Estimation of Small Hydropower Generation on Headwork

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Introduction

In Japan, water resource is abundant and the topography is steep, which are good conditions for development of small hydropower generation (SHP). There are a great potential generation for mid and small hydropower generation in Japan. Headwork (weir) is one of agricultural water supply facilities and it can be effective water resource for making SHP generation. It is hypothesized that it has great potential SHP generation in Japan. So, in this research, we focus on the discharge water from headwork to estimate the potential power generation on headwork for evaluating feasibility of SHP generation.

Materials and Method

In this research, eight headworks (Fig.1) located in Aichi and Gifu prefectures are evaluated for estimating the potential generation.

Using the daily flow rate (Tab.1) and the effective head (Tab.2) to obtain the power generation output which was calculated from the following equation.

$$P = g \times \eta \times Q \times H,$$

(p: generation output [kW], g: gravitational acceleration[m/s²], η: General efficiency (=0.72), Q: flow rate[m³/s]).

In this research, the annual and monthly power generation was obtained by using the

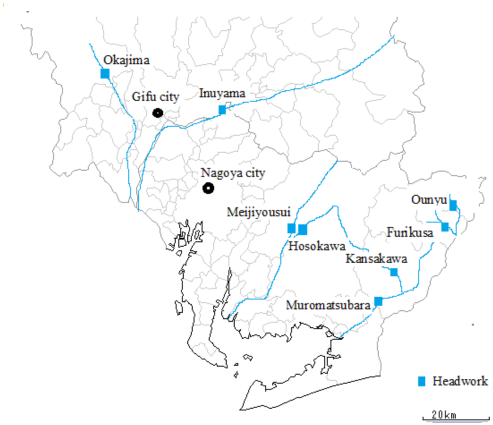

Figure 1 Location of test headworks

Table 1 Daily flow rate

Headwork	Duration (day)	Application data (day)	Absent data (day)
Inuyama (IY)	2008.1~2017.12	3,329	324
Meijiyousui (MJ)	1997.4～2018.3	7,669	1
Muromatsubara (MM)	2002.1~2017.12	5,842	2
Kansakawa (KS)	2002.1~2017.12	5,844	0
Onyu(ON)	2002.1~2017.12	5,429	415
Furikusa (FK)	2002.1~2017.12	5,691	153
Hosokawa (HK)	2012.1~2017.12	2,188	4
Okajima (OK)	2013.8~2018.5	1,465	301

Table 2 The outline of test headworks

Headwork	Location(°)		Effective head (m)	Weir length (m)	Type
	NL	EL			
IY	35.39	136.94	5.8	420	movable/immovable
MJ	35.05	137.18	5.6	167	floating
MM	34.88	137.47	3.3	196	movable
KS	34.97	137.55	3.9	58	movable/fixed
ON	35.14	137.7	3.8	30	movable
FK	35.08	137.68	2.5	34	movable
HK	35.03	137.18	2.1	64	floating
OK	35.48	136.57	3.3	162	movable

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maximum power output when the utilization rate is 60%.

Results and Discussion

Daily flow rate was ranked by descending order, and which was transformed to the excess probability shown in Fig.2 (a). Then, we obtained the utilization rate (%) corresponding to the excess probabilities of 10% to 90% expressed in Fig.2 (b).

Finally, the maximum power output was obtained when the utilization rate is 60% [Fig.2(c)], and then, estimated the annual and monthly power generation using the maximum power output obtained above (Fig.2 (d) and Table.3).

Relatively big potential of power generations were obtained for both annual and monthly power generation although it has big fluctuation between irrigation and non-irrigation season due to the changes of agricultural water demand.

From the results, three types of monthly power generation were obtained as follows; 1) Power generation in non-irrigation season is higher than in irrigation season, 2) power generation in non- irrigation is lower than in irrigation season, 3) power generation has constant tendency.

In this study, further detailed discussion and evaluation are needed. For evaluating small hydropower generations on headworks, stability of power generation is still a problem, and the limitation of intake flow rate for power generation should be consulted with river water users because it usually occurs water reduction section in the downstream from headwork after doing water intake.

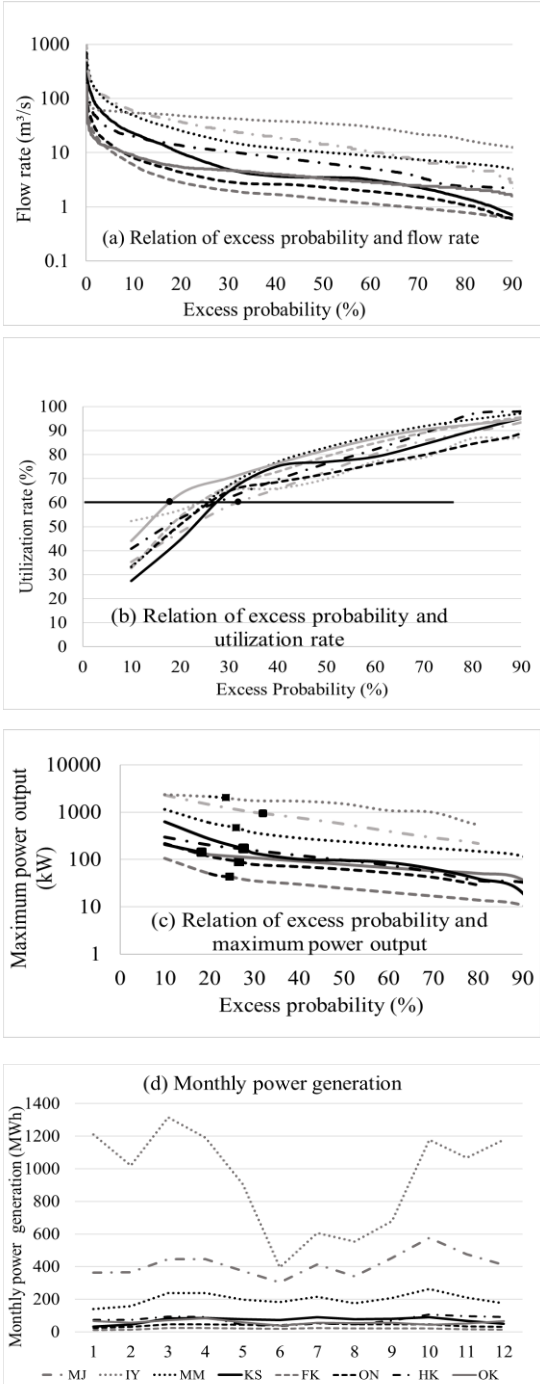

Figure 2 Monghly power generation

Table 3 Maximum power output, annual and monthly generation

Rsearch sites	Maximum power output	Annual power generation			Monthly power generation		
		Ave.①	SD ②	②/①	Ave.①	SD ②	②/①
	kW	MWh/Y			MWh/M		
IY	2002	10524	232	0.22	942	232	0.25
MJ	947	4971	161	0.19	414	161	0.39
MM	468	2406	57	0.15	200	57	0.28
KS	168	851	23	0.16	71	23	0.33
FK	43	224	6	0.14	19	6	0.32
ON	91	472	14	0.22	41	14	0.33
HK	167	876	23	0.21	73	23	0.31
OK	143	563	19	0.39	59	19	0.32