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STUDY ON FLOOD CONTROL EFFECT OF ABUGAWA DAM ON THE FLOOD IN JULY 2013 AND IMPROVEMENT MEASURES [(*)]

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1. INTRODUCTION

The purpose of this study is to verify the flood control effect of Abugawa Dam on the occasion of heavy rain disaster in Yamaguchi-Shimane area in Japan dated July 28, 2013 and, to suggest improvement ideas for dam operation. Abugawa Dam is the largest dam in Yamaguchi Prefecture and one of the largest in Japan. The height of the dam is 95 m, the volume of the dam is 426,000 m^3, and the storage-of-water capacity is 153.5 million m^3.On this heavy rain, the dam played a remarkable role to thoroughly protect Hagi City, which is a big city lying on the lower Abu River, from damages. In this paper, the water level lowering effect attributing to the dam is calculated and, whether adjustment operation from water storage for utilization to flood control was smoothly conducted is examined. In addition, in order to make dam operation safer and more reliable, the trial calculation is done on the applicability of the water level threshold discharge

[(*)] *Étude de l'efficacité du barrage d'Abugawa pour le contrôle de la crue de juillet 2013 et mesures d'amélioration*

method which was invented by Imamura. Also, the necessity of effective dam operation such as preliminary release system is examined by applying rainfall prediction. Preliminary release refers to discharging water before a flood comes to the dam. The prediction is done by Japan Meteorological Agency using MSM based on Global Spectral Model. Furthermore, measures are suggested for improvement of the reserved time between decision making of discharge and actual dam gate opening.

2. FLOOD CONTROL EFFECT OF ABUGAWA DAM

2.1. RAINFALL STATUS AT THE ABU RIVER WATERSHED

The Abu River (Abugawa) has its source in the Mt. Gongen and runs through Hagi City while merging a couple of branch rivers such as the Zoumeki River, the Ikumo River and the Sasanami River, then finally runs into Japan Sea. The watershed area reaches 694.8km^2 and the length is 82.2km. It is the largest river in the Japan Sea coast in Yamaguchi Prefecture. (see Fig.1 [1])

The river project on the Abu River was embarked in 1967 for flood control, water securement for unspecified use, and for power generation and was completed in 1975.

According to the data [2] from the prefectural government on the heavy rain dated July 28, 2013, a lot of rainfall was observed in the northeast side of the watershed which is located near the border between Shimane and Yamaguchi Prefectures, which corresponds to the upper reach of the Abu River System, namely the upper reach of the Abu River, the Ikumo River, and the Zoumeki River. The noticeable total rainfall observed at rain gauge stations are; 470mm at Tokusagamine, 330mm at Asoubashi, 305mm at Sengokudai. On the other hand, the rain gauge stations located in the mid or downstream area observed mostly less than 50mm with the most of 55mm at Fukuishia station.

The targeted safety level of flood control under the flood control plan of the Abugawa Dam is calculated based on 100 year occurence probability and, the projected figures are; 300.4 mm at Yoshibe, 293.9 mm at Tokusa, and 312.7 mm at Shino.[1] As for the heavy rain this time, the average rainfall of the area was 136 mm and, it is about one third of the flood control plan, while the upstream area had heavy rainfall.

2.2. FLOOD CONTROL METHOD AT ABUGAWA DAM

2.2.1. Abugawa Dam Operation Regulations

Abugawa Dam Flood Control Plan controls floods by reducing the unregulated peak discharge 3,750 m^3/s to 2,000 m^3/s at the downstream datum point, Nakatsue, by discharging maximum 1,200 m^3/s water from the dam where maximum flood flow 3,130 m^3/s becomes 1,930 m^3/s as a result of flood control.

Accordingly, the dam has flood control capacity of 65 million m^3 during flood period (June 16 through September 30). The specific operation method of the Abugawa Dam is prescribed in Abugawa Dam Operation Regulations [3] as the following equation.

2.2.2. The Actual Flood Control Conducted

The data of inflow and discharge volume of Abugawa Dam at this heavy rain are published by Yamaguchi Prefectural Government. See Fig. 2. The recorded largest inflow was 1,381 m^3/s and 105m^3/s was discharged at this point. The peak of the flood control volume is 1,276 m^3/s. Also, the maximum discharge after the flood peak is 552m^3/s.

