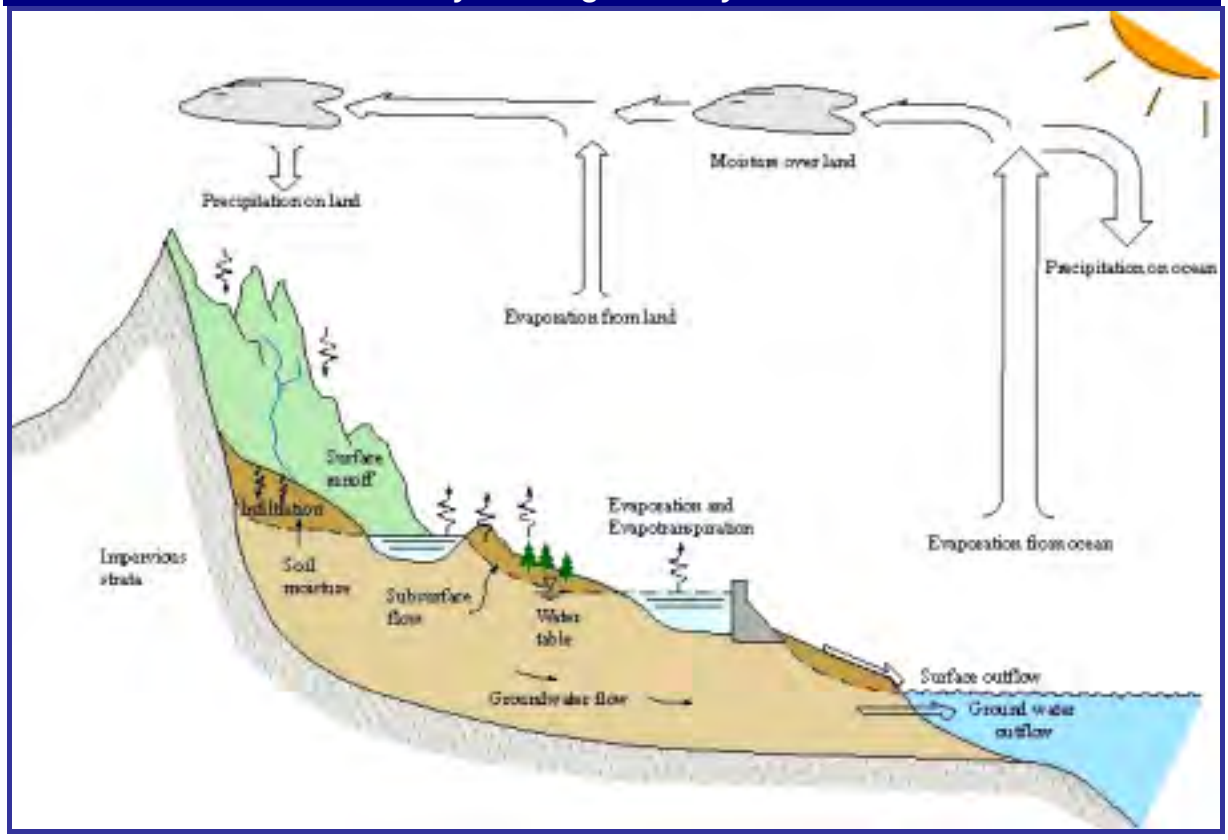
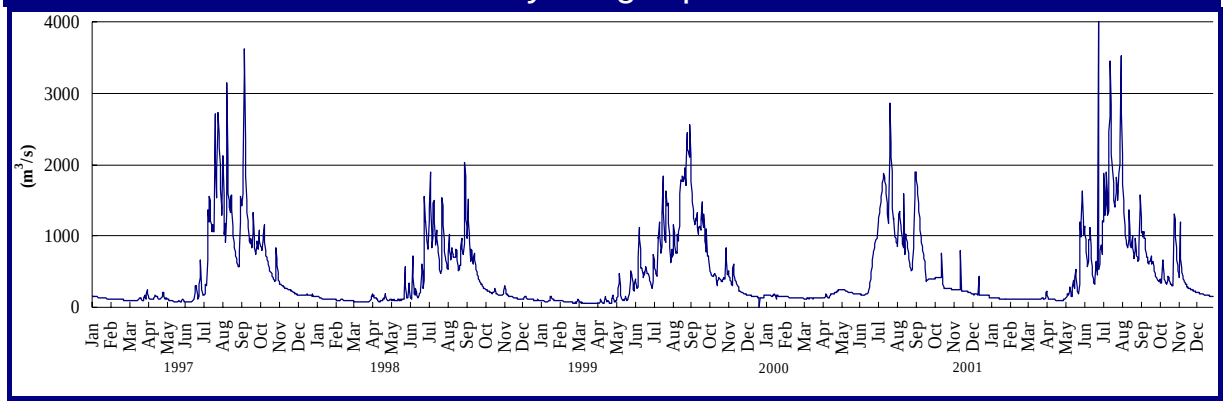
2. HYDROLOGY & SITE RECONNAISSANCE

Hydrological Cycle



Hydrograph



Daily Discharge of Station Ngoy, Nam Ou River (1997-2001)

