Appendix-6 Reference Data

PREPARATORY SURVEY
ON
MICRO-HYDROPOWER IMPROVEMENT PROJECT
IN WESTERN AREA
IN
FEDERAL DEMOCRATIC REPUBLIC OF NEPAL

REFERENCE DATA FOR
HYDROLOGY ANALYSIS

NIPPON KOEI CO., LTD.

1. General

Hydrological study was done for the three hydropower project sites in Bajhang, Bajura, and Syarpudaha located in the midwestern region of Nepal. The design flood at the intake point of each site was calculated for intake weir design. The probable rainfall was estimated considering rainfall characteristics before the design flood analysis. The design flood was calculated using the probable rainfall by flood runoff model.

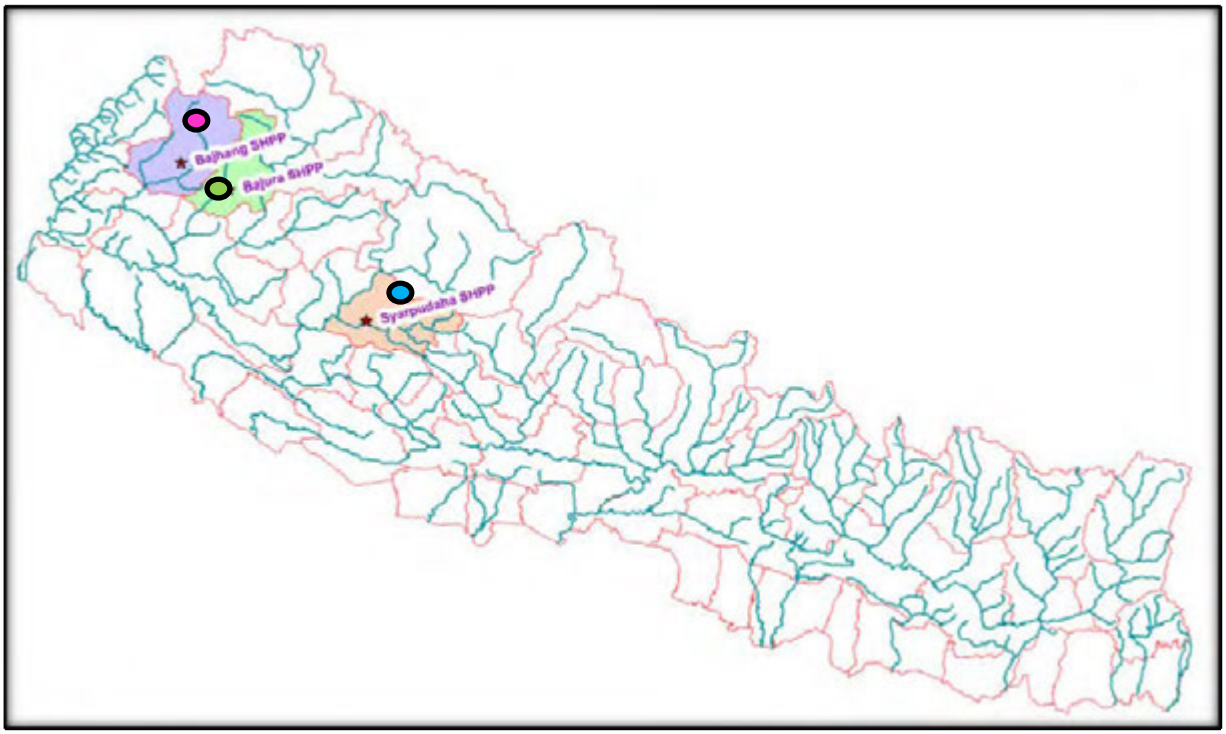


Figure 1.1 Location of three projects shown in the map of Nepal

The intake discharge of three hydroelectric power stations is shown in the table below. The intake discharge 0.415 m^3/s of Bajang site which has the largest catchment area is seven times larger than the two other sites' at 0.054m^3/s.

Table1.1 Catchment area and intake discharge of each site

Site	Catchment Area in ($K m^2$)	Power Generation Intake Water (m^3/s)	Remarks
① Bajhang	104.0	0.415	
② Bajura	27.3	0.054	
③ Syarpudaha	40.8	0.054	

(1) Bajhang

The catchment area of Bajang is 104 km^2 which is the largest of the three sites. The highest elevation of Bajhang basin is EL. 5,056 m, and the lowest is EL. 1,625 m. The average elevation of Bajhang basin area is more than EL. 2,000 m as shown in the figures below.

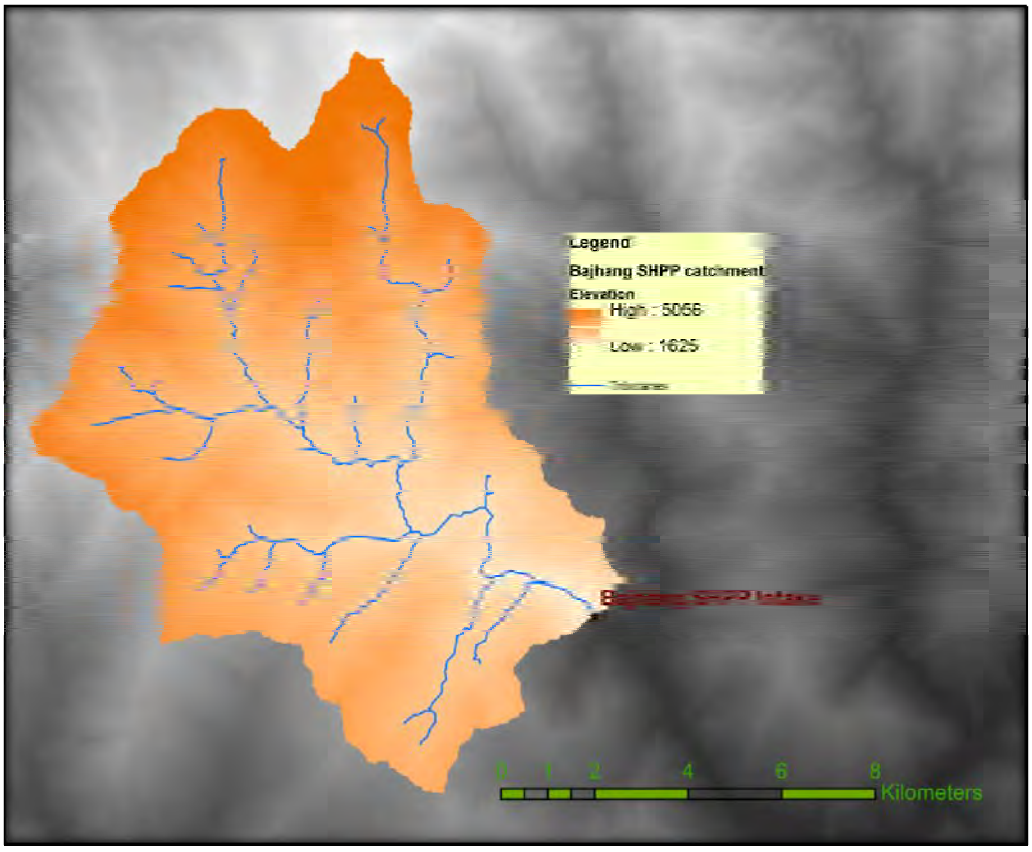


Figure 1.2 Catchment area computed at intake of Bajhang SHPP

Table 1.2 Hypsographic data of catchment area of intake

Elevation below (masl)	Catchment (km^2)
1,600	0
1,800	1.25
2,200	11.38
2,600	33.45
3,000	59.84
3,400	78.15
3,800	91.05
4,000	95.86
4,200	99.65
4,400	102.86
4,600	104.88
4,800	105.54
5,000	105.72
5,200	105.75

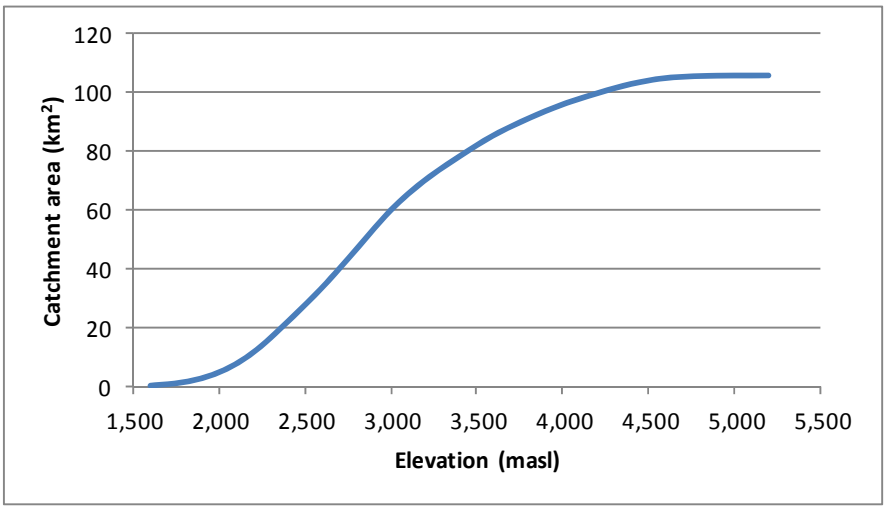


Figure1.3 Hypsographic curve of intake area of Bajhang SHPP intake area

(2) Bajura

The catchment area of Bajura is 27 km^2 which is the smallest of the three sites. The highest elevation of Bajura basin is EL. 4,114 m, and the lowest is EL. 1,622 m. The average elevation of Bajura basin area is more than EL. 2,000 m as shown in the figures below.

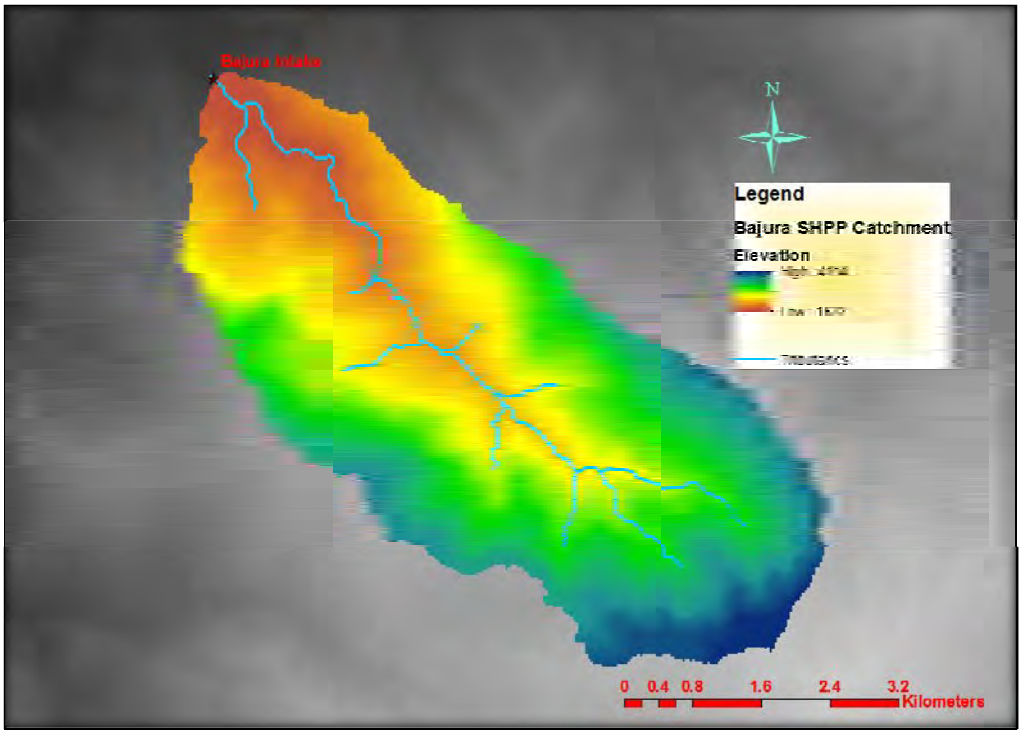


Figure 1.4 Catchment area computed at intake of Bajura SHPP

Table 1.3 Hypsographic data of catchment area of intake

Elevation (masl)	Catchment area (km^2)
1,600	0
1,800	0.39
2,000	1.64
2,200	3.62
2,400	5.92
2,600	8.67
2,800	12.00
3,000	15.40
3,200	18.70
3,400	21.77
3,600	24.53
3,800	26.02
4,000	26.78
4,200	26.89

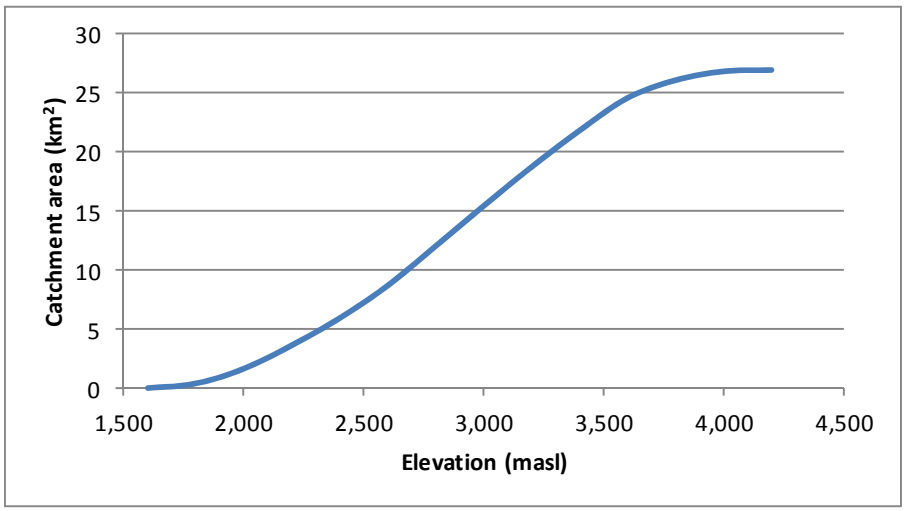


Figure1.5 Hypsographic curve of intake area of Bajura SHPP intake area

(3) Syarpudaha

The catchment area of Syarpudaha is 40 km² which is the middle of the three sites in terms of basin area. The highest elevation of Syarpudaha basin is EL. 3,671 m, and the lowest is EL. 1,215 m. The average elevation of Syarpudaha basin area is more than EL. 2,000 m as shown in the figures below.

