100	3	18	100	3	18	100	3	18	100	3	18	100	3
3	Mukade	Ye	5	130	2	5	130		5	130	2	5	130	2	5	130	2
4	Misa	Wana cape		260	4		260	4		260	4		260	4		260	4
5	Yui-I. G.	around Aoki	2	30	10	2	30	10	2	30	10	2	30	10	2	30	10
6	Kuu	Ku	1	30	7	1	40	0.7	1	40	0.7	1	30	0.7	1	30	0.7
7	Ya	Ya		200	20		200	20		200	20		200	20		200	20
8	Awa	Ao		280	10		280	10		280	10		280	10		280	10
9	Ko	Naka		240	10		240	10		240	10		240	10		230	10
10	Hato	Hachisu		120	10		120	10		120	10		120	10		120	10
11	Tori	Oni		82	15		82	15		82	15		82	15		82	10.5
12	Ye	Ki		120	5		120	5		120	5		120	5		120	5
13	Inazumi	Nakura cape		48	6		48	6		48	6		48	6		38	6
14	Kashi	White Kasuka		56	3		56	3		56	3		56	3		56	3
15	Aka	Black Kasuka		100	1.6		100	1.6		100	1.6		100	1.6		100	1.6
16	Tuki	Tuki	2	18	1	2	18	1	2	18	1	2	18	1	2	18	1
17	Maya	Yoko		86	5		86	5		86	5		86	5		86	5
18	Matsu	Matsu		80	8		80	8		80	8		80	8		80	8
19	Tsuru	Ohtsuru		210	9		210	9		210	9		210	9		210	9
20	Mi	Kaga cape		280	10		280	10		280	10		280	10		280	10
21	Katsura	Katsura	1	110	5	1	110	5	1	110	5	1	110	5	1	110	5
22	Kushi	Kushi		240	10		240	10		240	10		240	10		230	10
23	Koi	Kuri		80	10		80	10		80	10		80	10		80	10
24	Ma	Ma		180	10		180	10		180	10		180	10		180	10
25	Na	Kuro		180	9		180	9		180	9		180	9		180	9
26	Kuu	Tera		130	7		130	7		130	7		130	7		130	0.7
Aika county																	
27	Mi	Me		80	6		80	6		80	6		80	6		80	6
Izumo county																	
28	Ohsaki	Tsuru		250	1		255	1		250	1		250	1		250	1
29	Yamasaki	Hino cape	1	250	39	1	250	39	1	250	39	1	250	39	1	250	39
30	Mikuriya	Umaya		20	4		20	4		20	4		20	4		20	4
31	Kadoiwa	Benten		42	5		42	5		42	5		42	5		42	5

Note: 1) Records are from “Commentary on Izumonokuni-Fudoki (CIF)”.
2) Coloring columns are different from CIF. Different patterns are counted. (8/279).
3) Present Names in CIF were partially corrected.