Averaging of River Flow Records

Table Daily Discharge Table at Hinheup Station, Nam Lik River

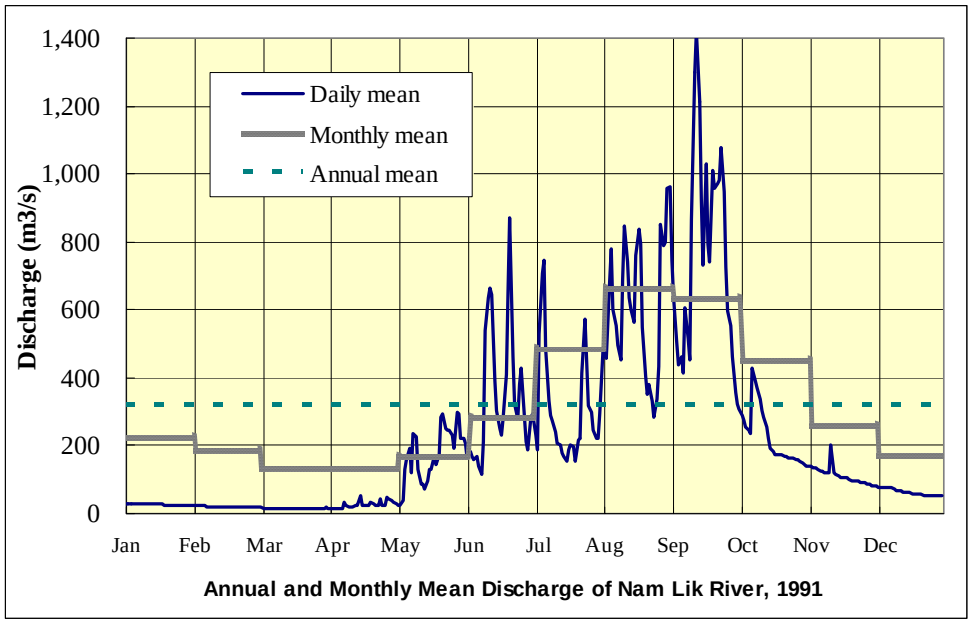
Year : 1991 Unit : m^3/s

Date	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1	229.0	215.0	158.0	134.0	127.0	181.0	372.0	367.0	625.0	557.0	411.0	205.0
2	231.0	215.0	154.0	134.0	129.0	151.0	392.0	609.0	575.0	616.0	398.0	205.0
3	231.0	215.0	150.0	132.0	130.0	190.0	403.0	i46,00	581.0	570.0	393.0	206.0
4	229.0	215.0	145.0	131.0	132.0	204.0	402.0	540.0	649.0	649.0	386.0	206.0
5	231.0	215.0	142.0	130.0	158.0	208.0	383.0	561.0	608.0	454.0	387.0	206.0
6	231.0	213.0	139.0	132.0	145.0	300.0	507.0	621.0	600.0	452.0	387.0	184.0
7	229.0	211.0	137.0	135.0	137.0	307.0	386.0	744.0	542.0	409.0	387.0	186.0
8	229.0	209.0	142.0	135.0	130.0	325.0	356.0	891.0	590.0	393.0	339.0	88.0
9	228.0	206.0	143.0	135.0	176.0	353.0	345.0	842.0	543.0	385.0	222.0	89.0
10	228.0	206.0	145.0	136.0	180.0	338.0	345.0	635.0	779.0	417.0	223.0	90.0
11	228.0	203.0	135.0	131.0	161.0	311.0	387.0	611.0	705.0	420.0	226.0	191.0
12	227.0	199.0	124.0	131.0	137.0	229.0	460.0	539.0	632.0	422.0	228.0	193.0
13	226.0	196.0	127.0	135.0	155.0	280.0	463.0	534.0	553.0	425.0	231.0	194.0
14	227.0	95.0	128.0	135.0	150.0	236.0	452.0	889.0	536.0	428.0	232.0	194.0
15	224.0	194.0	129.0	135.0	151.0	200.0	461.0	638.0	603.0	433.0	214.0	170.0
16	226.0	190.0	130.0	134.0	151.0	190.0	879.0	638.0	664.0	452.0	209.0	172.0
17	223.0	186.0	131.0	134.0	180.0	239.0	907.0	568.0	715.0	425.0	209.0	173.0
18	223.0	185.0	131.0	134.0	173.0	265.0	674.0	554.0	989.0	458.0	210.0	173.0
19	223.0	184.0	135.0	131.0	204.0	266.0	536.0	664.0	959.0	482.0	211.0	174.0
20	223.0	181.0	132.0	131.0	195.0	284.0	503.0	526.0	816.0	502.0	213.0	175.0
21	223.0	179.0	129.0	134.0	196.0	268.0	494.0	587.0	741.0	254.0	214.0	175.0
22	222.0	176.0	130.0	138.0	168.0	315.0	481.0	554.0	746.0	240.0	215.0	176.0
23	222.0	174.0	131.0	151.0	150.0	262.0	493.0	500.0	769.0	261.0	217.0	178.0
24	220.0	170.0	132.0	154.0	138.0	242.0	470.0	539.0	590.0	393.0	218.0	178.0
25	220.0	168.0	134.0	149.0	150.0	289.0	516.0	816.0	526.0	497.0	219.0	179.0
26	220.0	167.0	132.0	134.0	194.0	277.0	564.0	1120.0	502.0	479.0	195.0	180.0
27	220.0	164.0	134.0	129.0	239.0	285.0	525.0	1010.0	487.0	507.0	196.0	180.0
28	227.0	162.0	146.0	135.0	116.0	603.0	554.0	830.0	460.0	510.0	199.0	168.0
29	224.0		116.0	138.0	307.0	467.0	463.0	706.0	514.0	513.0	201.0	163.0
30	222.0		135.0	129.0	227.0	424.0	427.0	602.0	523.0	481.0	205.0	159.0
31	220.0		136.0		208.0		399.0	630.0		482.0		159.0
Mean	225.4	189.0	135.9	135.2	167.5	283.0	483.8	662.2	637.4	450.5	259.8	173.2
Max.	231.0	215.0	158.0	154.0	307.0	603.0	907.0	1120.0	989.0	649.0	411.0	206.0
Mim.	220.0	95.0	116.0	129.0	116.0	151.0	345.0	367.0	460.0	240.0	195.0	88.0