The reservoir level of Abugawa Dam at 5:00 on July 28, just before the afflux of flooded water, is 74.62 m. This level is lower by about 5m than the flood season control level 79.5 m. There are no national standard rules how much water should be discharged from a dam when flooding occurs during the period when reservoir level is within the water utilization capacity and lower than flood season control level. Therefore, it is left to the local dam administrators' discretion.

At 13:00 on July 28, reservoir level exceeded the flood season control level and reached 80.12m. Then the running water was stored in the flood control capacity. As the inflow at this point is 1,241m^3/s, the downstream discharge volume is calculated as 697m^3/s according to Eq. [1]. That is to say, according to the operation regulations, the discharge volume is supposed to corresponds to the dotted line when inflow is increasing, while it should be 697m^3/s after the peak of inflow. The actual discharge was 266m^3/s as indicated with the solid line and as a result, large volume of water indicated as the shaded portion (reaching 2.662 million m^3) was stored in the dam. This is the storage which is not allocated in the flood control plan. Therefore, if excess flood occurs, it would pose a danger to the downstream area. The cause of this storage lies in the operation regulations. The Article 25 [3] calls on dam administrators to send notification to the authorities concerned and, to take necessary measures for publicizing among ordinary people in order to prevent hazard upon discharging. In addition, the Article 12 [3] of the regulation states that the notification to the authorities concerned must be done 2 hours before discharge. To be specific, what have to be done are; to make

the announcement to all the authorities concerned; to blare sirens installed at downstream of the dam to make ordinary people aware; to patrol downstream to make sure nobody is in the river. To do all these tasks, it takes about 3 hours in total. Taking all these requirements into consideration, increase of discharge was refrained.

Outflow Discharge = 0.266 (Inflow – 500) + 500 (m^3/s) [1]

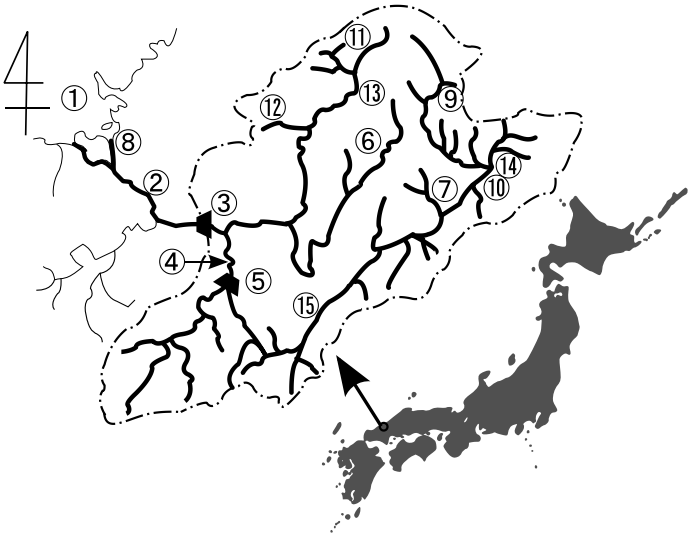

Fig. 1
The map of the Abu River (Abugawa) Watershed
Carte du bassin du feuve Abu

1	Japan Sea	*1*	*Mer du Japon*
2	Nakatsue	*2*	*Nakatsue*
3	Abugawa Dam	*3*	*Barrage d'Abu*
4	The Sasanami River	*4*	*Rivière Sasanami*
5	Sasanamigawa Dam	*5*	*Barrage de Sasanami*
6	The Zoumeki River	*6*	*Rivière Zoumeki*
7	The Ikumo River	*7*	*Rivière Ikumo*
8	Hagi City	*8*	*Ville d'Hagi*
9	Tokusagamine	*9*	*Tokusagamine*
10	Asoubashi	*10*	*Asoubashi*
11	Sengokudai	*11*	*Sengokudai*
12	Fukuishita	*12*	*Fukuishita*
13	Yoshibe	*13*	*Yoshibe*
14	Tokusa	*14*	*Tokusa*
15	Shino	*15*	*Shino*