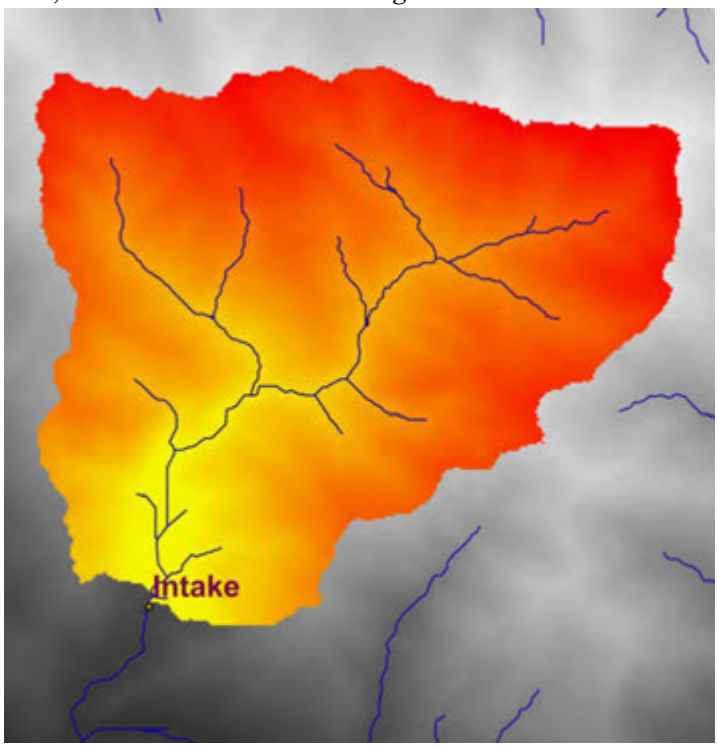


Figure Catchment area computed at intake of Syarpudaha SHPP

Table 1.4 Hypsographic data of catchment area of Syarpudaha intake

Elevation (masl)	Catchment area below (km2)
1,200	0
1,400	1.66
1,600	3.32
1,800	5.83
2,000	8.92
2,200	12.81
2,400	17.71
2,600	22.93
2,800	27.83
3,000	32.27
3,200	36.77
3,400	39.60
3,600	40.59
3,800	40.72

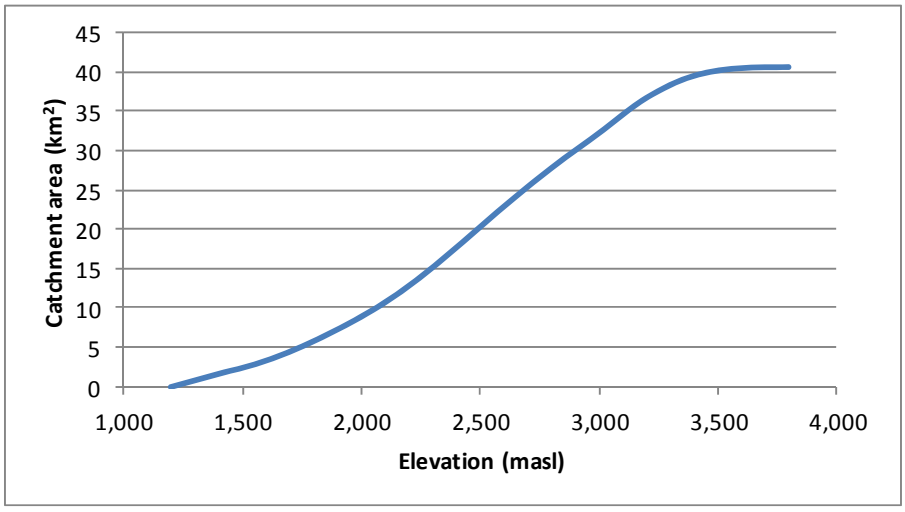


Figure1.7 Hypsographic curve of intake area of Syarpudaha SHPP intake area

2. Rainfall Analysis

The probable rainfall in each site was calculated considering the rainfall characteristics of three sites located in the midwestern region of Nepal.

2.1. Rainfall Characteristics in the Midwestern Region of Nepal

Nepal topography is divided into the mountainous district of the Terai plains bordering the plains of southern India, middle mountains, and northern mountains (Himalaya). The elevation difference from the world's highest peak of Mount Everest (EL. 8,848 m) to the Terai plains of altitude less than EL. 100 m is more than 8,700 m. In Nepal, from the cold mountainous terrain of the Northern Himalayan Region to the subtropical regions of the southern Terai plains, various climatic zones depending on the altitude are distributed. The largest area experiences subtropical monsoon climate and a divided rainy season from June to September and dry season from October to May. Eighty percent of the annual precipitation is concentrated in this rainy season and the month with the highest amount of rainfall is July or August. The month with the least amount of rainfall is November or December. The summer monsoon moves from Bangle Bay to the west and reduces humidity, so in the summer monsoon season, the rain usually comes from the west than the east.

2.2. Observed Hydrologic Data

The hydrologic data near the three sites were collected from the Department of Hydrology and Meteorology (DHM) in order to determine the rainfall and runoff values. The individual characteristics of collected rainfall and runoff from each station were studied.

2.2.1. Discharge Observation

The location map of discharge observation stations near the three sites is shown in Figure 2.1. In Nepal, discharge observation was done only for large rivers. Discharge observation for small branch rivers, such as those for the three sites, was not done. The flow characteristics of large rivers are different from small rivers. Therefore, the observed discharge data near the three sites were not used. Instead, the three sites' design floods were estimated from rainfall data by using runoff model.

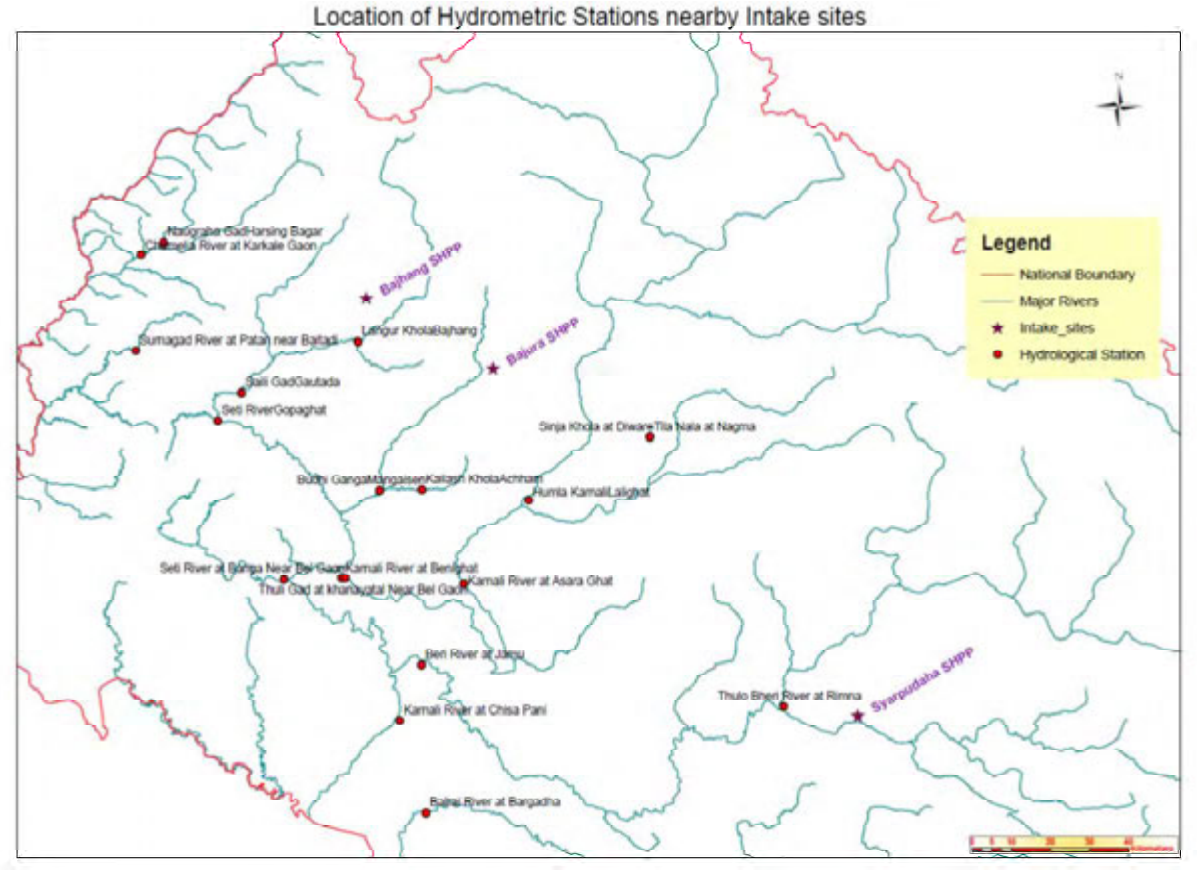


Figure 2.1 Location Map of Discharge Observation Station near the Three Sites

2.2.2. Rainfall Station

The accumulation areas of each rainfall station were calculated by using the Thiessen Method as shown in Figure 2.2. The rainfall stations of the three sites were selected using this figure.

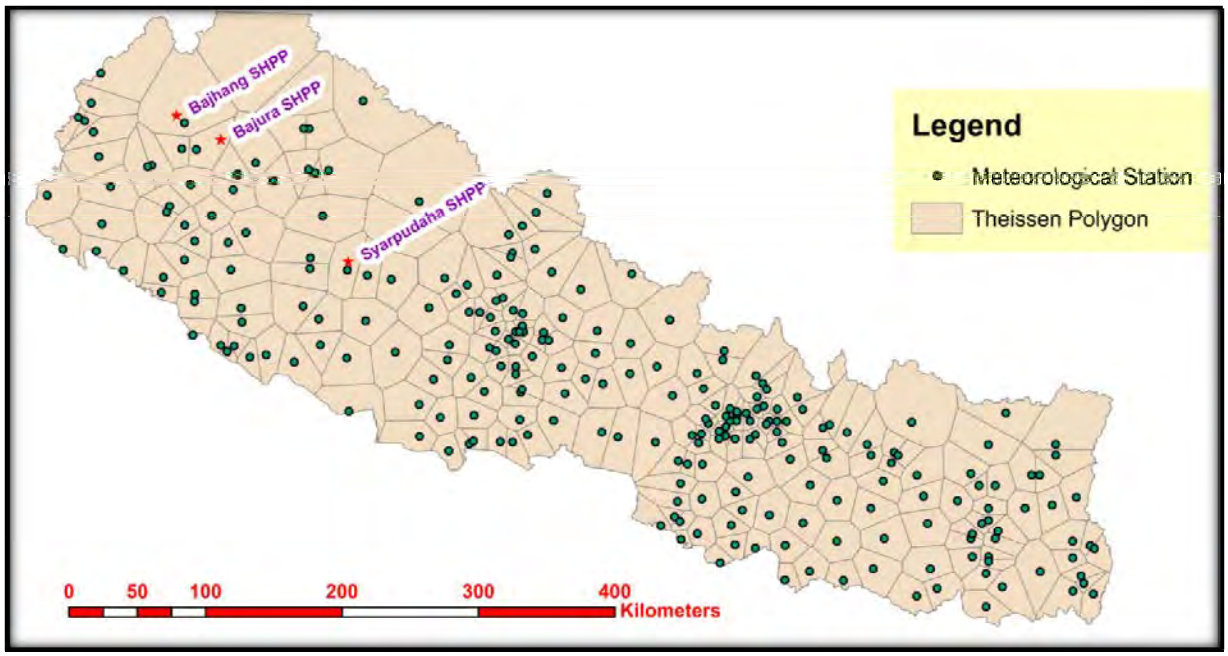


Figure2.2 Locations of meteorological stations spread over the country and the Theissen Polygon

(1) Bajura SHPP

The six rainfall stations were selected near the Bajura SHPP. The Bajura Rainfall Station (No. 0204) was selected from the six stations, because almost the whole basin area of Bajura intake site was included in the accumulation area of Bajura Rainfall Station (No. 0204).

