### 4.4 Flood Control Effects of 24-Dam Group

Flood control projects are generally regarded extremely high in public interests, and construction of such projects are normally financed by domestic capitals. In line with the national policy, a substantially low interest is usually allowed for such projects. The utility of flood control projects are all highly regarded.

With regard to flood control in multipurpose dam projects, a justifiable expenditure constitutes an important factor, and the benefit-to-cost ratio is computed taking interest on the appropriate investment. According to an accepted Japanese practice, life time of the project is 80 years, interest rate on flood control at 0.045, and annual capital recovery factor at 0.0464. Since in the current survey, life time of 50 years and interest rate on flood control at 8.0% are considered, the annual capital recovery factor jumps up to 0.08174, about double, and this could throw hindrances to the development of flood control projects in the country.

Also takings a time limit on survey and data collection, and an estimated effects of flood control at the dam site into consideration, a portion equivalent to the alternative justifiable expenditure and the separable costs-remaining benefits is regarded here as the flood control benefits. However, it is recommended that the benefit-cost analysis of flood control under a dam project will be carried out in an orthodox procedure at the time of the proposed 2nd stage survey and the like in future.

#### 4.4.1 Classification of Dam Group from the Viewpoint of Flood Control

Groups of the dams totalling 24 on four major river systems are classified as below taking topography of the flood prevention areas and alignments of the river channels.

(1) Dam groups with flood control functions to the downstream areas along the main river channel (Groups of 5 dams)

a. Han River: 3 dam groups, namely Hongcheon, Ganhyeon and Dalcheon.

b. Naktong River: 2 dam groups, namely Imha and Chibo.

(2) Dam groups with flood control functions only over a part of downstream areas of the dams (Groups of 19 dams)

The above-mentioned classification of the dam groups are based on such factors as location of the existing and proposed dams; flood protection areas in the downstreams of the dams; topography of the dam sites; alignments of the river channels; and also available survey data. Since the dams under the Group (1) will require considerably large flood storage capacities in future, it is anticipated benefit inducing effects equivalent to the alternative flood control dam justifiable expenditure. And for the ones under the Group (2), a flood storage of 2- to 3-meters was surcharged on top of the storage for water supply and power generation in anticipation of the flood-control benefits equivalent to the separable costs-remaining benefits. With regard to the dam groups of (1) above, the separable costs-remaining benefits are also computed for the purpose of reference.

### 4.4.2 Flood Control Benefits of the Dams

(1) Flood control benefits of the dam groups with flood control functions to the downstream area along the main river channel

Out of the dam groups under the classifications in the foregoing, for the five dams, namely, Hongcheon, Dalcheon, Ganhyeon, Imha and Chibo with the flood control functions all along the downstreams, flood control benefits equivalent to the alternative justifiable expenditure is expected, hence the relations between flood control storage and construction cost of the alternative dam are shown below.

The flood control storage was determined by values obtained from the existing dams by the respective river systems.

Table 4.8. Relation between Flood Control Storage and Construction Cost of Alternative Dam