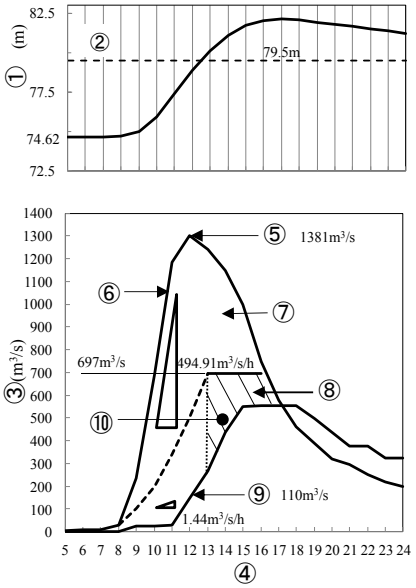

Fig. 2
Flood control at Abugawa Dam
Contrôle des crues du barrage d'Abu

1	Reservoir level	*1*	*Niveau de retenue d'eau*
2	Flood season control level	*2*	*Niveau d'eau limité en période de crue*
3	Flow	*3*	*Débit*
4	Time on July 28	*4*	*Heure(s), le 28 juillet*
5	The largest inflow	*5*	*Débit maximum*
6	Inflow to dam	*6*	*Débit sur le barrage*
7	Stored Water	*7*	*Retenue d'eau*
8	Discharge from dam	*8*	*Déchargement d'eau du barrage en aval*
9	Discharge at the largest inflow	*9*	*Déchargement d'eau au débit maximum*
10	2.662 million m^3	*10*	*2.662 million m^3*

2.2.3. Flood Control Effect of Abugawa Dam

In order to calculate the flood control effect of Abugawa Dam, the water level data at Nakatsue measured by the prefectural government are converted into flow

volume at Nakatsue by H~Q equation. The maximum flow is calculated by plugging in the Nakatsue flow volume and the flow data of Abugawa Dam for Eq.[2]. Considering the difference between the discharge time and the time when the flow reached the peak at Nakatsue, Δt=1hr30min and, calculations were done every 10 minutes.

$$Q_{es}(t+\Delta t) = Q_{ob}(t+\Delta t) + Q_{cut}(t) \quad [2]$$

$Q_{es}(t+\Delta t)$: estimated flow at Nakatsue without Abugawa Dam
$Q_{ob}(t+\Delta t)$: flow at Nakatsue converted from water level at Nakatsue
$Q_{cut}(t)$: flow controled by Abugawa Dam

The calculated flow at Nakatsue was plugged into H~Q equation and an estimated Nakatsue water level was back calculated. As a result of flood control, as shown in Fig. 3, it is considered that water level lowering effect by about 3.4 m at the downstream datum point Nakatsue was accomplished. If it had not been for Abugawa Dam, it is estimated that the water level would have reached 5.05 m at the flood peak. This number is only 5 cm lower than 5.10 m, which is the flood hazard water level. Thus, the evacuation order would have been ordered with high probability. Since the maximum 1,271 m^3/s flood control was executed, water level was kept under flood warning water level throughout the flood period. Especially the water level at the flood peak time was only 1.61 m, which is much below the flood fighters standby level, 2.40 m [4].

As a result, no damage was caused at the downstream of Abugawa Dam. On the other hand, at the upstream area of the river where there is no advantage of flood control effect of the dam, immense harm such as crash of houses and a railway bridge being washed away, was reported. This was because heavy rain was concentrated at the upstream area of the dam, such as Tokusagamine, and Asoubasi. More specifically, the highest intensity of hourly rainfall at Tokusagamine was 92 mm/h, and if the rainfall probability announced by Yamaguchi Observation Station is applied, the figure makes excess probability of more than 1/200.

As mentioned in 2.1., the rainfall which caused the flooding was, smaller comparing to the flood control plan since the total rainfall was about 136 mm even though partial guerilla-like rainfall was observed. In addition, it is considered that Abugawa Dam had a profound effect on flood control because the dam is located at the midstream of the main river and near Hagi Ciity where population and properties are concentrated and, the dam has 523 km^2 of catchment area which corresponds to 75% of the whole watershed. Since Abugawa Dam is located at directly upper stream of the city area which has big flooding potential, it is considered that the dam demonstrated notable flood control capability against regional localized torrential rain.