Table 2.1 Theissen Polygon based on the rainfall stations around Bajura project area

Station No.	Name	Latitude	Longitude	Elevation
0202	Chainpur (west)	29.55	81.21	1304
0204	Bajura	29.38	81.31	1400
0211	Khaptad	29.38	81.20	3430
0305	Sheri ghat	29.13	81.60	1210
0308	Nagma	29.20	81.90	1905
0309	Bijaypur (Raskot)	29.23	81.63	1814

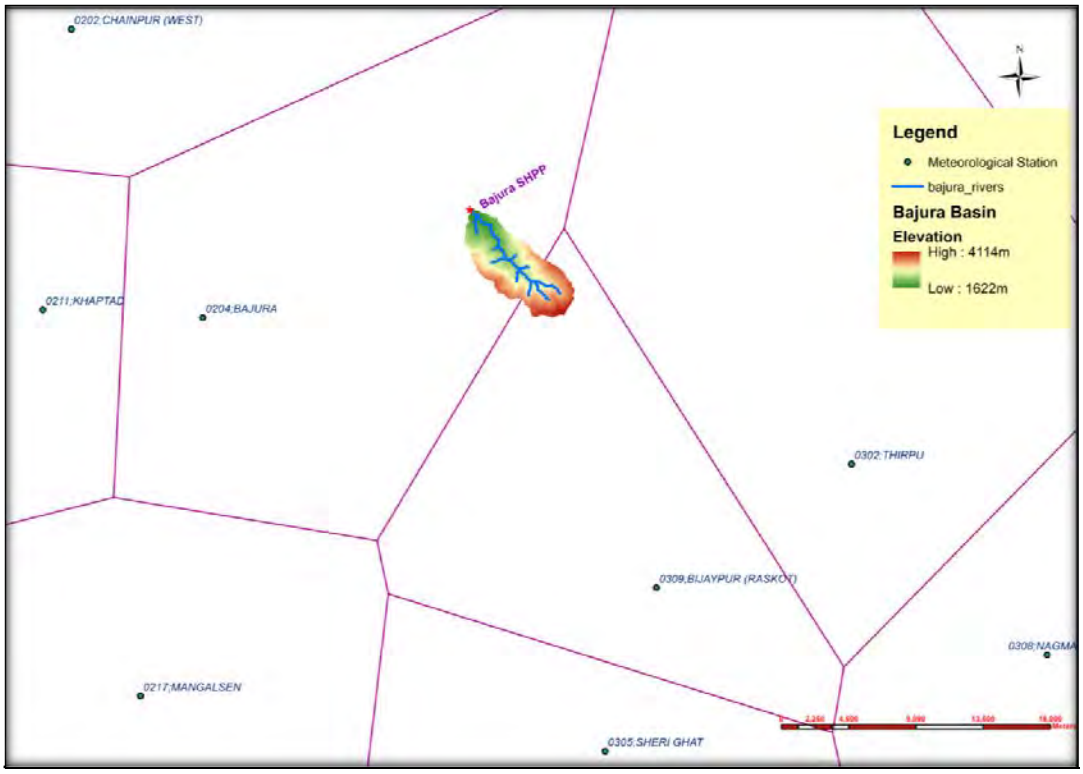


Figure2.3 Theissen polygon drawn with respect to the meteorological stations for computation of mean rainfall

(2) Bajhang SHPP

The seven rainfall stations were selected near the Bajhang SHPP. The Chainpur (West) Rainfall Station (No. 0202) was selected from the seven stations, because the whole basin area of Bajhang intake site was included in the accumulation area of Bajhang Rainfall Station (No. 0202).

Table 2.2 Theissen Polygon based on the meteorological stations around Bajhang project area

Station No.	Name	Latitude	Longitude	Elevation
0202	Chainpur (West)	29.55	81.21	1304
0203	Silgadhi Doti	29.26	80.98	1360
0204	Bajura	29.38	81.31	1400
0211	Khaptad	29.38	81.20	3430
0217	Mangalsen	29.15	81.28	1345
0218	Dipayal (Doti)	29.25	80.95	617
0302	Thirpu	29.31	81.76	1006

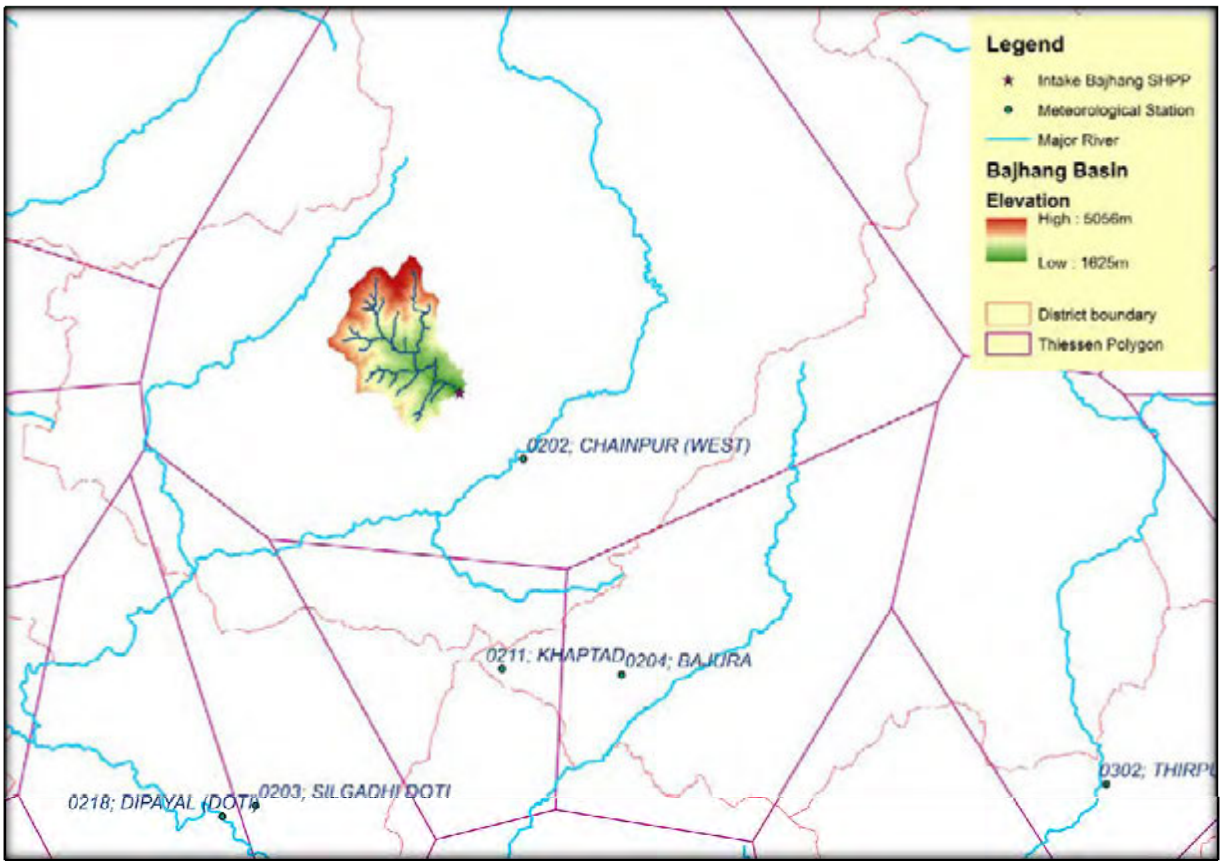


Figure 2.4 Theissen polygon drawn with respect to the meteorological stations for computation of mean rainfall

(3) Syarpudaha

The seven rainfall stations were selected near the Syarpudaha SHPP. The Musikot (Rumukot) Rainfall Station (No. 0514) was selected from the seven stations, because the whole basin area of Syarpudaha intake site was included in the accumulation areas of Musikot rainfall station (No. 0514).

Table 2.3 Theissen Polygon based on the meteorological stations around Syarpudaha project area

Station No.	Name	Latitude	Longitude	Elevation (masl)
0312	Dunai	28.93	82.91	2058
0404	Jajarkot	28.70	82.20	1231
0418	Maina Gaun (d.bas)	28.98	82.28	2000
0502	Rumukot	28.60	82.63	1560
0504	Shera Gaun	28.58	82.81	2150
0513	Chaur Jjhari Tar	28.63	82.20	910
0514	Musikot (Rumukot)	28.63	82.48	2100

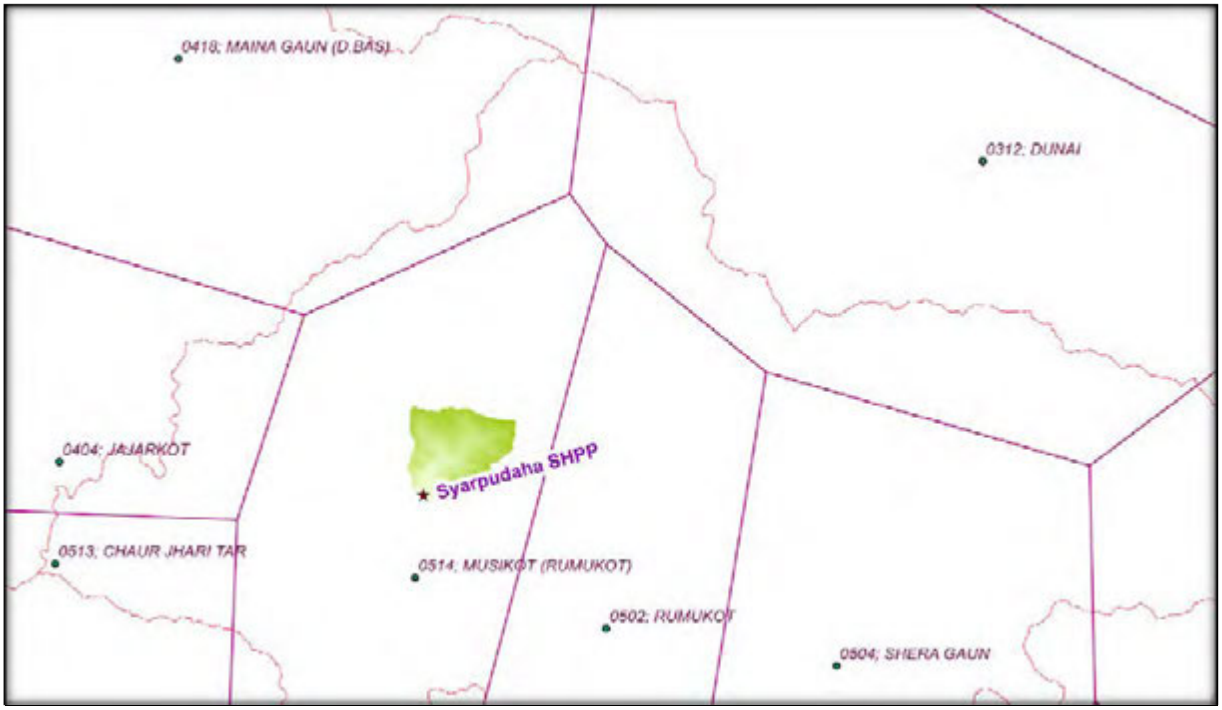


Figure2.5 Theissen polygon drawn with respect to the meteorological stations for computation of mean rainfall

2.3. Rainfall Characteristic at Sites

The rainfall characteristics was analyzed from rainfall data of selected stations.

(1) Duration of Observation

The duration of observation in Bajura Rainfall Station (No. 0204) is 34 years from 1976 to 2009, Chainpur Station (No. 0202) is 57 years from 1953 to 2009, and Musikot Station (No. 0514) is 37 years from 1973 to 2009. The entire durations for each station are more than 30 years.

Table 2.4 Duration of Rainfall Stations

NO	name	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	elevation (m)	Remarks
202	Chainpur (Bajhang)																																																										1,304	57years
204	Bajura (Bajura)																																																										1,400	34years
514	Musikot (Syarpuhada)																																																										2,100	37years

(2) Bajhang(Chainpur(West))

In the Chainpur Rainfall Station, the annual rainfall in the wet season (June–September) and the dry season (October–May) were calculated by using observed data as shown in Table 2.5. The graph of monthly average rainfall is shown in Figure 2.6. Annual average rainfall is 1,518 mm, wet season average rainfall is 1,151 mm, and dry season average rainfall is 368 mm. Seventy-six percent of the annual rainfall occurs during the wet season from June to September.

Table 2.5 List of rainfall at Bajhang（Chainpur(West)）

name	Evaluation	monthly rainfall （mm/m）												annual rainfall (mm/y)	season（mm）	
		1	2	3	4	5	6	7	8	9	10	11	12		rainy	dry
Chainpur (Bajhang)	Maximum	169	202	206	176	205	435	553	617	465	274	61	132	2,079	1,743	685
	average	52	60	63	46	60	177	372	386	216	54	9	25	1,518	1,151	368