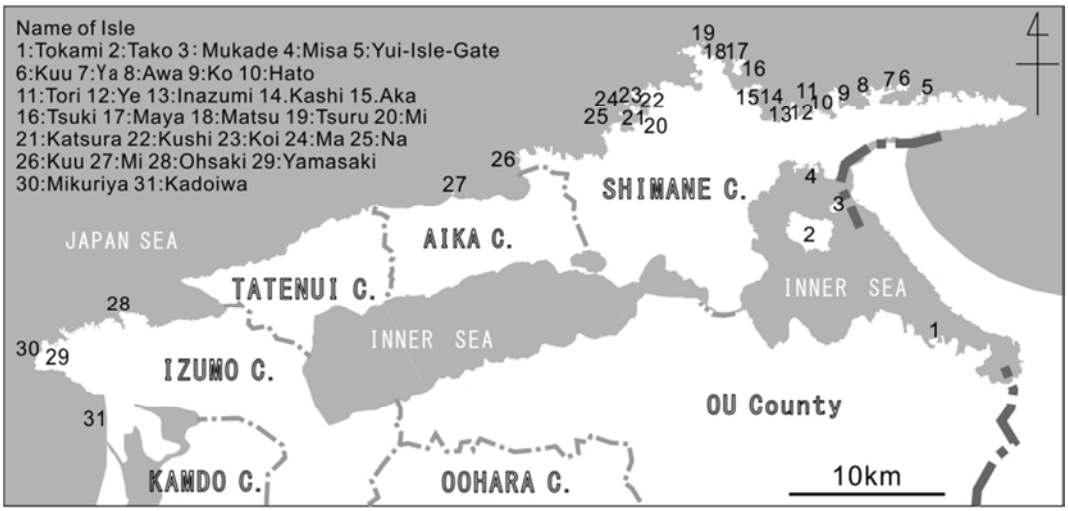

Figure 11. *Locations of the isles.*

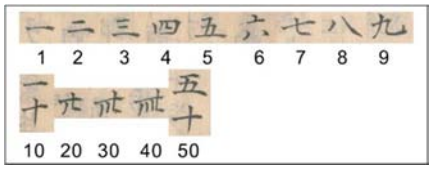

Figure 12. *Notation of numbers in the Fudoki.*

8.2. Description of the Isles

As showing table 5, regarding the sizes (lengths) of the isles, comparing the values in the Fudoki and the actual values on the map, there are not only some cases that the lengths are almost their perimeters, but also many different cases less than 1/2.

Previously, the latter was dealt with as mistakes in the transcription. However, as mentioned above, they are not many. Therefore, it is necessary to clarify what the measured values are.

Table 5. *Sizes (lengths) and heights of the isles.*

No.	Name of isle		Size				Height	
	Ancient	Present	Records			Actual length ratio	Records	
			ri	bu	m		jo	m
Ou county								
1	Tokami	Mt. Tokami	3	180	1920	1	60	178
Shimane county								
2	Tako	Daikon	18	100	9800	1	3	9
3	Mukade	Ye	5	130	2900	1	2	6
4	Misa	Wana cape		260	460	1/3	4	12
5	Yui-Isle-Gate	around Aoki	2	30	1120	1	10	30
6	Kuu	Ku	1	30	590	1/4	7	21
7	Ya	Ya		200	360	1/2	20	59
8	Awa	Ao		280	500	1/2	10	30
9	Ko	Naka		240	430	3/4	10	30
10	Hato	Hachisu		120	210	1/2	10	30
11	Tori	Oni		82	150	1/2	15	45
12	Ye	Ki		120	210	1/3	5	15
13	Inazumi	Nakura cape		48	86	1/8	6	18
14	Kashi	White Kasuka		56	100	1/3	3	9
15	Aka	Black Kasuka		100	180	3/4	1.6	5
16	Tuki	Tuki	2	18	1100	1/3	1	3
17	Maya	Yoko		86	150	1/4	5	15
18	Matsu	Matsu		80	140	1/3	8	24
19	Tsuru	Ohtsuru		210	370	3/4	9	27
20	Mi	Kaga cape		280	500	1/2	10	30
21	Katsura	Katsura	1	110	730	1/2	5	15
22	Kushi	Kushi		240	430	3/4	10	30
23	Koi	Kuri		80	140	1/4	10	30
24	Ma	Ma		180	320	1/3	10	30
25	Na	Kuro		180	320	3/4	9	27
26	Kuu	Tera		130	230	1/2	7	21
Aika county								
27	Mi	Me		80	140	1/2	6	18

No.	Name of isle		Size				Height	
	Ancient	Present	Records			Actual length ratio	Records	
			ri	bu	m		jo	m
Izumo county								
28	Ohsaki	Tsuru		250	450	1	1	3
29	Yamasaki	Hino cape	1	250	980	-	39	116
30	Mikuriya	Umaya		20	36	-	4	12
31	Kadoiwa	Benten		42	75	1	5	15

Note: 1) Records are from “Commentary on Izumonokuni-Fudoki”.
2) Actual length ratio is depended on the perimeter of the isle alone.

In Japanese, "meguri" usually means perimeter (table 1). Sometimes, it is used to mean tour around places in order. We inferred that the sizes of isles were the lengths of the tour routes near them [7], the same as lakes.

There are also big differences in the heights of the isles.

Using maps and photographs, we concluded that they were the visible impression, not showing the highest points of the isles [7].

The sizes（lengths）and heights of representative isles are mentioned below.

8.3. Tako Isle (Daikon Isle, Figure 13)

It is described as 18 ri 100 bu (9800m), almost equal to the perimeter of the isle.