Year	Monthly Mean Discharge (m^3/s)												Annual Mean
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1991	225.4	189.0	135.9	135.2	167.5	283.0	483.8	662.2	637.4	450.5	259.8	173.2	**316.9**
1992	98.1	77.6	80.2	76.6	110.8	174.3	323.1	341.1	364.4	202.5	113.1	92.6	**171.2**
1993	45.5	37.7	25.7	19.8	61.1	250.8	589.7	430.8	431.9	203.5	106.6	76.9	**190.0**
1994	103.2	97.1	100.6	96.5	199.9	350.4	538.6	692.2	696.9	356.7	194.9	172.4	**300.0**
1995	52.3	42.2	33.2	32.2	56.4	176.8	604.9	1164.1	748.3	194.4	102.5	39.1	**270.5**
1996	25.8	23.9	29.7	37.9	46.1	119.7	229.5	620.7	478.5	181.5	128.2	60.3	**165.1**
1997	42.0	31.7	25.8	28.4	57.8	89.8	723.8	461.2	945.1	202.1	87.4	47.4	**228.5**
1998	25.3	15.2	8.4	19.6	23.6	106.3	318.1	366.2	298.1	104.6	54.0	31.1	**114.2**
1999	27.1	20.3	15.8	25.4	160.5	339.1	304.5	588.2	780.2	231.7	113.7	64.1	**222.5**
2000	40.8	32.0	16.9	12.5	164.9	496.1	448.4	630.8	727.8	210.0	105.7	59.6	**245.5**
2001	43.3	36.6	55.4	30.7	100.3	318.5	519.8	963.3	669.6	255.1	136.8	89.7	**268.3**
2002	83.0	62.6	52.8	46.7	195.1	503.0	469.6	785.1	505.2	245.4	204.0	111.6	**272.0**
Mean Monthly	**67.6**	**55.5**	**48.4**	**46.8**	**112.0**	**267.3**	**462.8**	**642.1**	**607.0**	**236.5**	**133.9**	**84.8**	**230.4**