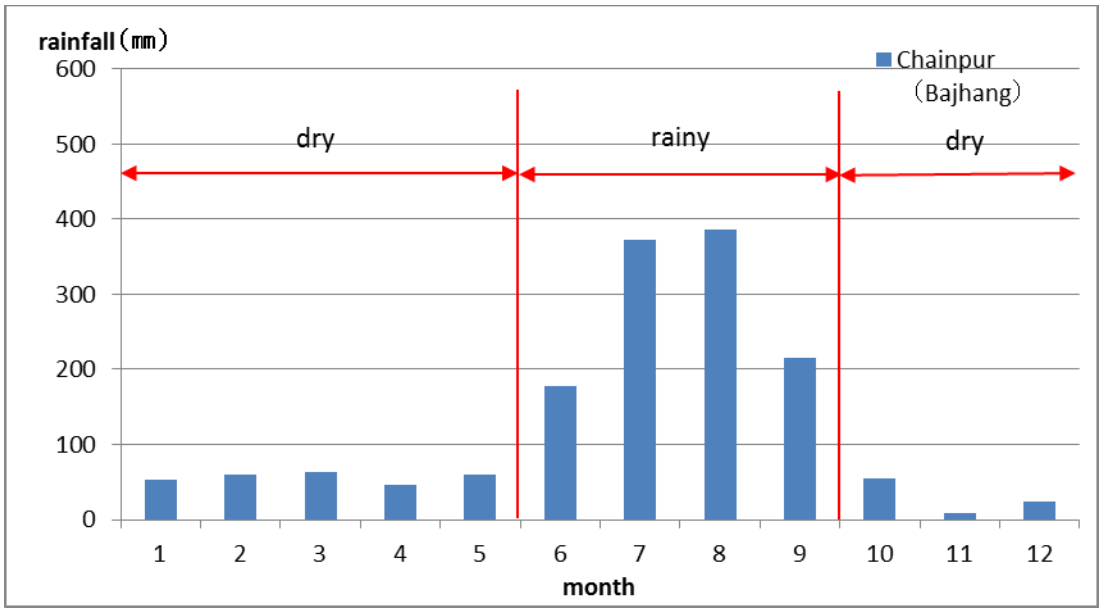


Figure 2.6 Monthly average rainfall at Bajhang（Chainpur(West)）

Table 2.6　List of rainfall data at Bajhang（Chainpur(West)）

year	annual rainfall (mm/y)	season(mm)		Large rainfall 1st-5th(mm/day)					monthly rainfall (mm/m)												missing(day)		
		rainy	dry	1	2	3	4	5	1	2	3	4	5	6	7	8	9	10	11	12	rainy	dry	year missing
1956	1,451	1,149	621	70.4	66.0	66.0	58.9	50.0	0	0	0	0	0	135	265	376	374	255	0	47	13	12	25
1957	1,296	894	291	82.3	66.0	63.5	55.4	49.3	135	2	111	44	26	93	350	315	136	2	6	76	4	3	7
1958	1,487	1,095	409	66.0	58.2	54.6	48.0	44.7	87	20	48	26	26	54	391	445	206	108	0	76	0	1	1
1959	1,488	1,118	296	85.1	52.1	48.3	47.5	38.1	73	67	36	10	40	330	350	235	203	136	9	0	3	8	11
1960	1,233	939	453	53.3	49.8	45.2	41.9	39.4	62	11	46	0	31	88	324	454	74	143	0	0	14	15	29
1961	1,755	1,140	499	73.1	48.3	48.3	45.2	44.7	151	110	29	0	20	161	330	423	227	260	1	43	7	9	16
1962	1,715	1,502	388	80.2	64.8	55.3	48.4	48.2	32	60	54	35	13	243	343	617	298	0	3	16	2	4	6
1963	2,021	1,633	293	80.2	79.8	64.8	64.4	55.3	31	23	206	83	28	283	435	617	298	0	3	16	2	1	3
1964	2,079	1,743	528	85.8	62.0	60.4	55.6	53.4	62	25	10	104	73	144	517	616	465	0	0	62	1	0	1
1965	1,511	962	216	87.8	78.2	51.6	49.4	46.8	36	202	188	33	6	146	316	365	135	50	33	0	0	0	0
1966	1,085	912	167	65.6	56.6	52.4	45.8	40.8	0	78	6	0	48	188	307	324	93	22	11	6	0	2	2
1967	1,127	946	327	64.2	46.5	41.5	33.4	32.0	0	28	64	29	7	79	393	308	166	10	17	26	5	0	5
1968	1,310	988	298	70.2	64.6	48.1	45.0	44.6	120	53	68	24	9	184	338	297	170	0	0	48	0	0	0
1969	1,401	1,140	232	68.3	63.3	50.0	45.0	38.3	71	40	66	46	28	124	386	368	262	11	0	0	0	0	0
1970	1,344	1,080	303	86.3	56.3	56.2	52.5	47.1	100	30	22	4	66	307	406	254	113	43	0	0	0	0	0
1971	1,407	1,033	323	70.0	42.2	41.4	40.2	40.1	35	48	33	119	25	271	219	271	272	110	4	0	0	0	0
1972	1,224	958	282	100.1	54.1	48.2	48.2	32.1	4	80	47	58	19	53	428	314	163	58	1	0	0	1	1
1973	1,565	1,236	250	70.2	55.0	50.0	42.4	40.0	71	31	52	1	67	302	268	417	248	105	1	0	12	4	16
1974	952	723	332	40.3	40.0	38.0	36.1	28.3	54	41	5	5	38	87	249	320	67	45	2	37	15	7	22
1975	1,581	1,277	268	80.0	53.0	50.0	49.2	47.0	100	54	55	1	37	363	298	261	355	56	0	1	11	4	15
1976	1,114	887	305	43.4	41.0	40.1	40.0	33.0	11	102	26	33	39	115	177	416	179	6	0	10	8	6	14
1977	1,422	1,015	505	66.3	62.0	45.0	45.0	42.0	57	20	8	89	113	163	427	238	187	64	2	54	4	0	4
1978	1,416	976	395	42.1	42.0	42.0	41.0	40.1	13	75	132	84	81	200	340	291	145	8	30	17	5	1	6
1979	1,130	718	341	46.2	40.3	36.0	35.3	34.0	27	67	50	95	101	81	354	253	30	20	0	53	0	7	7
1980	1,596	1,267	426	80.2	57.4	49.0	42.2	41.6	26	44	99	53	46	315	336	324	291	38	0	23	2	1	3
1981	1,645	1,192	642	74.8	52.0	50.2	48.2	47.3	106	40	78	40	101	149	417	388	238	0	61	27	0	6	6
1982	1,662	1,042	580	55.0	48.5	47.0	46.0	42.6	85	70	192	107	101	113	355	478	97	31	9	26	18	21	39
1983	2,005	1,369	417	103.0	87.0	70.2	69.0	67.0	68	19	65	176	187	172	240	520	437	110	0	12	7	9	16
1984	1,496	1,177	177	86.5	61.0	54.8	53.5	47.0	29	155	40	37	34	345	282	288	262	8	0	17	9	9	18
1985	1,675	1,162	685	107.2	95.5	47.0	42.0	41.2	34	8	4	43	63	77	508	308	270	265	3	92	4	11	15
1986	1,662	1,133	538	100.1	83.5	79.2	67.5	57.3	2	18	70	80	155	125	492	329	186	96	24	85	8	8	16
1987	1,349	975	316	71.5	47.3	43.5	42.5	37.5	23	68	28	72	142	65	371	350	190	15	0	26	4	6	10
1988	1,610	1,208	413	70.5	68.5	65.5	54.3	52.0	12	111	110	22	21	95	553	443	116	4	3	118	6	2	8
1989	1,547	1,226	434	67.0	61.0	48.5	46.5	45.5	169	28	48	8	36	140	332	551	203	11	19	4	4	18	22
1990	1,804	1,336	436	88.0	48.0	45.1	45.0	42.5	0	126	192	34	48	175	422	462	277	18	6	44	4	8	12
1991	1,658	1,251	304	71.5	69.7	65.0	59.5	57.0	40	81	116	68	63	221	285	581	164	4	8	28	8	10	18
1992	1,455	1,123	531	70.0	48.2	46.2	46.0	45.7	104	34	31	38	59	105	334	483	201	50	17	0	2	10	12
1993	1,302	838	275	97.8	52.2	45.1	42.1	34.5	73	63	154	20	154	150	184	254	250	0	0	0	34	8	42
1994	1,299	1,016	339	80.2	63.0	47.0	43.8	39.6	39	142	2	50	42	211	336	339	129	3	0	5	3	9	12
1995	1,677	1,285	343	78.2	70.0	58.5	56.0	54.6	105	110	64	20	32	173	533	372	207	21	37	3	5	3	8
1996	1,650	1,280	317	85.4	71.6	71.4	50.4	49.3	62	105	49	37	30	120	501	442	217	87	0	0	4	6	10
1997	1,768	1,327	513	87.8	76.0	65.1	64.4	59.0	59	22	20	75	53	162	508	417	240	32	49	132	7	10	17
1998	1,666	1,285	160	92.0	77.6	58.0	55.6	52.4	0	71	117	66	47	185	431	511	158	57	23	0	14	9	23
1999	1,438	1,263	494	60.0	58.0	57.6	57.2	52.0	20	19	2	0	39	287	516	275	185	80	0	15	8	12	20
2000	1,810	1,410	290	114.4	78.5	65.8	59.6	58.2	12	94	38	50	205	435	277	441	257	1	0	0	16	7	23
2001	1,322	1,015	458	55.4	43.0	43.0	40.7	38.2	65	43	53	25	104	278	397	281	60	15	3	0	10	12	22
2002	1,853	1,393	307	88.4	83.6	76.5	67.8	67.0	98	138	55	90	60	158	407	541	288	16	4	0	12	11	23
2003	1,747	1,446	225	89.8	69.7	57.5	49.2	48.4	48	118	54	26	41	243	408	474	321	0	3	10	10	5	15
2004	1,317	1,008	373	74.0	62.6	56.7	56.4	51.3	70	6	0	54	82	119	411	284	194	78	17	3	10	15	25
2005	1,445	1,133	355	89.0	68.0	61.0	52.2	50.0	118	78	17	7	56	111	410	348	264	10	1	27	10	13	23
2006	1,467	1,065	399	50.4	42.8	41.0	38.6	37.0	0	5	95	148	70	126	418	325	196	49	16	20	10	16	26
2007	1,620	1,238	244	61.0	55.0	53.6	51.0	50.6	0	93	172	19	31	121	376	405	335	28	16	23	10	11	21
2008	1,654	1,459	233	98.0	85.0	64.0	54.5	53.4	24	10	15	42	87	336	458	388	277	11	8	0	7	15	22
2009	1,673	1,152	306	111.6	105.4	81.0	75.8	71.0	4	31	51	44	85	58	377	453	264	274	32	1	6	1	7
Maximum	2,079	1,743	685	114.4	105.4	81.0	75.8	71.0	169	202	206	176	205	435	553	617	465	274	61	132	–	–	–
average	1,518	1,151	368	76.6	61.7	53.9	49.8	46.3	52	60	63	46	60	177	372	386	216	54	9	25	–	–	–

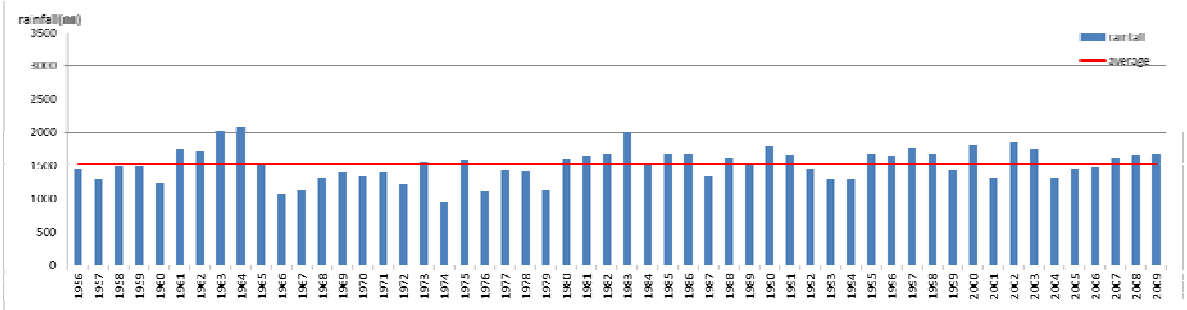


Figure 2.7　Annual rainfall at Bajhang（Chainpur(West)）

(3) Bajura (Bajura)

For the Bajura Rainfall Station, the annual rainfall in the wet season (June–September) and the dry season (October–May) were calculated by using observed data as shown in Table 2.7. The graph of monthly average rainfall is shown in Figure 2.8. Annual average rainfall is 1,949 mm, the wet season average rainfall is 1,506 mm, and dry season average rainfall is 430 mm. Seventy-seven percent of the annual rainfall occurs during the wet season from June to September.

Table 2.7 List of rainfall at Bajura (Bajura)

name	Evaluation	monthly rainfall (mm/m)												annual rainfall (mm/y)	season (mm)	
		1	2	3	4	5	6	7	8	9	10	11	12		rainy	dry
Bajura (Bajura)	Maximum	175	240	309	163	263	509	1,277	770	570	186	79	175	2,792	2,403	864
	average	55	71	64	60	115	255	528	492	231	40	10	27	1,949	1,506	430

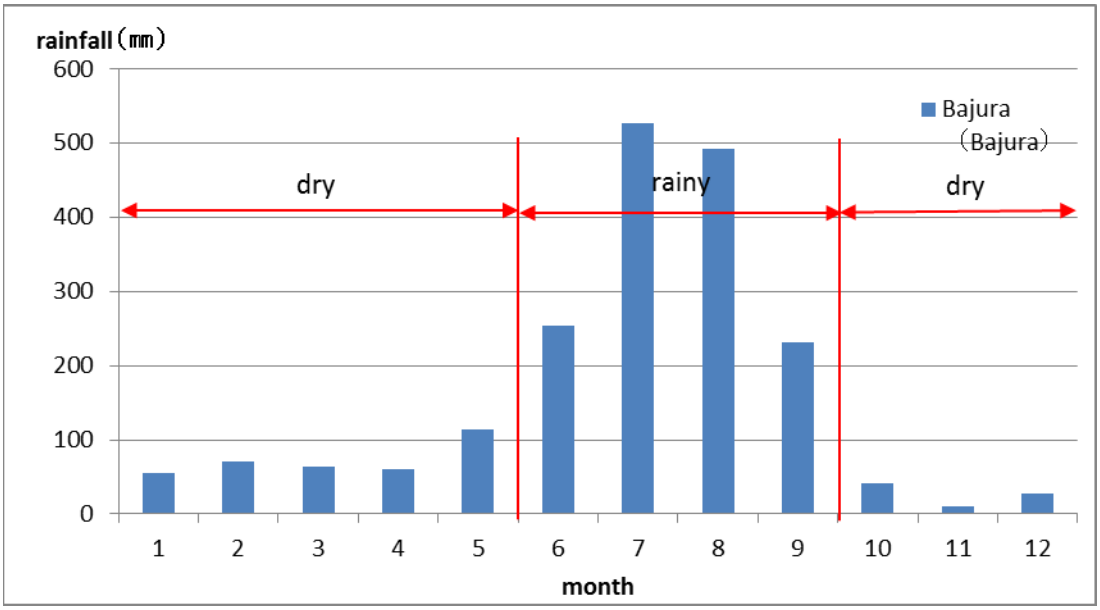


Figure 2.8 Monthly average rainfall at Bajura (Bajura)