The highest point is 42m in elevation. Therefore, 3 jo (9m) does not show the summit of the isle but the overall height, that is the impression of the landscape.

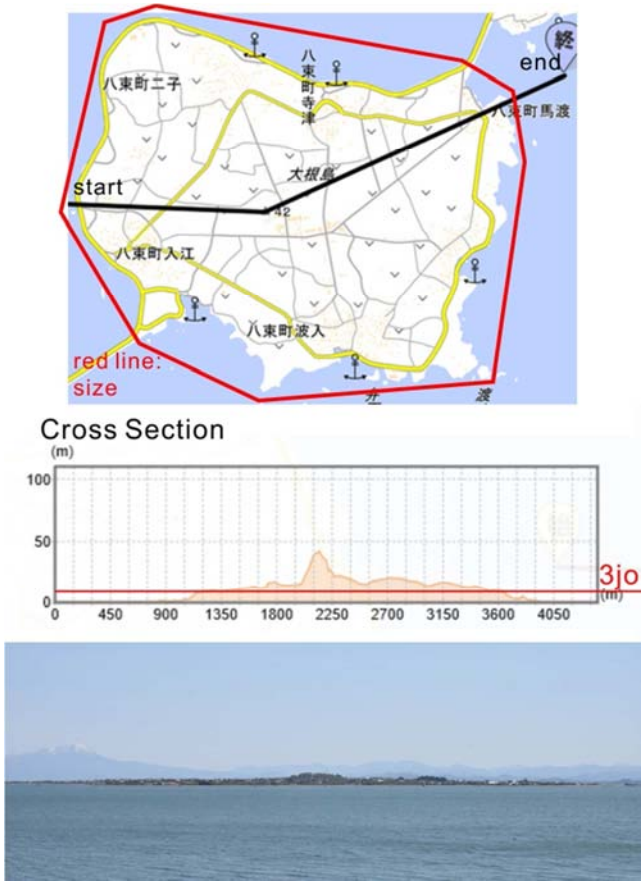

Figure 13. *Daikon Isle.*

8.4. Yui-Isle-Gate (Aoki Isle Area, Figures 14, 15) and Kuu Isle (Ku Isle, Figures 14, 16)

As you can see in figure 14, Aoki Isle, neighboring small isles, and a cape confront Kuu Isle on the opposite side, like a gate, at the bay entrance of Shichirui Port where 30 ships could be anchored.

The size (length) of Yui-Isle-Gate is 2 ri 30 bu (1120m), which is equivalent to the perimeter of Aoki Isle alone.

On the other hand, Kuu Isle on the opposite side is 1ri 30bu（590m）, which is about 1/4 of the perimeter of Ku Isle.

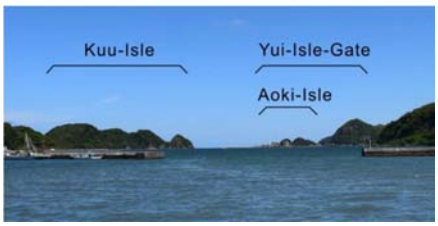

Figure 14. *Landscape from the port.*

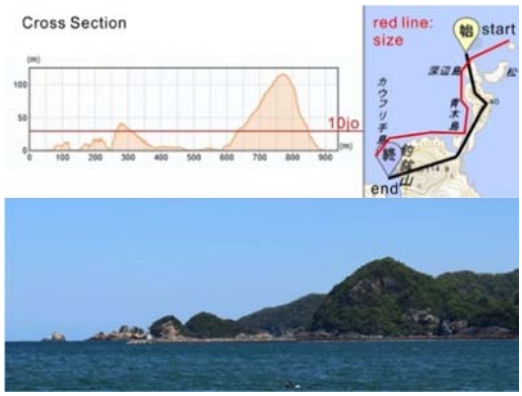

Figure 15. *Aoki Isle area.*

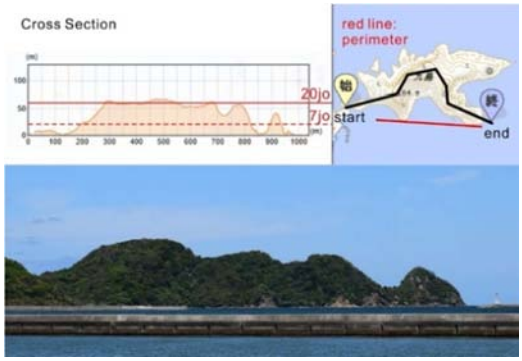

Figure 16. *Ku Isle.*

If it is a problem of only Kuu Isle, it must be judged as a mistake. However, as shown in Table 5, most of the isles are smaller than its perimeters.