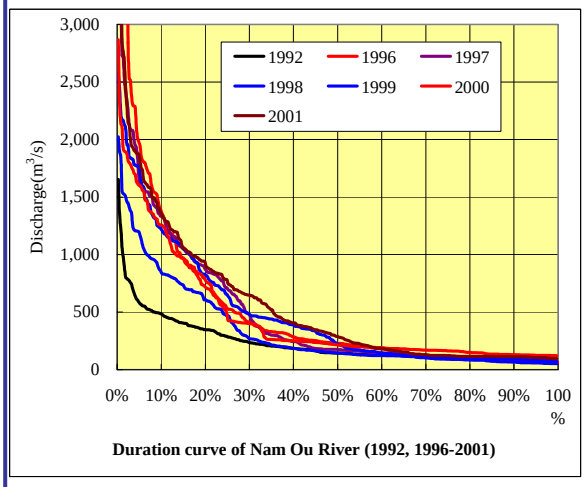
Mean Annual

Relationship among Daily Mean, Monthly Mean and Annual Mean Discharges

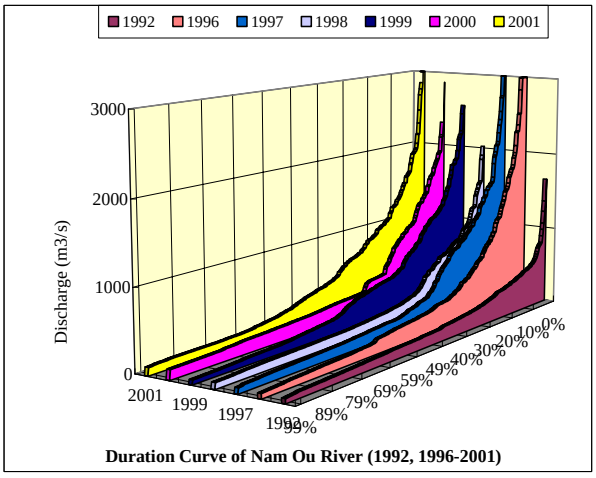


Annual and Monthly Mean Discharge of Nam Lik River, 1991

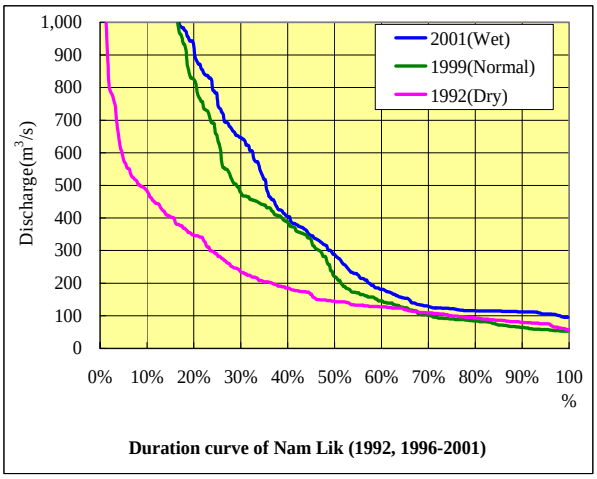
Flow Duration Curve



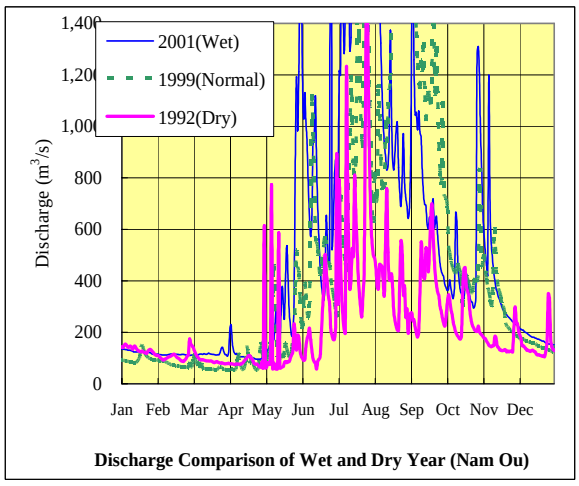
Duration curve of Nam Ou River (1992, 1996-2001)



Duration Curve of Nam Ou River (1992, 1996-2001)

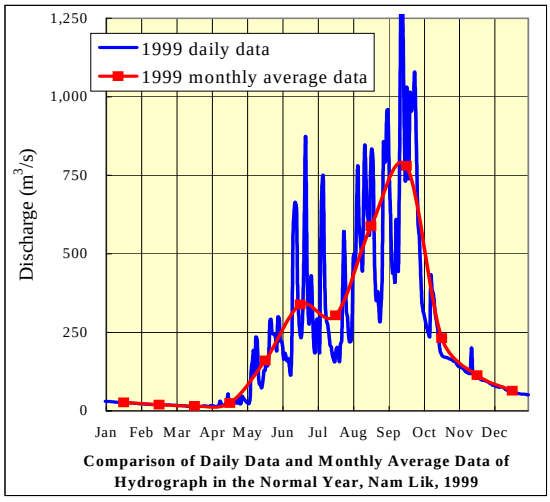


Duration curve of Nam Lik (1992, 1996-2001)

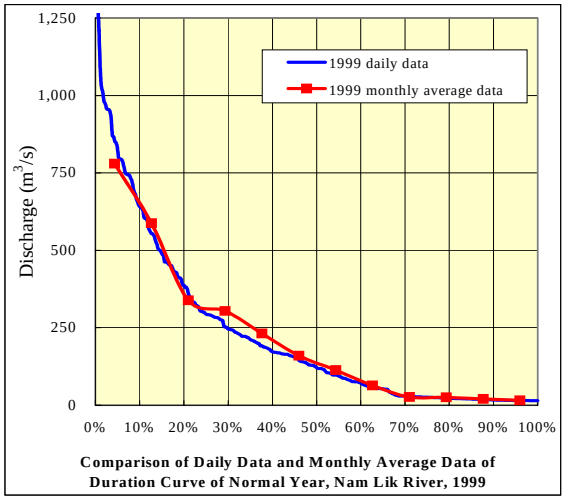


Discharge Comparison of Wet and Dry Year (Nam Ou)

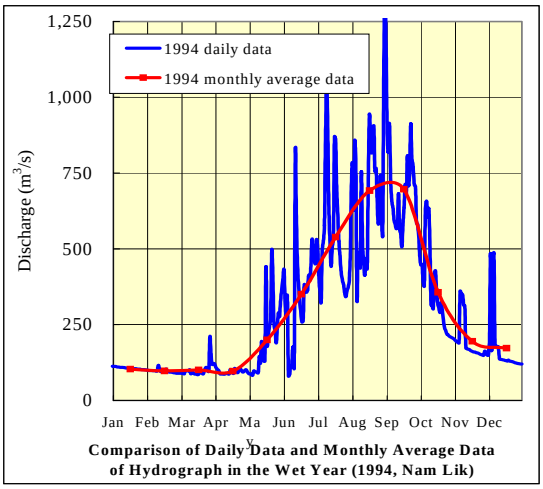
Comparison of Flow Duration Curves on Daily and Monthly Basis



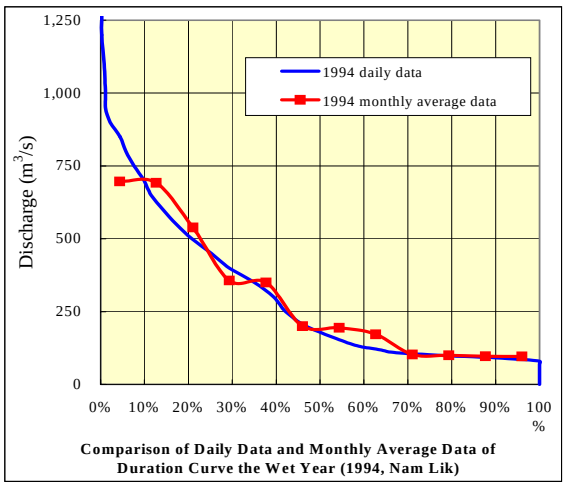
Comparison of Daily Data and Monthly Average Data of Hydrograph in the Normal Year, Nam Lik, 1999