Table 2.8　List of rainfall data at Bajura（Bajura）

year	annual rainfall (mm/y)	season(mm)		Large rainfall 1st-5th(mm/day)					monthly rainfall (mm/m)												missing(day)		
		rainy	dry	1	2	3	4	5	1	2	3	4	5	6	7	8	9	10	11	12	rainy	dry	year missing
1976	1,445	1,206	210	72.0	64.0	58.0	48.0	46.4	6	84	11	33	99	182	449	344	231	0	0	6	16	7	23
1977	982	698	566	60.2	54.5	45.2	40.2	38.6	46	0	38	28	92	157	253	245	42	2	9	70	13	13	26
1978	2,721	2,152	573	88.4	82.2	81.6	75.2	68.0	8	75	216	116	70	489	696	629	338	21	49	14	13	7	20
1979	1,843	1,214	477	92.4	84.0	58.8	51.6	47.6	54	90	82	65	198	308	447	399	60	57	8	75	10	2	12
1980	2,012	1,604	598	90.3	70.0	55.5	51.6	48.0	15	93	116	42	72	341	574	486	203	45	0	26	1	1	2
1981	2,420	1,794	864	144.5	111.0	74.0	65.5	60.0	143	38	101	68	179	279	627	605	283	7	66	26	2	1	3
1982	2,681	1,843	637	95.0	65.7	64.5	58.5	58.5	109	104	309	79	164	288	684	747	125	18	20	36	0	5	5
1983	2,792	2,023	500	90.0	86.0	85.0	82.0	75.0	115	46	70	163	171	221	640	594	570	186	0	18	0	0	0
1984	2,228	1,902	271	97.3	85.0	80.5	68.5	68.0	1	131	5	31	129	509	700	435	258	7	0	24	0	0	0
1985	2,179	1,705	491	63.0	60.5	51.0	50.0	47.5	55	17	0	26	143	312	556	556	281	183	9	43	0	0	0
1986	1,710	1,321	461	125.1	62.9	43.5	42.7	42.5	3	24	70	70	90	316	403	223	379	62	7	63	0	0	0
1987	1,458	1,080	488	73.0	52.0	50.5	42.5	42.5	0	39	7	106	178	172	455	293	161	9	0	40	2	0	2
1988	2,532	1,919	398	126.5	124.0	84.5	83.5	65.0	24	139	110	62	104	289	926	472	231	0	0	175	0	62	62
1989	2,289	2,066	376	80.9	80.3	80.3	80.1	77.0	151	0	0	1	71	165	732	682	487	0	0	0	23	119	142
1990	376	0	420	53.3	52.0	44.2	42.3	40.0	0	286	90	0	0	0	0	0	0	0	0	0	122	97	219
1991	1,745	1,299	343	79.7	60.0	59.0	56.8	53.4	52	50	85	143	91	310	355	570	64	5	0	21	12	6	18
1992	1,956	1,617	693	136.0	101.1	73.0	70.1	66.0	175	27	30	3	82	265	568	553	231	10	10	3	2	7	9
1993	2,554	1,883	401	156.0	108.0	103.0	86.0	82.0	121	240	143	84	83	317	506	770	290	0	0	0	6	14	20
1994	2,238	1,817	281	109.4	98.2	97.3	86.8	60.0	57	129	5	26	183	366	615	633	203	19	1	0	7	9	16
1995	2,159	1,879	224	128.0	108.1	96.0	79.0	74.4	59	23	0	81	97	264	866	648	101	20	0	0	8	3	11
1996	2,100	1,764	509	75.4	67.4	61.2	51.8	50.2	0	79	34	83	8	318	548	599	299	132	0	0	9	12	21
1997	2,088	1,414	635	67.2	61.6	56.4	48.6	45.6	103	31	47	83	113	279	388	449	298	85	79	132	25	17	42
1998	1,961	1,543	388	89.2	81.2	80.8	70.4	56.8	0	69	92	88	89	148	493	733	170	51	29	0	22	3	25
1999	1,895	1,385	712	81.6	72.2	54.4	43.7	40.2	18	26	0	0	263	167	523	367	329	163	0	40	13	5	18
2000	2,344	1,834	342	92.4	82.2	79.2	75.2	67.6	13	151	35	88	224	409	648	445	332	0	0	0	10	8	18
2001	1,950	1,601	521	77.8	76.4	76.4	65.4	54.6	67	34	40	61	140	480	567	496	58	0	7	0	11	6	17
2002	2,221	1,676	478	101.6	76.4	67.4	66.2	62.8	154	144	38	54	124	240	432	693	312	11	20	0	11	7	18
2003	1,799	1,352	206	80.2	53.5	52.3	47.6	47.2	57	165	24	44	156	230	360	735	27	0	0	0	15	25	40
2004	480	31	495	58.1	38.0	35.2	21.5	20.6	12	58	79	29	27	15	0	11	5	184	9	50	5	18	23
2005	670	407	258	58.1	40.0	38.5	37.2	31.5	75	103	48	10	16	51	149	126	81	9	0	3	14	11	25
2006	851	598	277	99.3	40.4	32.6	28.8	28.6	58	3	56	85	44	129	124	141	204	6	0	0	9	0	9
2007	1,442	1,151	98	78.0	56.0	53.0	46.4	45.0	0	47	117	10	97	77	331	473	270	5	0	16	0	74	74
2008	77	0	214	11.5	9.5	9.0	8.5	6.0	54	14	9	0	0	0	0	0	0	0	0	0	122	105	227
2009	2,617	2,403	0	120.1	111.3	109.6	107.4	98.7	0	20	48	72	74	58	1,277	600	469	0	0	0	18	91	109
Maximum	2,792	2,403	864	156.0	124.0	109.6	107.4	98.7	175	240	309	163	263	509	1,277	770	570	186	79	175	–	–	–
average	1,949	1,506	430	93.3	75.4	66.8	60.3	55.3	55	71	64	60	115	255	528	492	231	40	10	27	–	–	–

Note: The maximum daily rainfall in 1980 was 431 mm , but the rainfall data 431mm was deleted as abnormal record, because the daily rainfall of the same day around another rainfall stations are not recorded such as big rainfall.

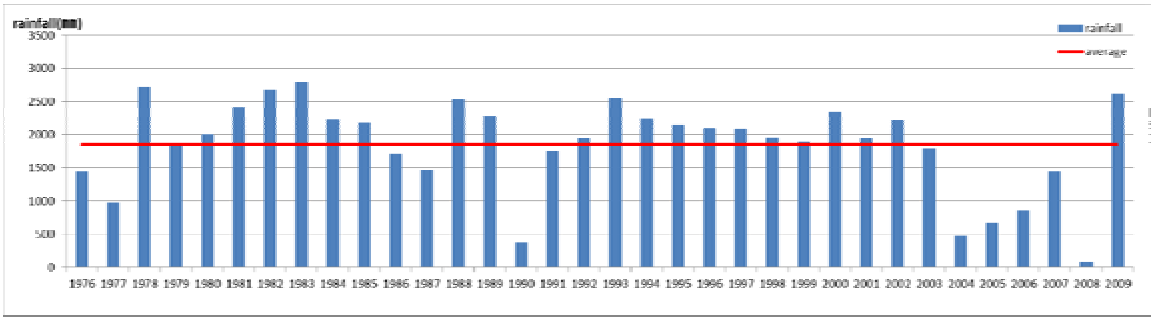


Figure 2.9　Annual rainfall at Bajura（Bajura）

(4) Musikot(Syarpudaha)

For the Musikot Rainfall Station, the annual rainfall in the wet season (June–September) and the dry season (October–May) were calculated by using observed data as shown in Table 2.9. The graph of monthly average rainfall is shown in Figure 2.10. Annual average rainfall is 2,050 mm, wet season average rainfall is 1,695 mm, and dry season average rainfall is 354 mm. Eighty-three percent of the annual rainfall occurs during the wet season from June to September.

Table 2.9 List of rainfall at Musikot(Syarpudaha)

name	Evaluation	monthly rainfall (mm/m)												annual rainfall (mm/y)	season (mm)	
		1	2	3	4	5	6	7	8	9	10	11	12		rainy	dry
Musikot (Syarpudaha)	Maximum	81	100	122	171	303	646	1,133	819	896	480	91	99	2,948	2,748	638
	average	23	31	37	46	116	291	545	548	311	69	14	17	2,050	1,695	354

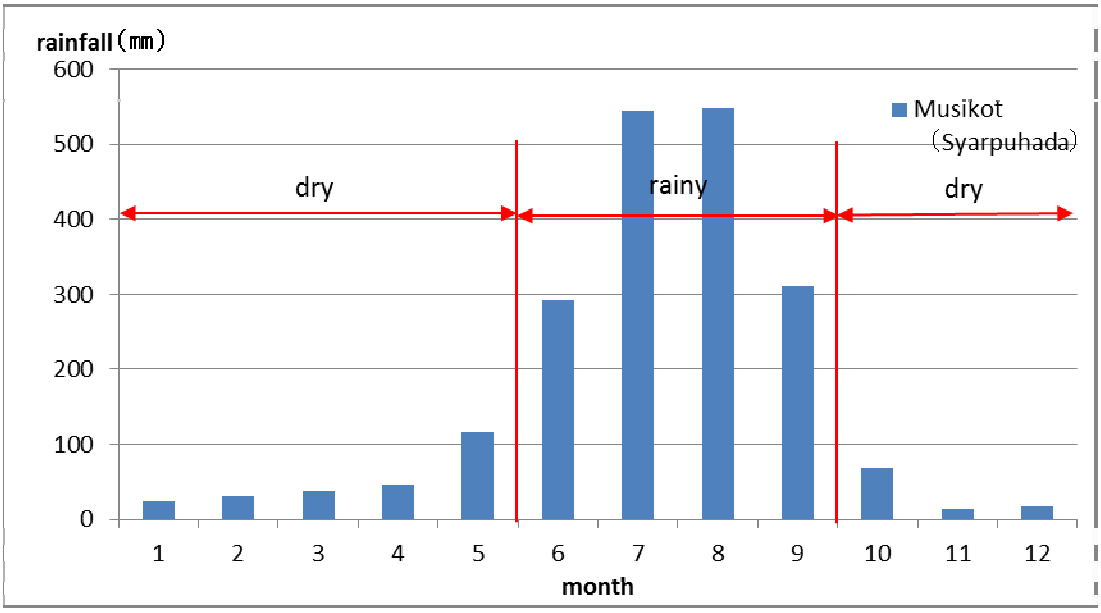


Figure 2.10 Monthly average rainfall at Musikot(Syarpudaha)

Table 2.10 List of rainfall data at Musikot(Syarpudaha)

year	annual rainfall (mm/y)	season(mm)		Large rainfall 1st-5th(mm/day)					monthly rainfall (mm/m)												missing(day)		
		rainy	dry	1	2	3	4	5	1	2	3	4	5	6	7	8	9	10	11	12	rainy	dry	year missing
1973	1,260	1,176	180	128.4	65.6	56.0	48.0	40.0	0	0	0	0	0	0	0	560	617	84	0	0	61	0	61
1974	1,339	1,205	170	52.0	42.8	41.2	40.8	40.2	28	15	0	7	45	116	512	341	236	25	0	14	0	1	1
1975	1,899	1,687	319	45.6	42.0	42.0	41.4	41.0	51	16	31	1	32	367	504	499	317	82	0	0	6	6	12
1976	1,668	1,426	187	54.0	50.2	47.0	46.0	42.8	11	24	0	42	159	225	447	501	253	5	0	0	1	9	10
1977	1,332	1,077	408	40.0	39.0	38.0	33.0	30.0	18	0	0	26	138	157	372	357	191	51	0	22	7	10	17
1978	1,489	1,154	171	120.0	58.0	56.0	42.0	42.0	6	55	54	98	123	558	344	252	0	0	0	0	8	33	41
1979	1,575	1,271	331	178.8	73.4	65.4	57.8	57.0	15	20	0	43	93	247	358	555	111	63	28	43	4	0	4
1980	2,538	2,280	357	138.4	106.5	98.0	80.6	80.4	7	30	50	0	111	458	938	531	353	60	0	1	0	3	3
1981	1,760	1,398	385	52.0	50.5	50.5	50.5	50.5	17	3	68	36	171	119	613	418	248	7	49	11	11	0	11
1982	1,787	1,388	353	78.4	70.5	59.0	56.0	56.0	37	37	113	25	110	266	234	690	198	12	55	13	0	0	0
1983	2,297	1,799	388	118.7	82.7	69.0	65.3	61.5	43	0	17	71	144	43	624	656	475	189	0	34	0	0	0
1984	2,270	2,078	221	108.0	95.3	94.4	85.4	83.0	43	5	4	33	81	447	750	581	299	8	3	17	0	28	28
1985	2,948	2,464	542	122.0	107.0	98.0	97.0	95.8	34	0	5	28	126	210	716	642	896	229	0	62	0	0	0
1986	2,426	2,008	500	120.0	91.0	72.0	71.5	64.0	0	24	11	109	107	339	801	619	249	70	3	94	2	0	2
1987	1,989	1,590	321	96.0	80.0	64.2	58.0	57.0	7	46	38	72	172	207	504	604	275	49	0	17	1	0	1
1988	2,060	1,743	153	212.6	95.0	84.0	83.2	72.0	7	19	60	41	129	368	1,133	242	0	26	0	36	29	1	30
1989	1,373	1,139	487	94.0	68.7	54.0	43.0	42.5	0	7	10	28	47	0	200	728	211	124	17	2	29	0	29
1990	2,465	2,049	289	88.3	84.0	61.3	59.2	50.2	0	100	95	22	128	269	755	622	402	58	0	15	0	0	0
1991	1,889	1,644	175	92.8	75.2	65.2	60.0	52.5	38	26	34	49	70	292	438	602	312	0	6	23	0	0	0
1992	2,001	1,790	419	96.5	95.7	63.6	57.0	56.0	35	28	0	19	63	183	475	690	443	48	7	10	0	0	0
1993	1,689	1,335	225	141.0	68.5	55.5	48.0	41.5	39	16	92	127	80	323	347	460	206	0	0	0	0	0	0
1994	2,042	1,816	237	170.0	93.7	75.0	70.6	69.6	36	46	0	32	110	330	576	515	394	0	2	0	0	0	0
1995	2,356	2,038	261	129.4	114.0	100.2	82.8	74.2	28	50	53	22	83	646	335	819	238	0	75	8	3	0	3
1996	2,188	1,858	455	119.2	91.2	81.4	77.0	72.3	47	84	18	28	2	454	458	619	327	152	0	0	0	0	0
1997	2,471	1,977	493	142.5	73.8	73.5	72.5	63.2	32	8	14	135	114	378	700	583	317	66	26	99	0	0	0
1998	2,356	1,916	514	95.2	92.0	88.2	76.0	68.0	1	25	110	93	73	391	516	616	393	87	51	0	0	0	0
1999	2,746	2,249	638	103.6	83.5	80.7	77.4	63.6	17	1	110	13	236	328	808	639	473	117	0	4	0	0	0
2000	2,843	2,319	314	129.2	81.5	75.8	68.4	66.2	32	55	33	171	225	600	551	730	438	4	4	0	0	0	0
2001	2,373	2,018	493	84.0	75.4	71.4	69.2	60.2	7	30	15	65	190	535	618	622	243	48	0	1	0	0	0
2002	2,236	1,710	294	113.0	72.2	69.7	62.2	60.0	81	76	15	46	228	245	470	703	292	56	5	21	0	0	0
2003	1,747	1,497	431	97.5	77.5	77.2	61.7	57.2	0	94	70	11	37	367	662	0	468	16	11	10	0	0	0
2004	2,305	1,705	393	95.8	77.5	72.0	69.0	66.9	26	6	0	59	303	117	720	685	183	177	3	26	0	0	0
2005	2,256	1,967	369	92.2	83.5	81.5	69.5	69.5	69	42	58	5	14	205	819	690	254	102	0	0	0	0	0
2006	1,495	1,104	545	96.2	77.6	52.2	52.2	41.0	0	24	65	62	116	77	536	484	7	48	39	37	0	0	0
2007	1,946	1,501	387	70.0	60.3	60.0	51.2	49.0	22	96	122	26	157	250	469	467	315	16	0	7	0	0	0
2008	2,389	1,962	132	67.0	66.2	64.5	60.6	60.0	39	23	5	60	237	535	579	496	352	0	63	0	0	0	0
2009	2,030	1,391	571	70.0	62.0	57.0	57.0	57.0	0	22	19	0	29	134	272	473	513	480	91	0	0	0	0
Maximum	2,948	2,464	638	212.6	114.0	100.2	97.0	95.8	81	100	122	171	303	646	1,133	819	896	480	91	99	–	–	–
average	2,050	1,695	354	104.1	76.3	68.0	62.2	58.2	23	31	37	46	116	291	545	548	311	69	14	17	–	–	–