| Dam | Data | Equivalent precipitation | | | |
|---|---|---|---|---|---|
| | | 90.0mm | 100.0mm | 137.5mm | 185.0mm |
| Hongcheon (C.G.) | Catchment Basin, $km^2$ | 1473 | 1473 | 1473 | 1473 |
| | Silt Storage, x $10^6$ $m^3$ | 73.65 | 73.65 | 73.65 | 73.65 |
| | Flood Control Storage, x $10^6$ $m^3$ | 132.57 | 147.30 | 202.54 | 272.51 |
| | Gross Storage, x $10^6$ $m^3$ | 206.22 | 220.95 | 276.19 | 346.16 |
| | H.W.L. (E.L.M.) | 86.0 | 87.0 | 89.5 | 92.5 |
| | Crest H. (E.L.M.) | 88.0 | 89.0 | 91.5 | 94.5 |
| | Construction Cost, x $10^9$ W | 6.02 | 6.22 | 6.75 | 7.30 |
| | Compensation, x $10^9$ W | 10.49 | 10.55 | 10.69 | 10.85 |
| Dalcheon (C.G.) | Catchment Basin, $km^2$ | 1348 | 1348 | 1348 | 1348 |
| | Silt Storage, x $10^6$ $m^3$ | 67.40 | 67.40 | 67.40 | 67.40 |
| | Flood Control Storage x $10^6$ $m^3$ | 121.32 | 134.80 | 185.35 | 249.38 |
| | Gross Storage, x $10^6$ $m^3$ | 188.71 | 202.20 | 252.75 | 316.78 |
| | H.W.L. (E.L.M.) | 100.5 | 101.30 | 103.50 | 106.0 |
| | Crest H. (E.L.M.) | 102.5 | 103.8 | 105.5 | 108.0 |
| | Construction Cost, x $10^9$ W | 4.65 | 4.82 | 5.03 | 5.35 |
| | Compensation, x $10^9$ W | 9.0 | 9.40 | 9.90 | 10.44 |
| Ganhyeon (C.G.) | Catchment Basin, $km^2$ | 1180 | 1180 | 1180 | 1180 |
| | Silt Storage, x $10^6$ $m^3$ | 59.000 | 59.000 | 59.000 | 59.000 |
| | Flood Control Storage x $10^6$ $m^3$ | 106.200 | 118.000 | 162.25 | 218.300 |
| | Gross Storage, x $10^6$ $m^3$ | 165.200 | 177.000 | 221.25 | 277.30 |
| | H.W.L. (E.L.M.) | 92.1 | 93.0 | 96.0 | 99.10 |
| | Crest H. (E.L.M.) | 94.1 | 95.00 | 98.00 | 101.10 |
| | Construction Cost, x $10^9$ W | 2.19 | 2.28 | 2.56 | 2.87 |
| | Compensation, x $10^9$ W | 7.42 | 7.48 | 7.72 | 7.97 |

| Dam | Data | Equivalent precipitation | | | |
|---|---|---|---|---|---|
| | | 49.0mm | 69.0mm | 86.0mm | 100.0mm |
| Imha (R.F.) | Catchment Basin, $km^2$ | 1230 | 1230 | 1230 | 1230 |
| | Silt Storage, x $10^6$ $m^3$ | 49.20 | 49.20 | 49.20 | 49.20 |
| | Flood Control Storage, x $10^6$ $m^3$ | 60.27 | 84.87 | 105.78 | 123.3 |
| | Gross Storage, x $10^6$ $m^3$ | 109.47 | 134.07 | 154.98 | 172.20 |
| | H.W.L. (E.L.M.) | 155.0 | 157.5 | 159.0 | 160.5 |
| | Crest H. (E.L.M.) | 158.0 | 160.5 | 162.0 | 163.7 |
| | Construction Cost, x $10^9$ W | 4.06 | 4.28 | 4.40 | 4.54 |
| | Compensation, x $10^9$ W | 10.26 | 10.66 | 10.80 | 10.96 |
| Chibo (C.G.) | Catchment Basin, $km^2$ | 4556 | 4556 | 4556 | 4556 |
| | Silt Storage, x $10^6$ $m^3$ | 227.50 | 227.50 | 227.50 | 227.50 |
| | Flood Control Storage, x $10^6$ $m^3$ | 229.95 | 313.95 | 391.3 | 455.0 |
| | Gross Storage, x $10^6$ $m^3$ | 450.5 | 541.5 | 618.8 | 682.5 |
| | H.W.L. (E.L.M.) | 79.6 | 81.8 | 83.2 | 84.5 |
| | Crest H. (E.L.M.) | 81.6 | 83.8 | 85.2 | 86.5 |
| | Construction Cost, x $10^9$ W | 4.90 | 5.54 | 6.06 | 6.47 |
| | Compensation, x $10^9$ W | 31.64 | 32.35 | 32.60 | 33.03 |

When the flood control storage equivalent to R= 137.5 mm and R= 69 mm are considered for the dams on Han and Naktong river systems respectively, annual benefits of the respective dams would be as shown below. In the alternative justifiable flood control expenditure, interest rate is 8% and life time is 50 years.