Comparison of Daily Data and Monthly Average Data of Duration Curve of Normal Year, Nam Lik River, 1999

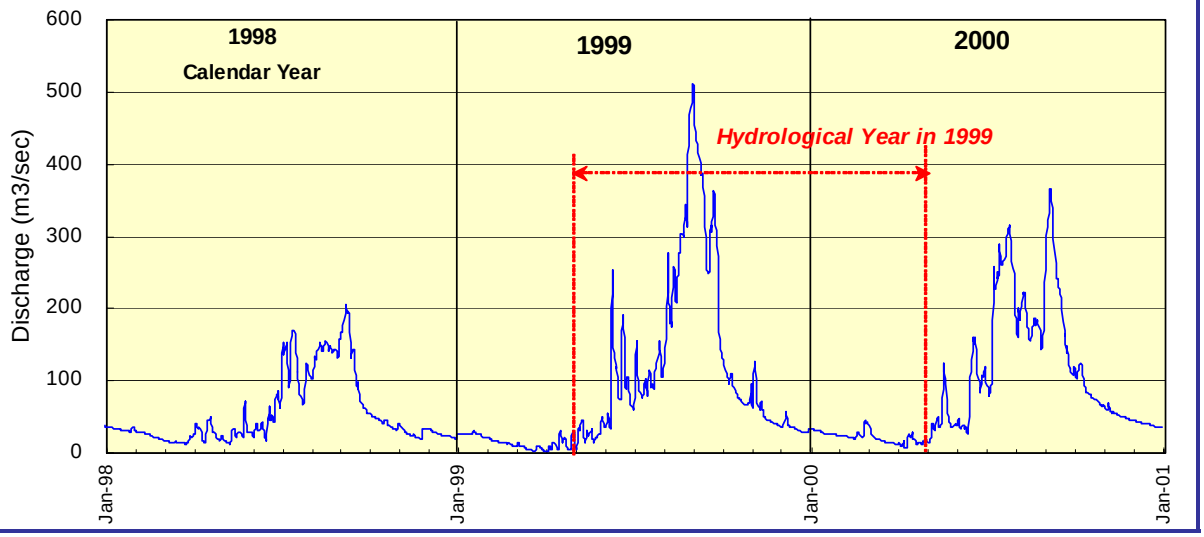


Comparison of Daily Data and Monthly Average Data of Hydrograph in the Wet Year (1994, Nam Lik)



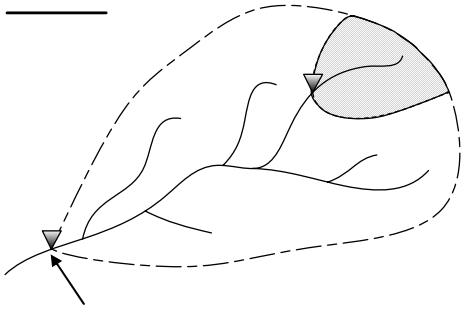
Comparison of Daily Data and Monthly Average Data of Duration Curve the Wet Year (1994, Nam Lik)