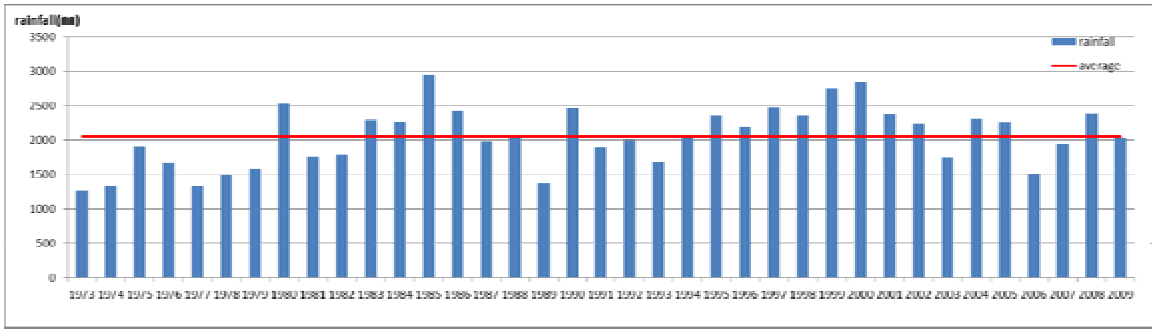


Figure 2.11 Annual rainfall at Musikot (Syarpudaha)

2.4. Probable Rainfall Analysis

Probable daily rainfall at each site was analyzed by using the maximum daily rainfall taken from rainfall records. The methods of statistical analysis applied were: (1) Gumbel Distribution, (2) Generalized Extreme Value Distribution (GEV), and (3) SQRT-Exponential Type Maximum Distribution which are based on Extremal Theory.

The extremal distribution based on Extremal Theory shall be guided by theoretical maximum or minimum value of sample taken from the population distribution pattern of arbitrary distribution form. Distributions other than extremal distribution have been used empirically to comply with hydrological data, such as distributions from the application of basin problems expected in Nepal. Therefore, the three extremal distributions based on Extremal Theory were selected.

The smallest method of evaluation index SLSC was selected as the best fit method.

$$SLSC = \frac{\sqrt{\xi^2}}{|S_{0.99} - S_{0.01}|} \quad \text{(Standard Least-Squares Criterion Formula)}$$

$$\xi^2 = \frac{1}{N}\sum_{i=1}^{N}(S_i - r_i)^2$$

where, SLSC : Standard Least-Squares Criterion Formula

$S_{0.99}$,$S_{0.01}$:Normal variate of probability distribution when non-excess probability is set to 0.99 and 0.01

Si :Normal variate which changed order-statistics data by the presumed population parameter

ri :Normal variate which changed theoretical probability hydrological value corresponding to a plotting position by the presumed population parameter

N : Number of samples

(1) Probable Daily Rainfall

Probable daily rainfall analysis was carried out and the result is shown in Table 2.12. The selected method for evaluation index SLSC is GEV for Bajhang site, Gumbel for Bajura site, and Gumbel for Syarpudaha site. The 50-year probable daily rainfall was 111 mm/day at Bajhang site, 163 mm/day at Bajura site, and 204 mm/day at Syarpudaha site. It was assumed that the difference in probable daily rainfall is due to the difference of elevation. It was judged that the probable daily rainfall of 204 mm/day at Syarpudaha site was suitable for all three sites, because the basin elevation of the three sites are more than 2,000 m and the Syarpudaha Rainfall Station is the closest in terms of elevation to the basin elevation of all sites.

Table 2.11 Elevation of Rainfall Station

NO	name	elevation (m)
202	Chainpur (Bajhang)	1,304
204	Bajura (Bajura)	1,400
514	Musikot (Syarpudaha)	2,100

Table 2.12 Result of Statistical Analysis

Return Period (Year)	Probable Daily Rainfall (mm/day)		
	Chainpur (Bajhang)	Bajura (Bajura)	Musikot (Syarpudaha)
	Gev	Gumbel	Gumbel
1.1	52.8	63.2	60.6
2	76.8	89.0	97.8
3	84.6	100.1	113.9
5	91.9	112.5	131.7
10	99.4	128.0	154.2
20	105.1	143.0	175.8
30	107.9	151.6	188.2
50	110.9	162.3	203.7
80	113.3	172.1	217.9
100	114.3	176.8	224.6
150	115.9	185.2	236.8
200	117.0	191.2	245.4
400	119.1	205.6	266.2