We inferred that the causes of the inconsistencies did not depend on inaccurate surveying, but what were measured.

Then we have concluded that the sizes of the isles are the lengths of the tour routes. Since there is not much evidence, it is necessary to collect other instances.

The height of Yui-Isle-Gate is 10 jo (30 m), which is roughly same as Aoki Isle.

The height of Kuu Isle is 7 jo (21m), but Ku Isle is much higher than it. Depending on the forms of Chinese characters of "7 and 20" are judged to be confused, as mentioned above.

8.5. Ya Isle (Ya Isle, Figure 17)

The size (length) of Ya Isle is 200bu (360m), which is about half of the perimeter.

The height is 20 jo (59m), it should be corrected to 7 jo (21m) based on figure 17, in addition, the forms of Chinese characters of "20 and 7" are similar (figure 12). Note that there is a possibility of 10 jo (30m).

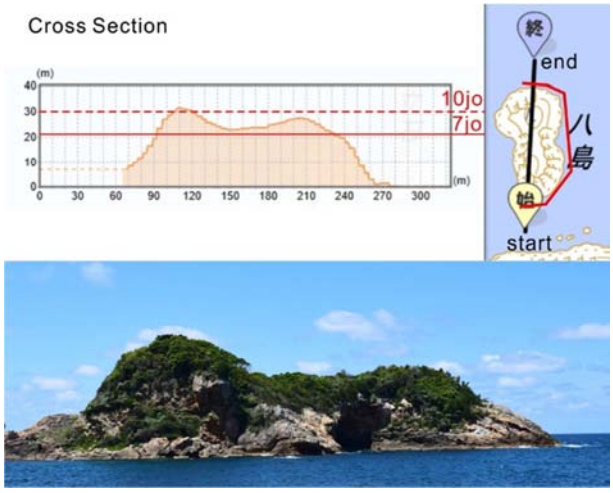

Figure 17. *Ya Isle.*

Looking at the photograph of Ya Isle, we notice that the lower part of it has no vegetation and the rocks are exposed due to waves.

If the height of the boundary line between rocks and vegetation is set to 5 jo (15m), the height of the isle can be estimated by its multiple.

For example, if when 1.5 times it will be 7-8jo (21-24m), 2 times -10 jo (30m), and much higher with rich vegetation, it will be 20 jo (60m). This method is simple but has a certain degree of accuracy and seems to be useful.

The heights such as 4jo, 6jo, 9jo, etc., are seemed to be added or subtracted 1 jo (3m) on the basic values, as an opinion.

9. Conclusion

In this paper, we infer the surveying methods in Izumo Fudoki as follows.

It is estimated that the distances described in the Fudoki were measured by poles, ropes, or pacing, and that the 8 directions were based on the movement of the sun. These methods depend on general literatures.

The heights of the mountains were converted every 20 steps to 1 jo (3m). This method may be inaccurate to measure mountain elevations, but it can be easily converted into the climbing times.

The perimeters of the mountains were confirmed that the numerical values based on the mountain trails as the diameters.

The lake sizes were estimated to the lengths of waterways. It is convenient to know the tour times of the lakes.

Though it had been thought that the sizes of the isles were the perimeters, it is impossible to explain the dispersions of the ratios compared with the actual isles. The idea that the sizes of isles were the lengths of the tour routes is reasonable.

The heights of the isles do not depend on the highest points, seem to be estimated by the overall landscapes.

In Japan, it is said that the oldest map is one around in the 9th century. However, we imagine that there was a map not inherited to nowadays, when the Fudoki was edited (in 733). It is difficult without a map to explain the circumstances. We also imagine that the triangulation by drawing was used to make the map at the time, which requires neither elaborate tools nor difficult calculations.

The ancient surveying methods are simple and practical. We think that they are not limited to one region or one period. We desire to collect related instances, in the future.

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