Calendar Year and Hydrological Year



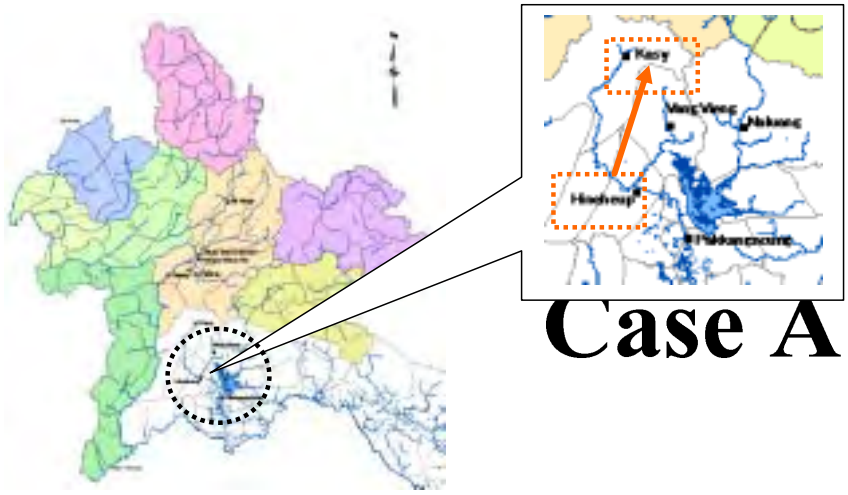
Estimation of Runoff at the Site

A) By Use of Catchment Area Ratio



$$Q_A = Q_s \times \frac{C_A}{C_s} = \frac{Q_s}{C_s} \times C_A$$

Specific Discharge

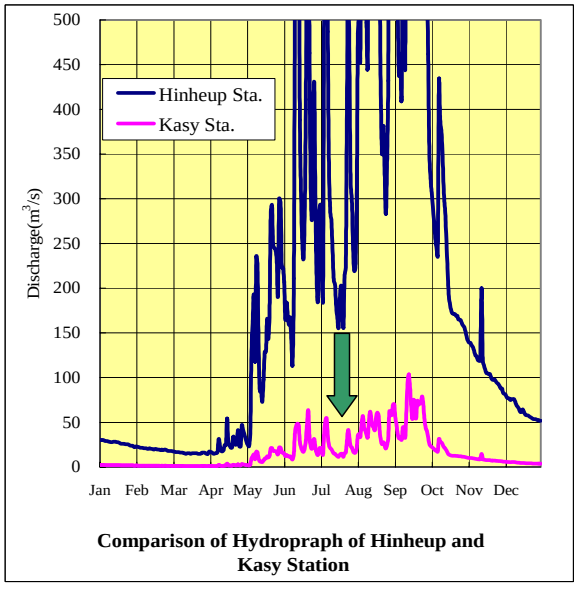


Case A

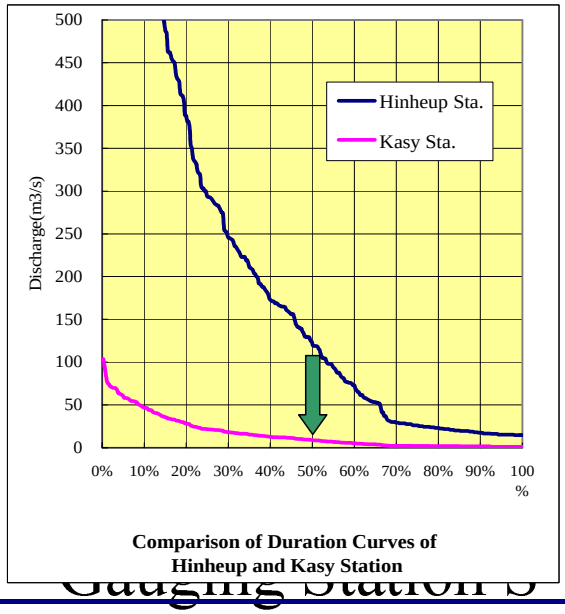
Catchment Area of Hinheup C_S= 5,115 m^2 **0.073118**

Catchment Area of Kasy C_A= 374 m^2

$$Q_A = Q_s \times \frac{374}{5115} = 0.0731 Q_s$$



Comparison of Hydropraph of Hinheup and Kasy Station

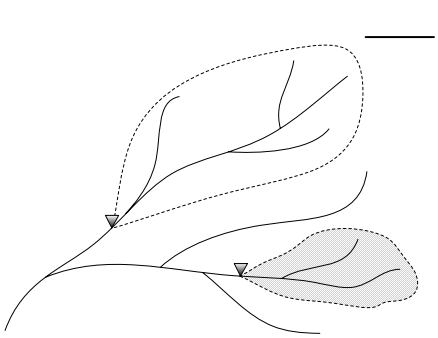


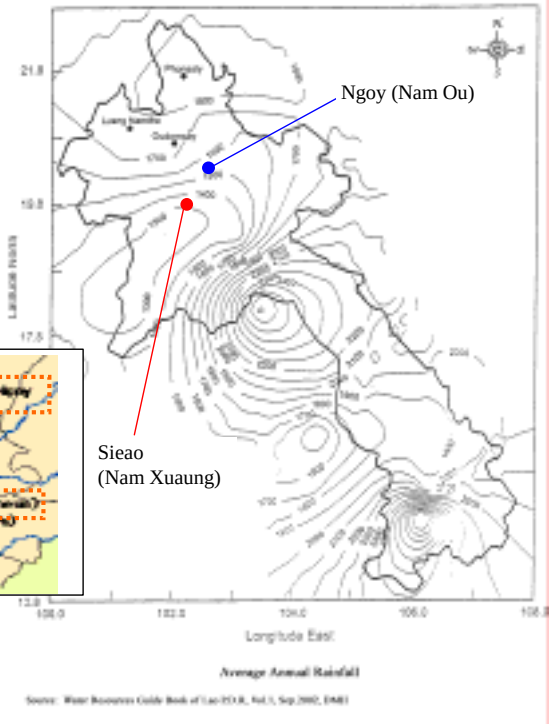
Comparison of Duration Curves of Hinheup and Kasy Station

Gauging Station's Catchment Area: C_s

Estimation of Runoff at the Site

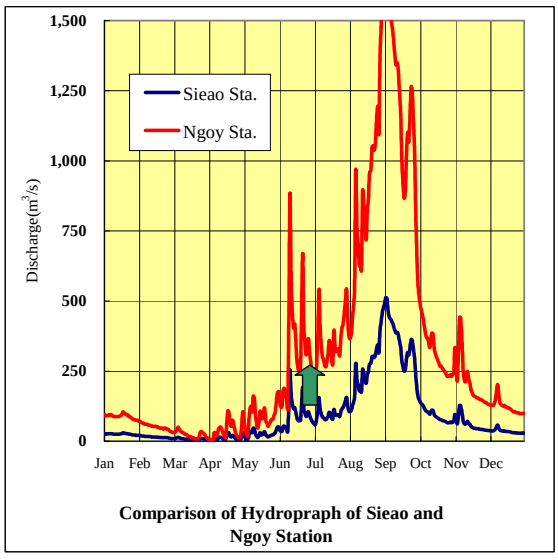
B) By Use of Ratio of Catchment Area and Annual Basin Mean Rainfall