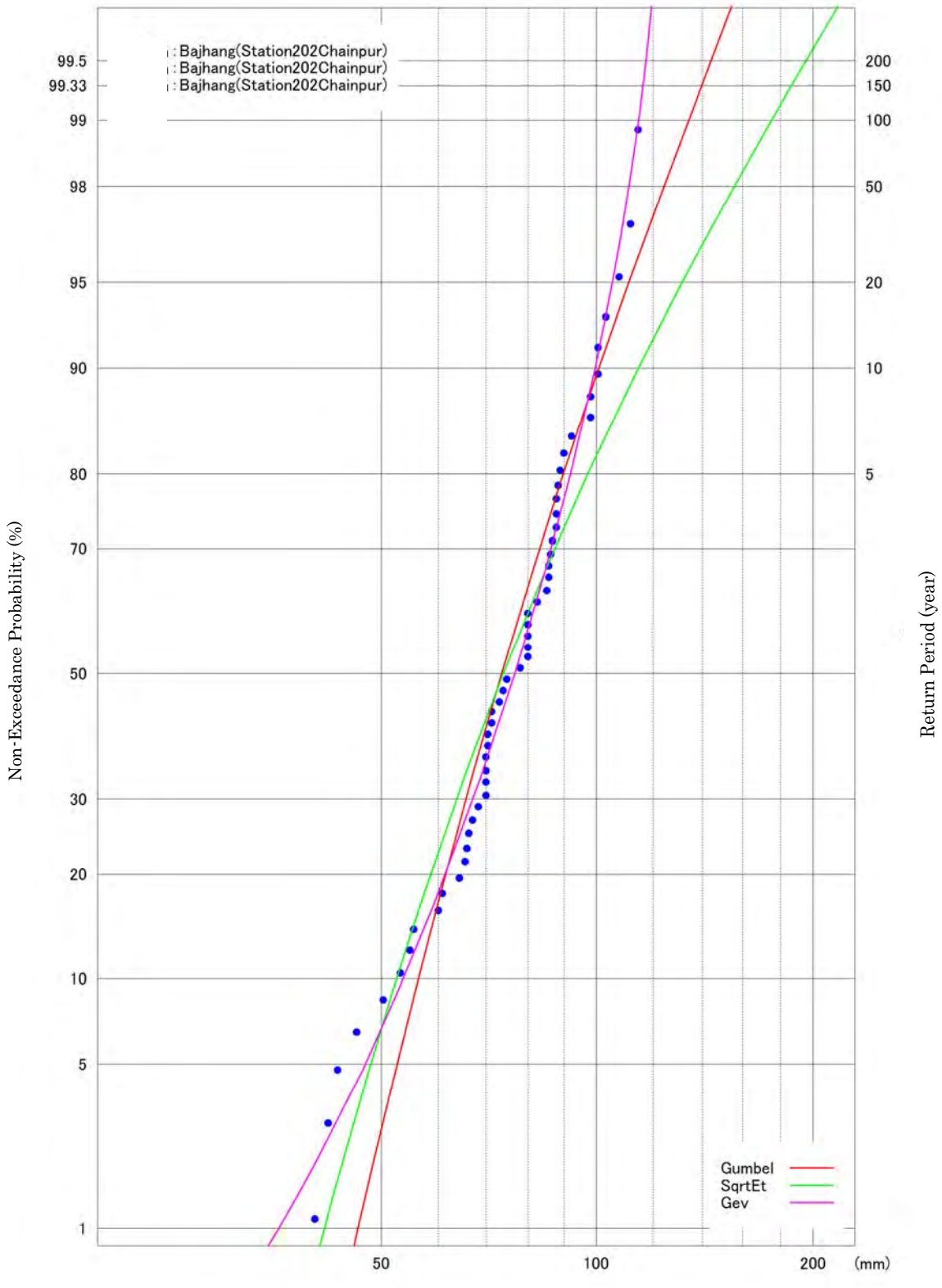


Figure 2.12 Frequency Curve of Annual Maximum Daily Rainfall

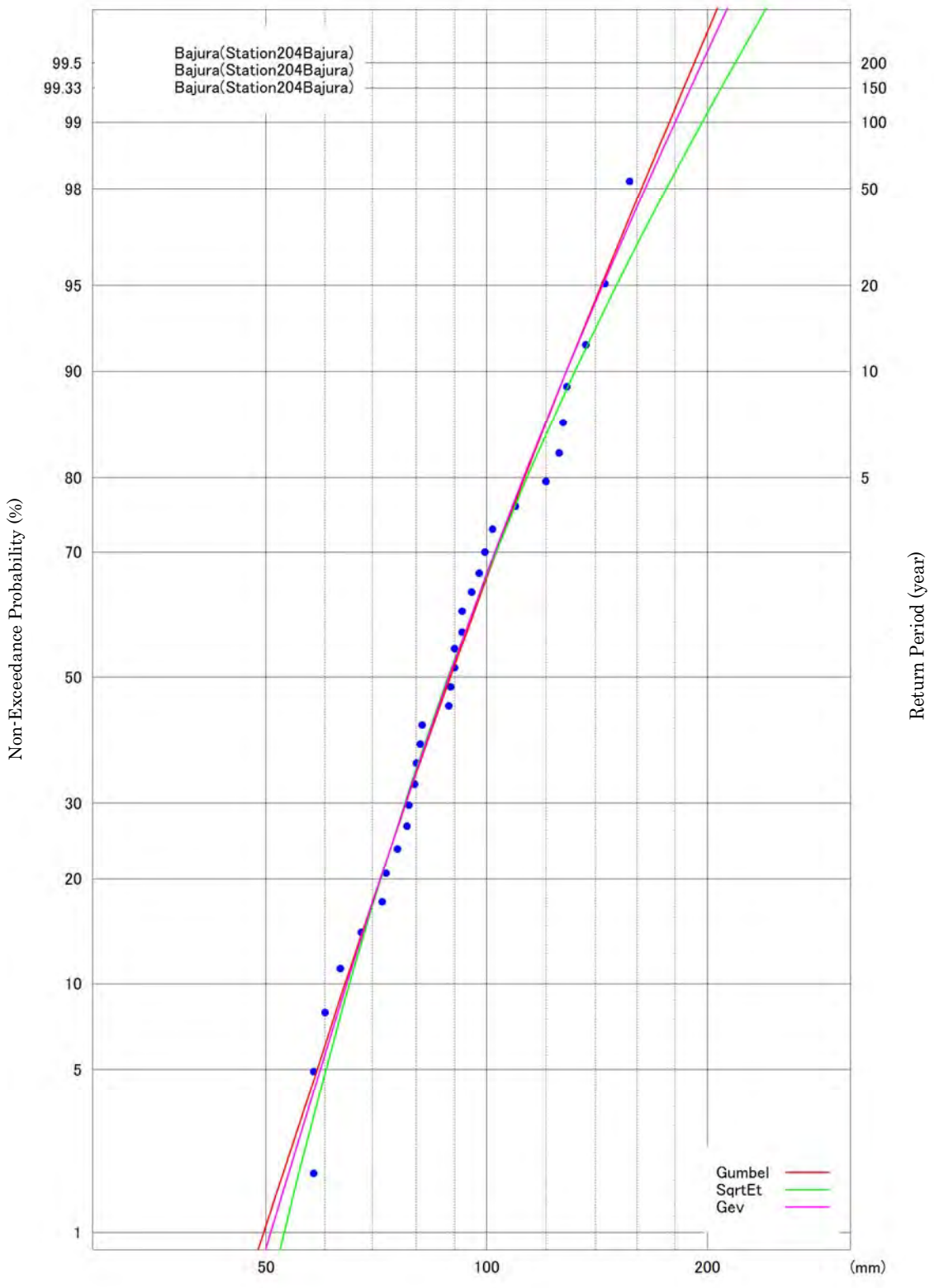


Figure 2.13 Frequency Curve of Annual Maximum Daily Rainfall

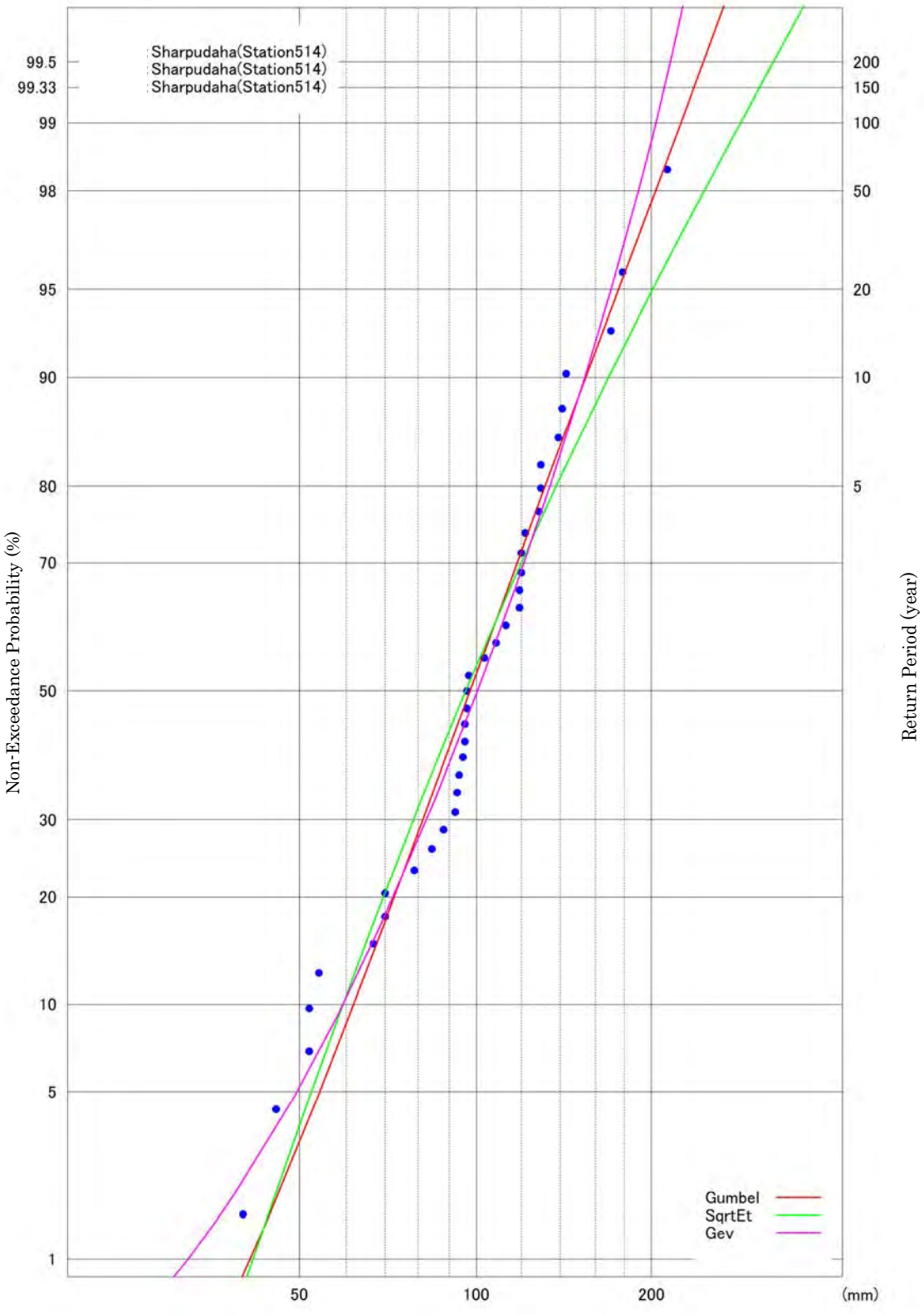


Figure 2.14 Frequency Curve of Annual Maximum Daily Rainfall

Table 2.13 Result of Statistical Analysis at Chainpur（Bajhang）

Name of River System	Bajhang(Station202Chainpur)
Name river	Bajhang(Station202Chainpur)
Name Spot	Bajhang(Station202Chainpur)
number of data	54
α	0.4
Bootstrap number of the samples	2000
LN4PM of upper limit Value g	-9999
LN4PM of lower limit Value b	0
K(Every year) = (Xp - X)/S	1.78
K(Non-every year) = (Xp - X)/S	1.78

	Gumbel	SqrtEt	Gev
X-COR(99%)	0.968	0.944	0.994
P-COR(99%)	0.987	0.981	0.995
SLSC(99%)	0.05	0.078	0.023
Logarithm likelihood	-236.2	-237.2	-230.2
pAIC	476.5	478.3	466.3
X-COR(50%)	0.983	0.975	0.986
P-COR(50%)	0.986	0.98	0.983
SLSC(50%)	0.081	0.152	0.041

probable rainfall	return period	Gumbel	SqrtEt	Gev
	1.1	55.8	51.9	52.8
	2	73.6	74.0	76.8
	3	81.3	84.6	84.6
	5	89.8	97.2	91.9
	10	100.5	114.1	99.4
	20	110.8	131.5	105.1
	30	116.8	142.0	107.9
	50	124.2	155.7	110.9
	80	131.0	168.7	113.3
	100	134.2	175.0	114.3
	150	140.0	186.8	115.9
	200	144.1	195.4	117.0
	400	154.1	216.7	119.1

Table 2.14 Result of Statistical Analysis at Bajura（Bajura）

Name of River System	32Bajura(Station204Bajura)
Name river	32Bajura(Station204Bajura)
Name Spot	32Bajura(Station204Bajura)
number of data	32
α	0.4
Bootstrap number of the samples	32
LN4PM of upper limit Value g	-9999
LN4PM of lower limit Value b	0
K(Every year) = (Xp - X)/S	2.1
K(Non-every year) = (Xp - X)/S	2.1

	Gumbel	SqrtEt	Gev
X-COR(99%)	0.99	0.985	0.989
P-COR(99%)	0.994	0.995	0.994
SLSC(99%)	0.028	0.032	0.029
Logarithm likelihood	-146.3	-146.3	-146.2
pAIC	296.6	296.5	298.5
X-COR(50%)	0.975	0.966	0.972
P-COR(50%)	0.982	0.983	0.982
SLSC(50%)	0.053	0.059	0.053

probable rainfall	return period	Gumbel	SqrtEt	Gev
	1.1	63.2	64.2	63.6
	2	89.0	88.3	88.6
	3	100.1	99.8	99.6
	5	112.5	113.3	112.1
	10	128.0	131.4	128.0
	20	143.0	149.9	143.6
	30	151.6	161.0	152.7
	50	162.3	175.5	164.2
	80	172.1	189.3	174.9
	100	176.8	195.9	180.0
	150	185.2	208.3	189.3
	200	191.2	217.3	195.9
	400	205.6	239.7	212.2

Table 2.15　Result of Statistical Analysis at Musikot（Syarpudaha）

Name of River System	Sharpudaha(Station514)
Name river	Sharpudaha(Station514)
Name Spot	Sharpudaha(Station514)
number of data	37
α	0.4
Bootstrap number of the	2000
LN4PM of upper limit Val	−9999
LN4PM of lower limit Val	0
K(Every year)　= (Xp −	2.09
K(Non−every year) = (Xp	2.09

	Gumbel	SqrtEt	Gev
X−COR(99%)	0.988	0.977	0.988
P−COR(99%)	0.987	0.979	0.991
SLSC(99%)	0.031	0.05	0.038
Logarithm likelihood	−185.4	−186.7	−184.9
pAIC	374.8	377.5	375.7
X−COR(50%)	0.986	0.988	0.978
P−COR(50%)	0.978	0.976	0.981
SLSC(50%)	0.038	0.083	0.071

probable rainfall	return period	Gumbel	SqrtEt	Gev
	1.1	60.6	58.2	57.8
	2	97.8	96.1	100.7
	3	113.9	114.9	117.2
	5	131.7	137.6	134.2
	10	154.2	168.7	153.7
	20	175.8	201.2	170.7
	30	188.2	221.0	179.7
	50	203.7	247.0	190.3
	80	217.9	271.9	199.5
	100	224.6	284.1	203.6
	150	236.8	306.9	210.7
	200	245.4	323.5	215.6
	400	266.2	365.1	226.5

3. Runoff Analysis

The basin characteristics of each site are discussed in this chapter, and the design flood was calculated by using runoff model.

3.1. Runoff Model

(1) Method of Runoff Analysis

The peak runoff at each site was estimated by applying the Rational Formula, which is one of the most common methods in estimating the runoff discharge. The formula is described as follows:

$$Q_p = \frac{1}{3.6} f \cdot R_t \cdot A \qquad \text{(Rational Formula)}$$

where, Q_p : Peak runoff discharge (m^3/s)
f : Runoff coefficient (see Table 3.4 below for details)
R_t : Average rainfall intensity (mm/hr)
A : Catchment area (km^2)

(2) Basin characteristics

The basin dimension of each site was measured by using the topographic map 1:50,000 as shown in the following table.

Table3.1 Basin Dimension（BAJHANG）

Descriptions		Unit	Remarks
Catchment Area=	104.020	㎢	River Reach section
Length of river reach=	18,992	m	
Difference in elevation=	2,182	m	
Slope of river=	0.115	1/8.70	
Length of inflow basin channel=	1,637	m	Inflow Channel section
Difference in elevation=	810	m	
Slope of inflow basin channel=	0.495	1/2.02	
Catchment Area of inflow basin=	0.934	㎢	

Table 3.2　Basin Dimension（BAJURA）

Descriptions		Unit	Remarks
Catchment Area=	27.270	㎢	River Reach section
Length of river reach=	10,032	m	
Difference in elevation=	1,464	m	
Slope of river=	0.146	1/6.85	
Length of inflow basin channel=	1,735	m	Inflow Channel section
Difference in elevation=	920	m	
Slope of inflow basin channel=	0.530	1/1.89	
Catchment Area of inflow basin=	0.575	㎢	

Table 3.3　Basin Dimension（SYARPUDAHA）

Descriptions		Unit	Remarks
Catchment Area=	40.776	㎢	River Reach section
Length of river reach=	11,046	m	
Difference in elevation=	1,788	m	
Slope of river=	0.162	1/6.18	
Length of inflow basin channel=	1,322	m	Inflow Channel section
Difference in elevation=	660	m	
Slope of inflow basin channel=	0.499	1/2.00	
Catchment Area of inflow basin=	0.492	㎢	