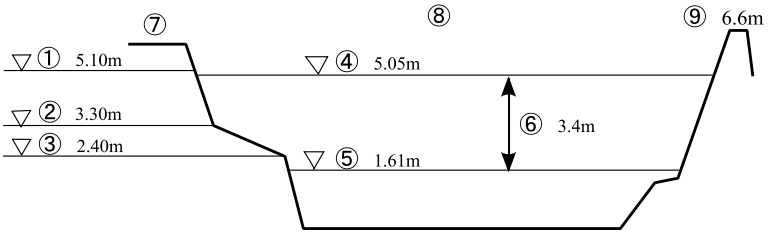

Fig. 3
Abugawa Dam's water level lowering effect upon July 2013 flooding
Effet de la baisse du niveau d'eau du barrage d'Abu sur la crue de juillet 2013

1	Flood hazard water level	*1*	*Cote de danger de crue*
2	Flood warning water level	*2*	*Cote d'alerte de crue*
3	Flood fighters standby level	*3*	*Cote de contrôle de crue*
4	Estimated water level without the dam	*4*	*Niveau d'eau supposé sans barrage*
5	Actual water level	*5*	*Niveau d'eau réel*
6	Estimated decrease in water level	*6*	*Baisse estimée de niveau*
7	Left bank	*7*	*Rive gauche*
8	the Abu River(Abugawa)	*8*	*Fleuve Abu*
9	Right bank	*9*	*Rive droite*

Considering the fact that flood damages are reported in many places in Japan recently, there is a high possiblity that the larger scale rainfall will occur in the future. Therefore, analyzation is conducted here assuming that the same volume of rain measured at 6:00 would fall during 3 hours from 11:00~14:00. Refer to the hydrograph on hypothetical rainfall in Fig. 4. As a result of runoff analysis by storage function method, the maximum flow without dam is 2,060 m^3/s and, the maximum flow with dam is 973 m^3/s. Without the dam, the peak flow at Nakatsue exceeds the harmless flow rate. On the other hand, with dam, even at the highest water level, it doesn't exceed flood hazard level because of the flood control effect. As a conclusion, it is considered that the dam performs the water level lowering effect by about 1.6 m at the downstream datum point Nakatsue.

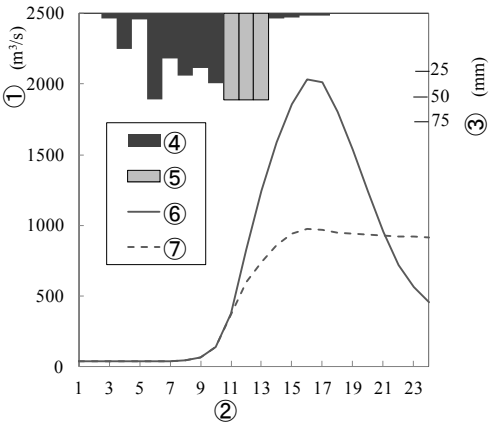

Fig. 4

Hydrograph of hypothetical rainfall at Nakatsue

Hydrographie de la pluviosité hypothétique à Nakatsue

1	Flow	*1*	*Débit*
2	Time on July 28	*2*	*Heure(s) le 28 juillet*
3	Rainfall per 60min.	*3*	*Précipitations sur 60 min*
4	Rainfall measurements	*4*	*Mesures de précipitations*
5	Hypothetical rainfall	*5*	*Précipitations hypothétiques*
6	Hydrograph without dam	*6*	*Hydrographie sans barrage*
7	Hydrograph with dam	*7*	*Hydrographie avec barrage*