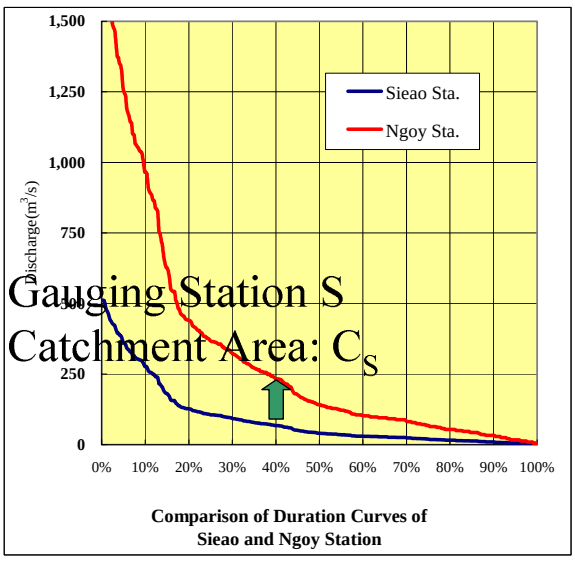


	Flow Data (m^3/s)	Catchment Area (km^2)	Mean Rainfall (mm)
Cauging Station S (Sieao)		**6,503**	**1350**
Site A (Ngoy)	**?**	**19,698**	**1550**

$$Q_A = Q_s \times \frac{C_A}{C_s} \times \frac{R_A}{R_s}$$



Comparison of Hydropraph of Sieao and Ngoy Station



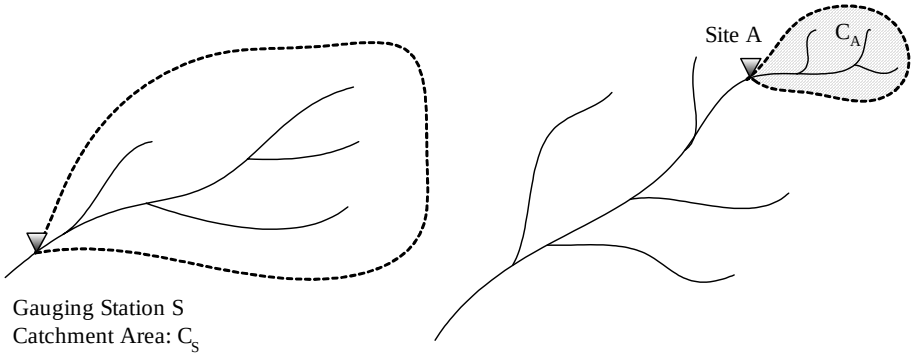
Comparison of Duration Curves of Sieao and Ngoy Station

Site

Estimation of Runoff at the Site

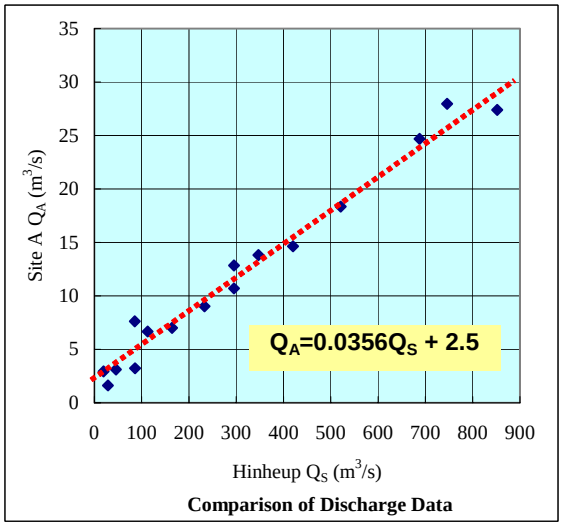
C) By Use of Ratio of Flow Correlation

Case C

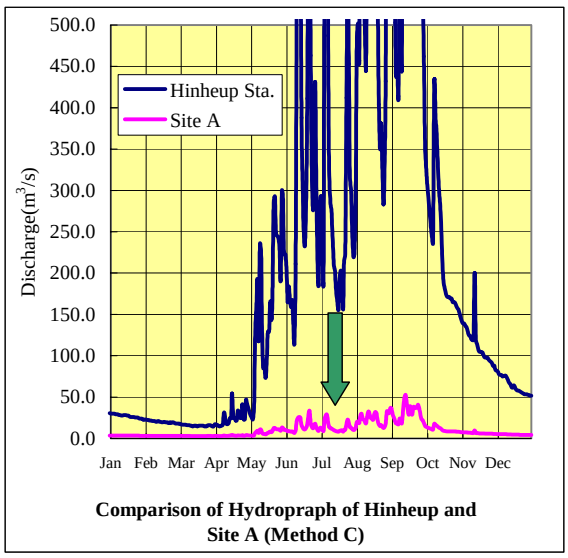


Discharge Measurement Data

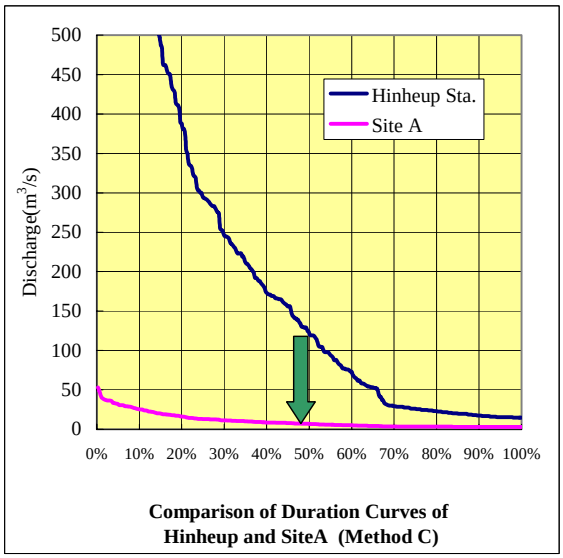
	Hinheup Q_S (m^3/s)	Site A Q_A (m^3/s)
1998/1/14	28.4	1.63
1998/1/24	85.4	7.63
1998/2/8	521	18.35
1998/2/22	19.5	2.95
1998/3/29	45.4	3.12
1998/4/18	420	14.63
1998/5/14	687.7	24.68
1998/5/30	295	12.84
1998/6/16	233	9.02
1998/7/7	746	27.96
1998/8/28	852	27.4
1998/10/2	347	13.82
1998/10/24	295	10.7
1998/11/19	164	7.02
1998/12/22	86.2	3.23
1998/12/29	112.6	6.68