Table 4.9. Alternative Justifiable Flood Control Expenditure

| Dam | River | Annual Expenditure x $10^6$ W | Dam Type | Q max (Inflow) | $Q_o$ max (Outflow) |
|---|---|---|---|---|---|
| Honcheon | Han | 2,158 | Concrete | 8,460 | 4,350 |
| Dalcheon | " | 1,868 | " | 6,980 | 2,850 |
| Ganhyeon | " | 1,260 | " | 7,670 | 3,500 |
| Imha | Naktong | 1,915 | Rockfill | 6,750 | 3,600 |
| Chibo | " | 4,527 | Concrete | 11,780 | 6,650 |

(2) Flood control benefits of the dam groups with regional flood control effects

There are 19 dam groups fall under the above-mentioned classifications. For flood control benefits of the respective dams, a flood control storage, namely surcharge of 2 meters (3 meters in concrete dams) on top of the normal water supply storage is considered in the design. Accordingly, an increase in the construction costs of the dams to cover the one for the required flood control storage, namely, the separable cost-remaining benefits is considered as the flood control benefits.

The below is the procedure of computation.

Separable Costs-Remaining Benefits

= (Overall Dam Construction Costs) - (Dam Construction Costs excluding Flood Control Facilities)

Flood control benefits and particulars of the dams are given in the table below.

Table 4.10 Flood Control Benefits and Particulars of Dams

| Dam | Catchment Basin $km^2$ | Water Supply H.W.L.(ELM) | Surcharge Level (ELM) | Flood Control $x10^6$ $m^3$ | Storage Equivalent Precipitation(mm) | Design Flood Discharge Inflow $m^3/s$ | Outflow $m^3/s$ | Control $m^3/s$ | Annual Expenditure $x10^6$ W |
|---|---|---|---|---|---|---|---|---|---|
| Bamseonggol (up-s) | 582.7 | 300 | 302 | 19,8 | 34.1 | 5,400 | 4,300 | 1,100 | 88 |
| Hupyeong (down-s) | 576.2 | 469 | 471 | 34.6 | 60.1 | 5,270 | 3,800 | 1,570 | 97 |
| " (up-s) | 305 | 566.4 | 568.4 | 14.0 | 45.9 | 3,830 | 2,650 | 1,180 | 45 |
| " (up-s) | 1,043.3 | 344 | 346 | 67.8 | 65.0 | 7,200 | 5,100 | 2,100 | 66 |
| Weolhak | 563.4 | 300 | 302 | 20.9 | 37.0 | 5,310 | 4,200 | 1,110 | 74 |
| Gujeol | 100.8 | 746.1 | 748.1 | 9.9 | 98.4 | 1,870 | 900 | 970 | 66 |
| | | 742.5 | 744.5 | 9.0 | 89.2 | " | 950 | 920 | 78 |
| Pyeongchang | 485.3 | 420 | 422 | 35.6 | 73.5 | 4,570 | 2,950 | 1,620 | 84 |
| | | 411.5 | 413.5 | 32.4 | 66.9 | " | 3,100 | 1,470 | 98 |
| Suju | 328.9 | 432 | 434 | 31.8 | 96.7 | 3,710 | 2,000 | 1,710 | 35 |
| | | 425.5 | 427.5 | 24.0 | 72.9 | " | 2,350 | 1,360 | 49 |
| Dogog | 492.6 | 325 | 327 | 16.2 | 32.9 | 4,610 | 3,750 | 860 | 45 |
| Bonghwa (down-s) | 1,105 | 303.8 | 305.8 | 53.4 | 47.1 | 6,360 | 4,300 | 2,060 | 35 |