3. APPLICATION OF WATER LEVEL THRESHOLD DISCHARGE METHOD

3.1. INTRODUCTION OF WATER LEVEL THRESHOLD DISCHARGE METHOD

As stated in Chapter 2, there are no standard rules in operation regulations how much water should be discharged from a dam when the water level is below flood season control level and, it is left to the local dam administrators' discretion. As a result, if a judgment when to start discharging water delays, there is a possibility to have over storage. Here, "over storage" means storing of excess water in the flood control capacity as a result of failing to discharge the water

designated in the operation regulations when the reservoir level exceeds flood season control level. Over storage is not allocated upon making flood control plan as required capacity. With regard to the dam operation for this heavy rain, when water level reached flood season control level at 13:00, discharge volume had not attained the designated volume of 697m^3/s and the dam had over storage of about 2.662 million m^3. Especially, when a large scale flooding which exceeds the flood control plan occurs, the operation prescribed in the proviso clause is taken and the discharge exceeding the maximum discharge volume provided in the plan occurs. In case flood control capacity is partially used up because of over storage prior to necessary flood control, it causes increase of maximum discharge volume to the downstream area, and becomes conductive to downstream damage [5].

Water level threshold discharge method is the method proposed by Imamura [6]. It is the dam operation method to make decision on timing and volume of discharge based on the data of reservoir. The timing to start discharge is determined by using critical inflow volume which is obtained by Eq. [3] as an index. Discharge is started when inflow and the critical inflow volume become equal. It is expected that this method makes it possible not only to uniquely determine the timing of commencement of discharge but also to considerably lessen the over storage in the flood control capacity.

$$Q_{ic} = \frac{H_c \sqrt{K} V_w}{\sqrt{q_u}} \qquad [3]$$

Definitions are; Q_{ic} : critical inflow(m^3/s), H_c : limit of rising speed of river channel(cm/s), K : river channel factor, V_w : remaining capacity up to flood season control level(m^3), q_u : flow volume to start flood control(m^3/s)

3.2. WATER LEVEL THRESHOLD DISCHARGE METHOD AT ABUGAWA DAM

Here, on assumption that Abugawa Dam is operated using water level threshold discharge method, the commencement time of discharge is especially examined. When water level threshold discharge method is applied by using Eq.[3], the time when inflow and critical inflow become equal is 9:50 and, this is the time when discharge is started. According to the record, the judgment to start adjustment operation was actually made at 8:00 on July 28, and it is earlier than the discharge commencement time which is ruled out by water level threshold discharge method. That is, the decision making by the local dam administrator in the case of this heavy rain was earlier. From this time forward, in order to do adjustment operation stably and adequately upon various rain storms, it is expected that critical inflow volume calculated by water level threshold discharge method is used as so called “alarm for commencement time of discharge”.

4. PROBLEMS OF OPERATIONS PROVIDED IN THE OPERATION REGULATIONS

4.1. RULES BEFORE COMMENCEMENT OF DISCHARGE

Proposals are made here to reduce time period before opening of dam gate. Upon this heavy rain, the decision for the adjustment operation was made at 8:00. However, the actual discharge of water by opening the gate started at 11:00. This heavy rain did not cause hazard at the downstream area since the rainfall was much less than the planned rainfall capacity. However, as mentioned in Chapter 3, over storage of 2,662 kilo m^3 was generated.

The reason for this is that it is required to send necessary information to the authorities concerned prior to a discharge. In the case of Abugawa Dam, as prescribed under the Abugawa Dam Operation Bylaws Article 12, two hours must be reserved between the announcement to the authorities concerned, namely Yamaguchi Prefectural Government, Hagi Municipal Office, police, fire stations fishery unions, etc. and the actual discharge, as shown in Fig. 5. The duration of such time must have been decided considering the characteristics of the dam and various areas. Thus, it might not be easy to change. However, in the interviews to the administrator of Abugawa Dam, it was found that the only downstream people that would be affected by dam discharge are the drivers who park their cars in the River Park. In this connection, it should be considered to revise the Abugawa Dam Operation Bylaws to shorten the time reserved between the announcement and discharge.