Comparison of Discharge Data



Comparison of Hydropraph of Hinheup and Site A (Method C)

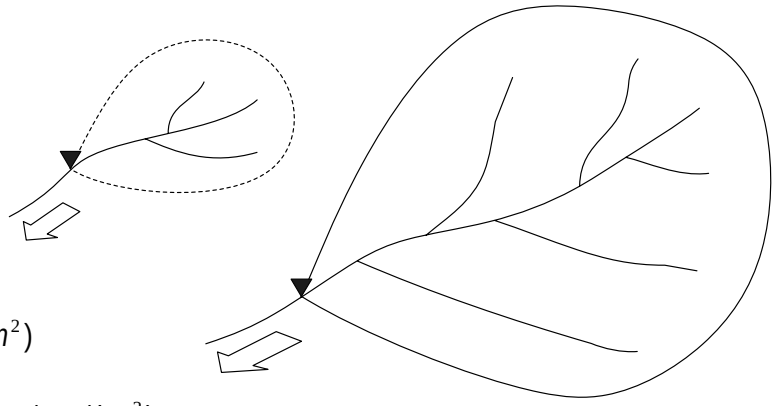


Comparison of Duration Curves of Hinheup and SiteA (Method C)

Estimation of Runoff at the Site

D) By Use of Specific Discharge in the Dry Season

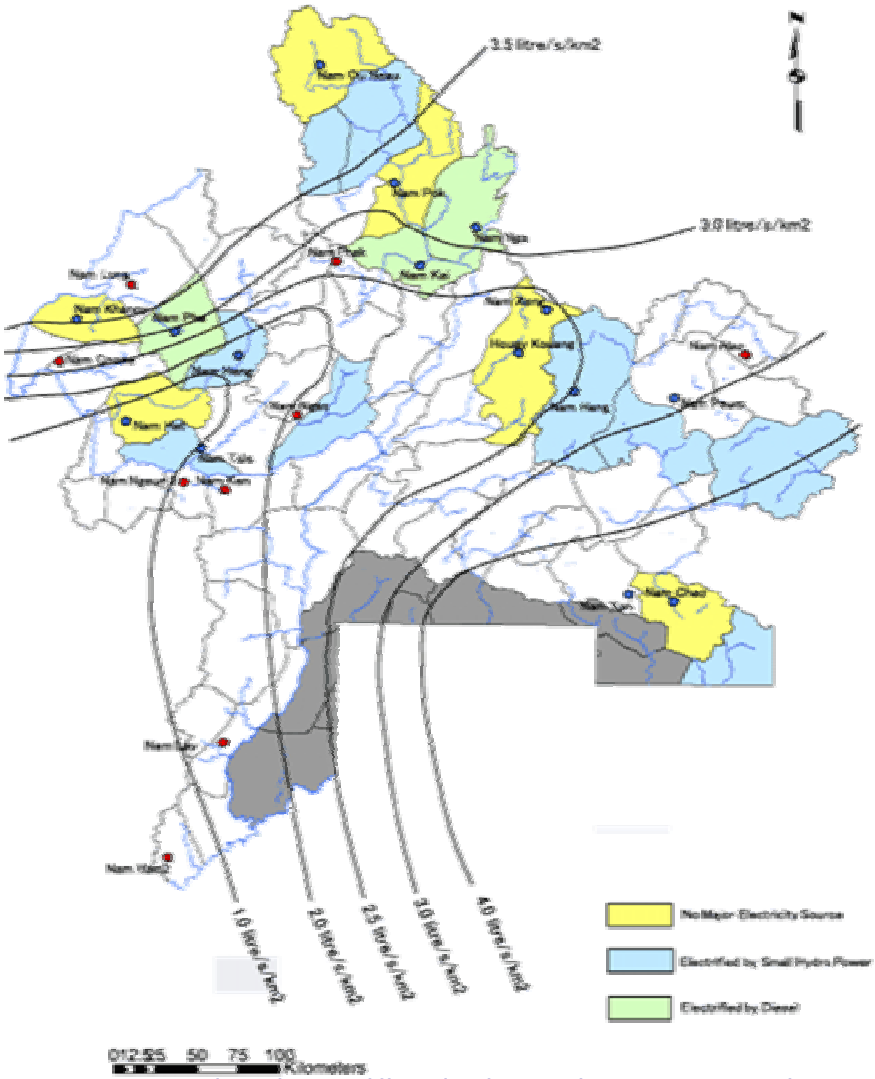
Specific Discharge ($m^3/s/km^2$) = Discharge (m^3/s) / Catchment Area (km^2)



Specific Discharge

$$SD_A = \frac{0.04}{10} = \frac{40}{10} = 4(liter/sec/km^2)$$

$$SD_B = \frac{40}{10,000} = \frac{40 \times 1,000}{10,000} = 4(liter/sec/km^2)$$



Regional Specific Discharge in Dry Season in Northern Laos