| Dam | Catchment Basin $km^2$ | Water Supply H.W.L.(ELM) | Surcharge Level (ELM) | Flood Control $x10^6$ $m^3$ | Storage Equivalent Precipitation(mm) | Design Flood Discharge | | | Annual Expenditure $x10^6$ W |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Inflow $m^3/s$ | Outflow $m^3/s$ | Control $m^3/s$ | |
| Hamyang | 264 | 380.5 | 382.5 | 13.0 | 49.3 | 3,290 | 2,200 | 1,090 | 36 |
| Dogsan | 231 | 167 | 169 | 21.0 | 91.1 | 3,280 | 1,700 | 1,580 | 55 |
| | | 158.4 | 160.4 | 17.0 | 73.8 | " | 1,900 | 1,380 | 57 |
| Yongdam | 949 | 269.7 | 271.7 | 86.1 | 90.7 | 5,910 | 3,250 | 2,660 | 48 |
| | | 258 | 260.0 | 64.0 | 67.5 | " | 3,750 | 2,160 | 47 |
| Sutong | 1,526 | 200 | 202 | 48.9 | 32 | 7,390 | 5,650 | 1,740 | 28 |
| Myeongcheon | 2,003 | 150 | 152 | 105.6 | 52.7 | 8,350 | 5,850 | 2,500 | 46 |
| Jeokseong | 1,004 | 133 | 135.0 | 27.0 | 26.9 | 6,580 | 5,450 | 1,130 | 55 |
| Juam | 1,010 | 124.5 | 126.5 | 124.5 | 123.3 | 6,590 | 3,200 | 3,390 | 131 |
| | | 121 | 123 | 121.5 | 120.0 | " | 3,250 | 3,340 | 127 |
| No.2 Boseonggang | 457 | 126.7 | 128.7 | 41.9 | 91.6 | 4,430 | 2,350 | 2,080 | 38 |
| | | 119 | 121 | 30.5 | 66.7 | " | 2,750 | 1,680 | 47 |
| Panun | 651.9 | 280 | 282 | 8.5 | 17.4 | 5,310 | 4,850 | 460 | 29 |
| Simcheon | 640.3 | 170.7 | 172.7 | 55.4 | 86.5 | 4,870 | 2,450 | 2,420 | 74 |
| | | 161.4 | 163.4 | 54.4 | 85.0 | " | 2,500 | 2,370 | 88 |
| Hongcheon | 1,473 | 120 | 123 | 190.0 | 129.0 | 8,460 | 4,550 | 3,910 | 131 |
| Ganghyeon | 1,180 | 111.4 | 114.4 | 130.7 | 110.7 | 7,670 | 4,100 | 3,570 | 34 |

| Dam | Catchment Basin $km^2$ | Water Supply H.W.L.(ELM) | Surcharge Level (ELM) | Flood Control $x10^6$ $m^3$ | Storage Equivalent Precipitation(mm) | Design Flood Discharge | | | Annual Expenditure $x10^6$ W |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Inflow $m^3/s$ | Outflow $m^3/s$ | Control $m^3/s$ | |
| Dalcheon | 1,348 | 115.8 | 118.8 | 138.5 | 102.7 | 6,980 | 4,250 | 2,730 | 107 |
| Chibo | 4,550 | 87.7 | 90.7 | 380 | 83.5 | 11,780 | 6,000 | 5,780 | 141 |
| Imha | 1,230 | 192 | 194 | 107.4 | 87.2 | 6,700 | 3,100 | 3,600 | 61 |

Note: up-s – Proposed Up-stream Location

mid-s – " Mid-stream "

down-s – " Down-stream "

#### 4.4.3 Flood Control Scheme at Each Dam

(1) Establishment of flood control storage

From the observation of precipitation pattern in the country, it is noticed that flood season in all river basins are concentratedly found in the period between June and October. About 60 to 70% of annual average precipitation is found in the above-mentioned June, July months and results in repeated floods. Accordingly, to utilize the limited flood control storage most effectively, a drawdown during flood seasons may be considered to obtain a larger flood control storage, however, on the other hand, a resulting conflict with a water supply may have to be anticipated.

Therefore, it is necessary to take the above-mentioned merits and demerits into consideration in water supply planning, however, the foregoing extra drawdown makes recovery of water level difficult especially in the dams with larger water supply storage. As shown in the table below, precipitation after flood months of October-December constitutes a small percentage, only about 11% of the annual total.