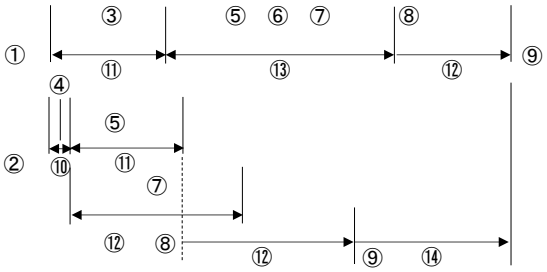

Fig. 5

Time required for actual start of discharge

Temps nécessaire pour le démarrage réel de l'évacuation

1	Current status	*1*	*État actuel*
2	Suggested idea	*2*	*Proposition d'amélioration*
3	Communication with the authorities concerned (by phone)	*3*	*Transmissions aux intéressés (téléphone)*
4	Communication with the authorities concerned (by simultaneous e-mail)	*4*	*Transmissions aux intéressés (courriels simultanés)*
5	Time to be secured before opening of dam gate	*5*	*Temps à garder avant l'ouverture de la vanne*
6	(Abugawa Dam Operation Bylaw Article 12)	*6*	*(Article 12 des règlements détaillés de l'exploitation du barrage d'Abu)*
7	Patrol	*7*	*Patrouille*
8	Dam gate opening	*8*	*Ouverture de la vanne*
9	Arrival of the flood at the river mouth	*9*	*Arrivée de la crue à l'embouchure*
10	10 minutes	*10*	*10 min*
11	1 hour	*11*	*1 heure*
12	1.5 hours	*12*	*1 heure et demi*
13	2 hours	*13*	*2 heures*
14	1 hour 50 minutes	*14*	*1 heure 50 min*

In addition, at Abugawa Dam, the conveyance of the information is done orally by telephone. Since there are many authorities to have the message conveyed, it takes about one hour before completing the conveyance. It should be considered to change the current oral communication by telephone to simultaneous delivery of the message by e-mail or telefax. If it is a written message, it is possible to send it out to all the concerned authorities at once, thus it enables not only to reduce time to convey messages but also to lead more

certainty. Furthermore, this makes it possible to start patrolling right after the announcement without any trouble.

The comparison made between the current time schedule and the suggested improvement is shown in Fig.5. The suggested measures can shorten the time by 1hour50min. If these measures are employed, it is possible to largely decrease the over storage and to realize stable dam operation.

5. DAM OPERATION USING RAINFALL PREDICTION

5.1. INTRODUCTION OF RAINFALL PREDICTION TO DAM OPERATION

The recent technological progress in the climate model which utilizes analysis technology by GSM (Global Spectral Model) is remarkable and, up to 48 hours rainfall prediction has become capable with considerable credibility [7]. To be more specific, in the USA, WRF (Weather Research and Forecasting Model) as a mesoscale model is published and, it made it easy to do calculation by non-statics model with 1km mesh. In Japan, Meteorological Agency delivers rainfall prediction by GSM and MSM (Meso Scale Model) to the public. GSM is a non-statics model which numerically analyze the entire globe by using 20km analytic mesh. MSM is a down-scaled version of GSM using 5km mesh and covers Japan and the peripheral area.

If it becomes possible to figure out inflow volume to a dam in advance by utilizing these rainfall predictions, the maximum discharge and downstream hazard are considerably decreased by efficiently utilizing the spare capacity of dam putting both flood control capacity and water utilization capacity into full use. That is, when a large scale flood which exceeds the flood control plan is expected, preemptive discharge can be put in operation by jointly using the water utilization capacity for the flood control. As a result, it is expected to avoid the operation prescribed under the proviso clause as much as possible and to minimize the damage.

5.2. RAINFALL PREDICTION DATA AT THE ABU RIVER AREA

In this chapter, optimization of flood control operation for this heavy rain in 2013 by using the above mentioned MSM rainfall prediction data delivered by Japan Meteorological Agency is examined. Note that the data are easily accessible to the staff of Yamaguchi Prefectural Government. Putting the scale of the Abu River water area, the length of flood control time and the duration of rain into consideration, 33 hour prediction is adopted. 33 hour rainfall prediction at the Abu River area at 12:00 on July 27 is shown in Fig. 6.

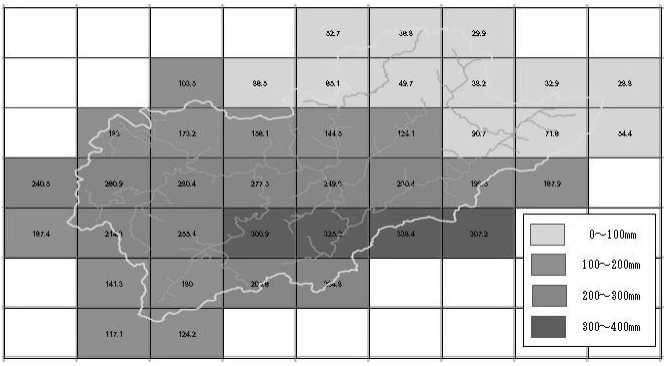

Fig. 6
Rainfall prediction by MSM (rainfall for 33 hours)
Précipitations prévues par les modèles à méso-échelle (précipitations sur 33 heures)

Rainfall prediction, however, is always accompanied by errors and, the errors should be put into consideration when it is used for dam operation. Especially, the errors resulted from more actual rainfall measurements than the prediction can lead flooding in the downstream area. In this study, the research on the errors in rainfall prediction at the Saba River area in Yamaguchi Prefecture done by Huruhama [8] is employed.

As +2σ, which is widely used in engineering as risk management, is employed, about 2.9 times as much rainfall should be assumed in the case of 33 hour rainfall prediction. Since the predicted rainfall at 12:00 on July 27 is 184.7 mm, the result obtained by multiplying by 2.9 is 542.5 mm. This amount is much more than about 300 mm, which is the projected rainfall at Abugawa Dam [1]. Therefore, there was room for discussing preemptive discharge.

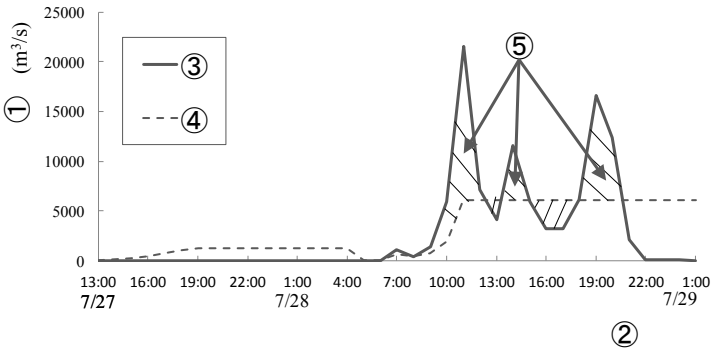

Fig. 7

Dam operation in the case of 542.5mm rainfall

Exploitation avec 542,5 mm de précipitations

1	Flow	*1*	*Débit*
2	Time	*2*	*Heure(s)*
3	Calculation of inflow to dam	*3*	*Prévision de débit d'entrée*
4	Discharge	*4*	*Évacuation*
5	Flood Control Capacity 121.441 million m³	*5*	*Volume de contrôle des crues 121,441 million m³*

In order to make more precise and adequate decision on an execution and on the amount of preemptive discharge, a judgment method based on the hydrograph, which is worked out by entering the rainfall prediction and its error distribution data into runoff analysis model such as distributed system model and storage function method, is suggested. Further study is expected on this technique. In this paper, runoff analysis is conducted by using the maximum possible rainfall 542.5 mm. The result of the operation executed in accordance with the regulations is shown in Fig.7. The flood control capacity of Abugawa Dam is 65 million m³ while necessary flood control capacity is 121 million m³, which means 56 million m³ is in short for flood control. The conclusion is that the execution of preemptive discharge is expected.

6. CONCLUSION

When Yamaguchi-Shimane rain storm occurred on July 28, 2013, Abugawa Dam showed remarkable flood control effect such as lowering water level at Nakatsue datum point by 3.4 m. As far as the flood control function of Abugawa Dam upon this heavy rain is concerned, the dam is considered to carry out an effective role against a regional and guerilla-like heavy rain. Considering the fact that damages were caused frequently by the recent heavy rains, it is expected to do adjustment operation and preemptive discharge utilizing the water level threshold discharge method and rainfall prediction. In addition, it is desirable to realize more assured and safer dam operation by reducing the time between the decision making of discharge and actual gate opening.

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SUMMARY

The purpose of this paper is to verify the flood control effect of Abugawa Dam on the occasion of heavy rain disaster in Yamaguchi-Shimane area in Japan dated July 28, 2013 and, to suggest improvement ideas for dam operations.