Table 4.11 Precipitation Particulars

| River System | 1<br>Annual Precipitation<br>mm | 2<br>Flood Season Precipitation Jun-Sept<br>mm | 3<br>2/1<br>% | 4<br>Precipitation Oct-Dec | 5<br>4/1<br>% |
|---|---|---|---|---|---|
| Whole country | 1,159.2 | 710 | 65 | 125.1 | 11 |
| Han | 1,253.0 | 885.0 | 71 | - | - |
| Naktong | 1,106.0 | 699.0 | 63 | 120.0 | 11 |
| Geum, Seumjin | 1,290.3 | 819.1 | 63 | 137.2 | 11 |

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Where the possibility of a recovery of water level is proved, an introduction of a limit-water level procedure may be considered, but further details are beyond the scope of this report. So only the flood control scheme by surcharge will be considered in principle here.

(2) Operation scheme of dams

The foregoing discussion has been focussed on rainfall and the resulted flood damage, and now a study of how flood are controlled will be made by utilizing flood hydrographs obtained from a hydrological survey.

Flood control effects are expressed by the formula given below in the fixed ratio method.

$$Qo = \alpha (Qi - O_B) + Q_B \ldots\ldots\ldots\ldots\ldots \quad (1)$$

where, Qo : discharge out of the dam

Qi : inflow at the dam site

$Q_B$ : discharge at the commencement of control (harmless discharge)

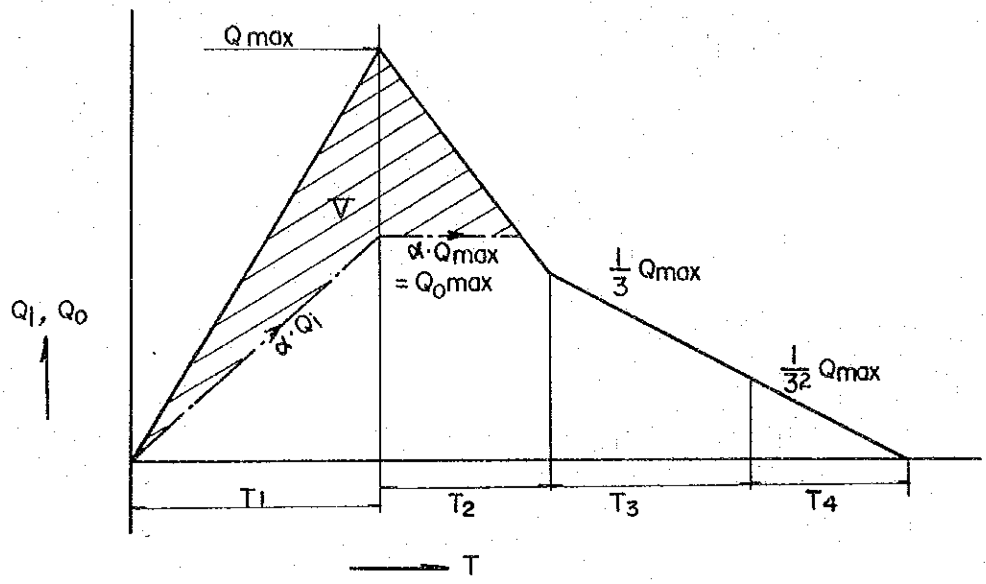
$\alpha$ : fixed ratio

$$\frac{Qo}{Qi} = \alpha \left(1 - \frac{Q_B}{Qi}\right) + \frac{Q_B}{Qi} \quad \ldots\ldots\ldots \quad (2)$$

Since $\frac{Qo}{Qi} \ll 1$ at the time of floods, it may be reasonably assumed that $Qo \doteqdot \alpha\ Qi$.

Since inflow flood hydrographs of the respective dams are treated in the way as shown below, the control storage at the time of floods may be expressed as below.

$$V = 1{,}800 \times Qmax. \times (1 - \alpha) \left\{ T_1 + \frac{3}{2}(1 - \alpha) \cdot T_2 \right\} \quad (m^3)$$




Since the surcharge, V and flood inflow discharge, Qmax. of the respective dams are determined, free discharge,

$$Qomax. = \alpha \ Qmax.$$

may be computed without difficulties.