Abugawa Dam stored about 1271 m^3/s flood water at the peak of inflow and had a remarkable flood control effect by lowering water level at Nakatsue datum point by 3.4 m. While the upper branch river areas suffered immense damages, no damage was caused in Hagi City which is located downstream of the dam. The cause of this fact is that the average rainfall was much less than the flood control plan though partial guerilla-like rainfall was observed in the upper stream. Therefore, it is possible to conclude that the dam is useful to local and short guerilla-like rainfalls.

At this flood, the reservoir level of the dam was lower than the flood season control level by about 5m, thus the adjustment operation was executed. Nevertheless, a large volume of over storage was generated as it took 3 hours to open dam gate after the decision of discharge. If a large scale flood which exceeds the flood control plan occurs in the future, the operation prescribed under the proviso clause is taken and it can lead to tremendous damages. In order to execute adjustment operation smoothly and stably, the introduction of water level threshold discharge method is effective and, as an aid to judge the commencement time of the operation, utilization of critical flow is highly suggested.

As it took 1 hour to convey necessary information to the authorities concerned in addition to 2 hour reserved time, both of which are required by the operation regulations, 3 hours in total were spent before the actual gate opening at this flood and, this is the main cause for the over storage. There is room for improvement of this operation by adopting one time distribution of written information by facsimile etc. and, by reducing the reserved time before gate opening to more than 1 hour.

When a large scale flood which exceeds the flood control plan occurs in the future, an adequate preemptive discharge becomes necessary from the view point of realizing the dam's maximum flood control function and avoiding the operation prescribed under the proviso clause. Considering the data of MSM rainfall prediction published by Japan Meteorological Agency, there was also room for discussing preemptive discharge.

RÉSUMÉ

Cette étude examine l'efficacité du contrôle des crues du barrage d'Abugawa et propose des plans d'amélioration suite aux dégâts causés par la pluie diluvienne à Yamaguchi et Shimané le 28 juillet 2013.

Le barrage d'Abugawa a montré une grande efficacité de contrôle des crues en stockant 1271 ㎥/s à la pointe de débit, en abaissant de 3,4 m le niveau d'eau au point Nakatsue. Des dégâts catastrophiques ont été constatés sur les affluents en amont du barrage, tandis qu'il n'y a eu aucun dégât dans la ville de Hagi en aval du barrage. Ceci s'explique par le fait que les précipitations ont été localement violentes en amont, alors que les précipitations moyennes sur le bassin étaient bien inférieures à celles prévues pour le barrage. On peut donc en conclure que le barrage résiste à des pluies diluviennes localisées et de courte durée.

Pour cette crue, le niveau d'exploitation du barrage était inférieur de 5 m au niveau de contrôle des crues à cette saison, et les opérations d'ajustement ont été lancées. Cependant, un large volume de surstockage s'est produit car il a fallu 3 heures pour ouvrir la vanne du barrage après la prise de décision. Si une crue importante dépassant celle prévue par le plan de contrôle se produisait à l'avenir, les opérations inscrites dans la réglementation pourraient conduire à des dommages énormes. Afin d'effectuer en douceur les opérations d'ajustement, l'utilisation d'une méthode d'évacuation liée au niveau serait efficace, et comme aide à la décision de démarrage de l'opération, l'utilisation d'un débit critique est fortement recommandée.

Il a fallu une heure pour transmettre les informations nécessaires aux autorités, en addition aux deux heures de temps réservé pour les opérations. Trois heures se sont donc écoulées avant l'ouverture réelle de la vanne et c'est l'explication principale pour le stockage excessif. Il est possible d'améliorer ces opérations en adoptant une diffusion unique des informations écrites par fax etc. et en réduisant la période réservée avant l'ouverture des vannes de plus d'une heure.

Si une crue de grande ampleur dépassant la crue prévue arrive dans le futur, une évacuation préventive adéquate devient nécessaire pour optimiser la fonction de contrôle des crues du barrage et éviter d'arriver à l'opération prévue par la réglementation. Sur la base des données de prévisions de précipitations du modèle méso-échelle de l'Agence météorologique japonaise, il est également possible d'envisager une évacuation préventive.