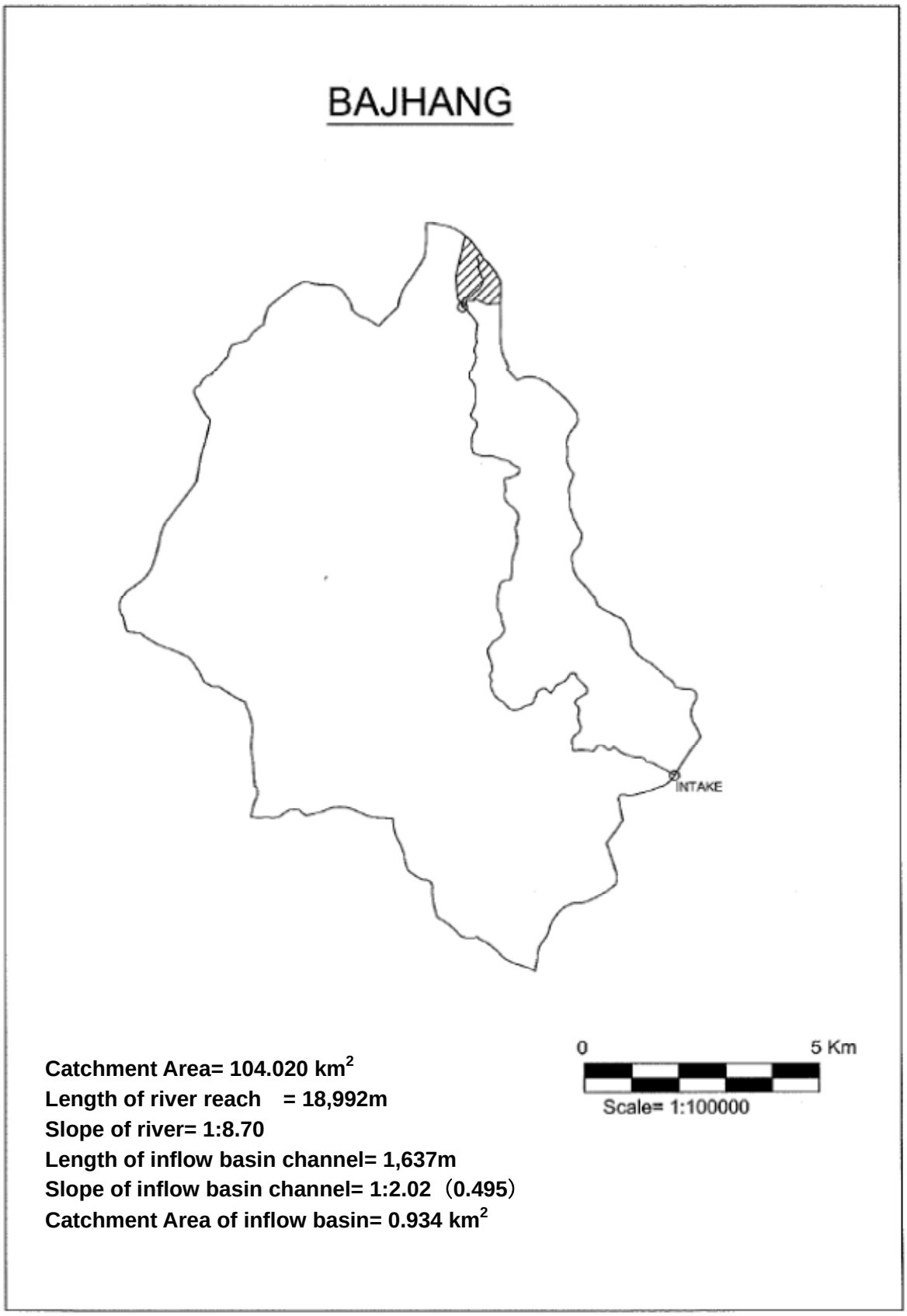


Figure 3.1 Basin Dimension at BAJHANG

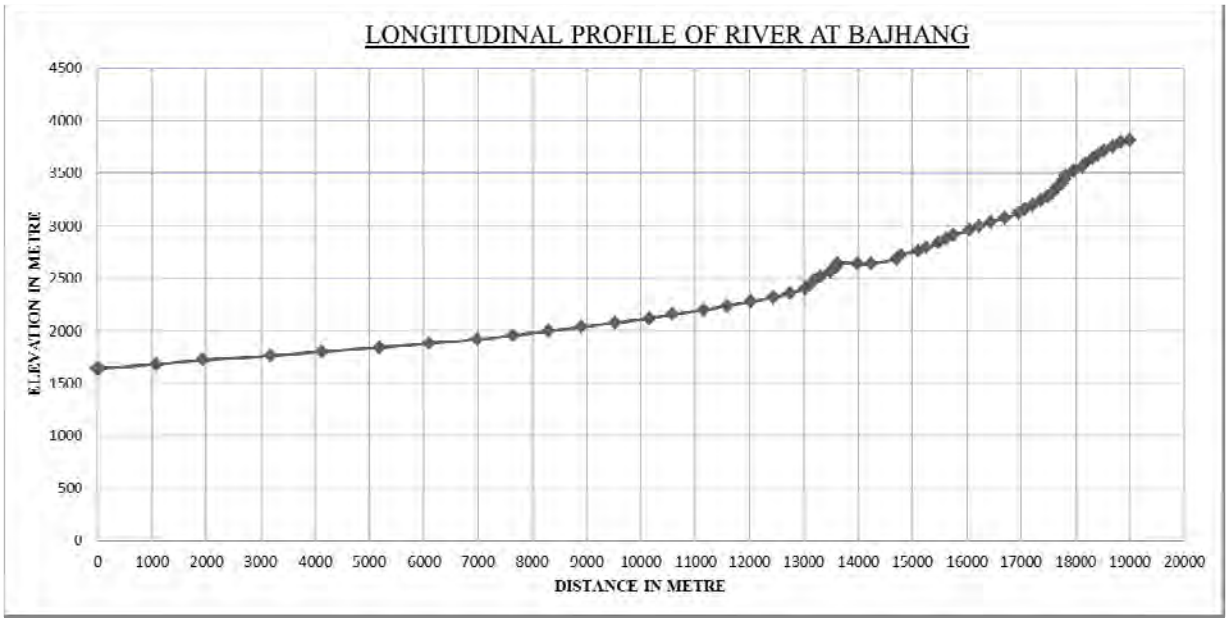


Figure 3.2 River Profile (BAJHANG)

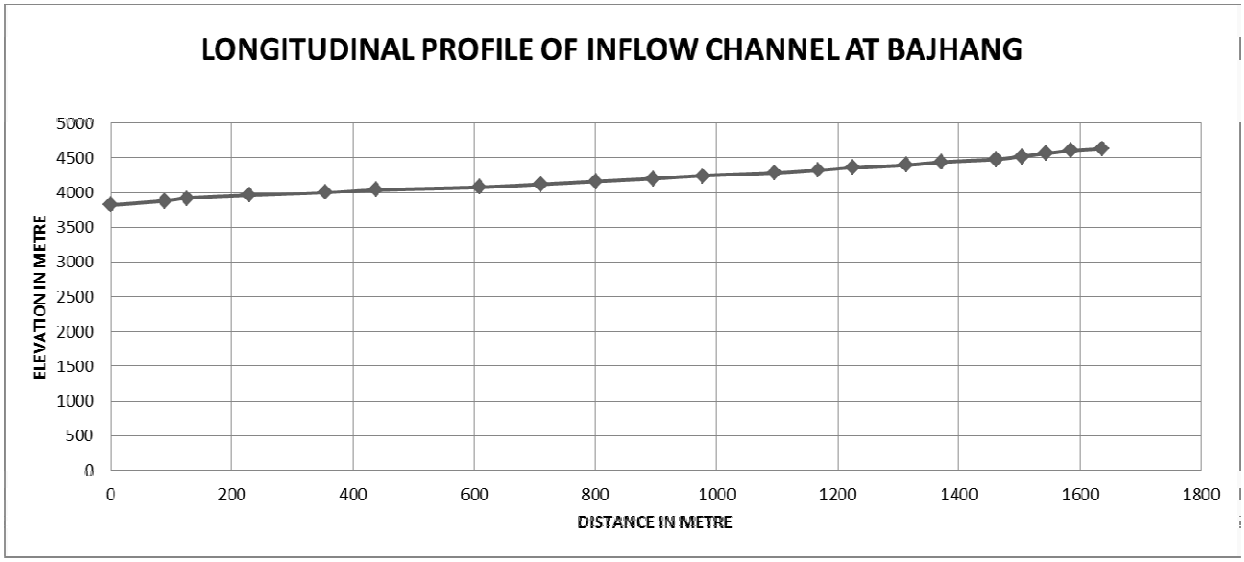


Figure 3.3 River Profile (BAJHANG)

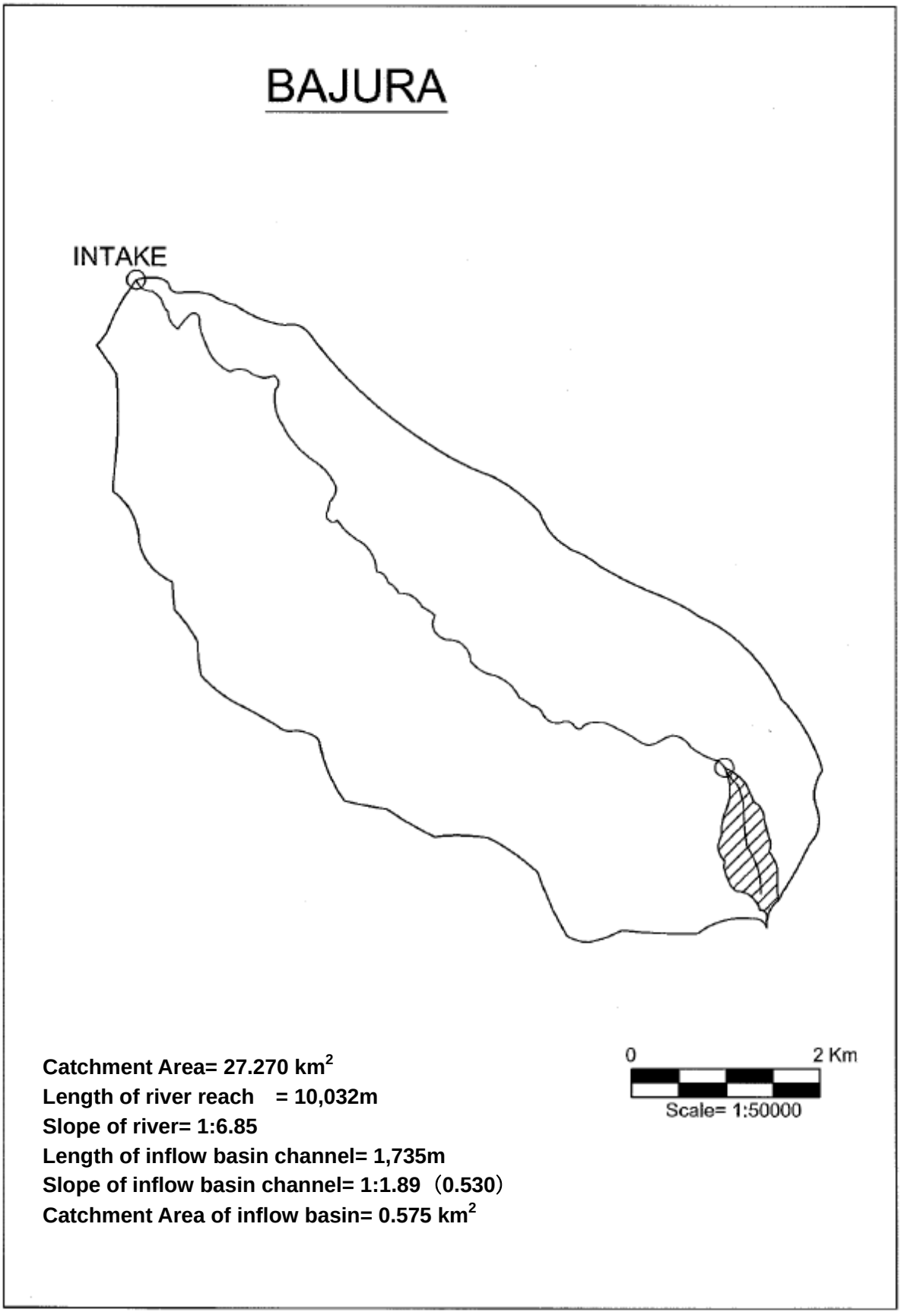


Figure 3.4 Basin Dimension at BAJURA

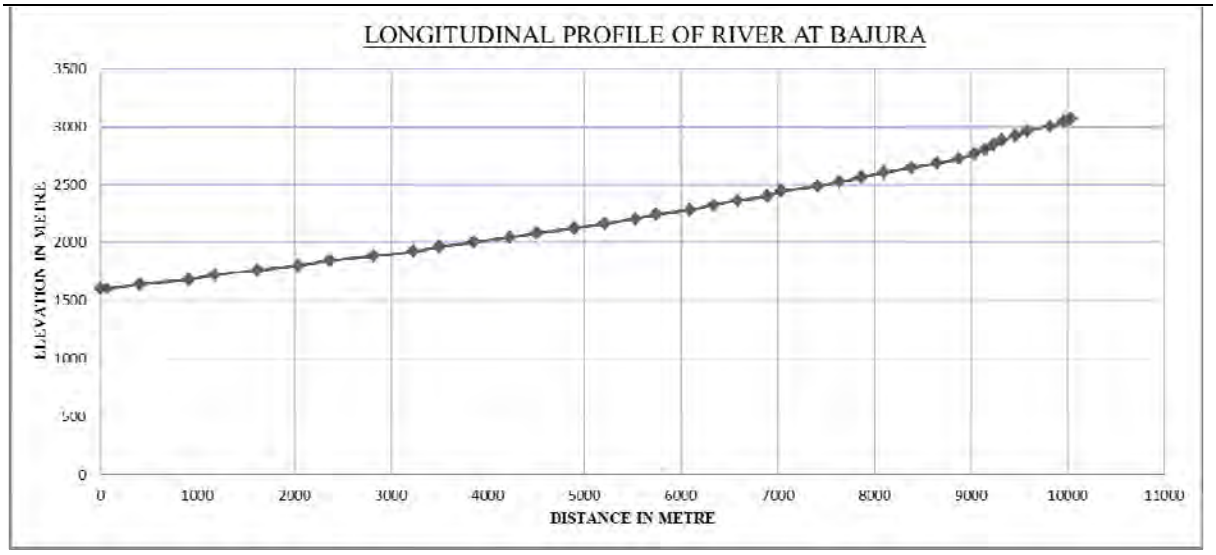


Figure 3.5 River Profile (BAJURA)

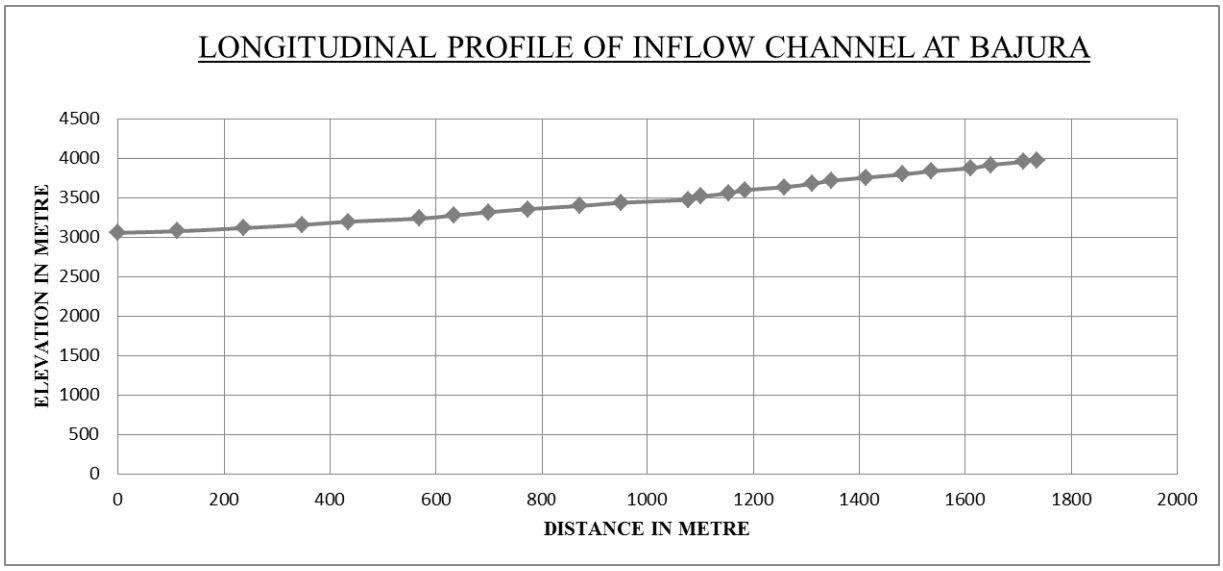
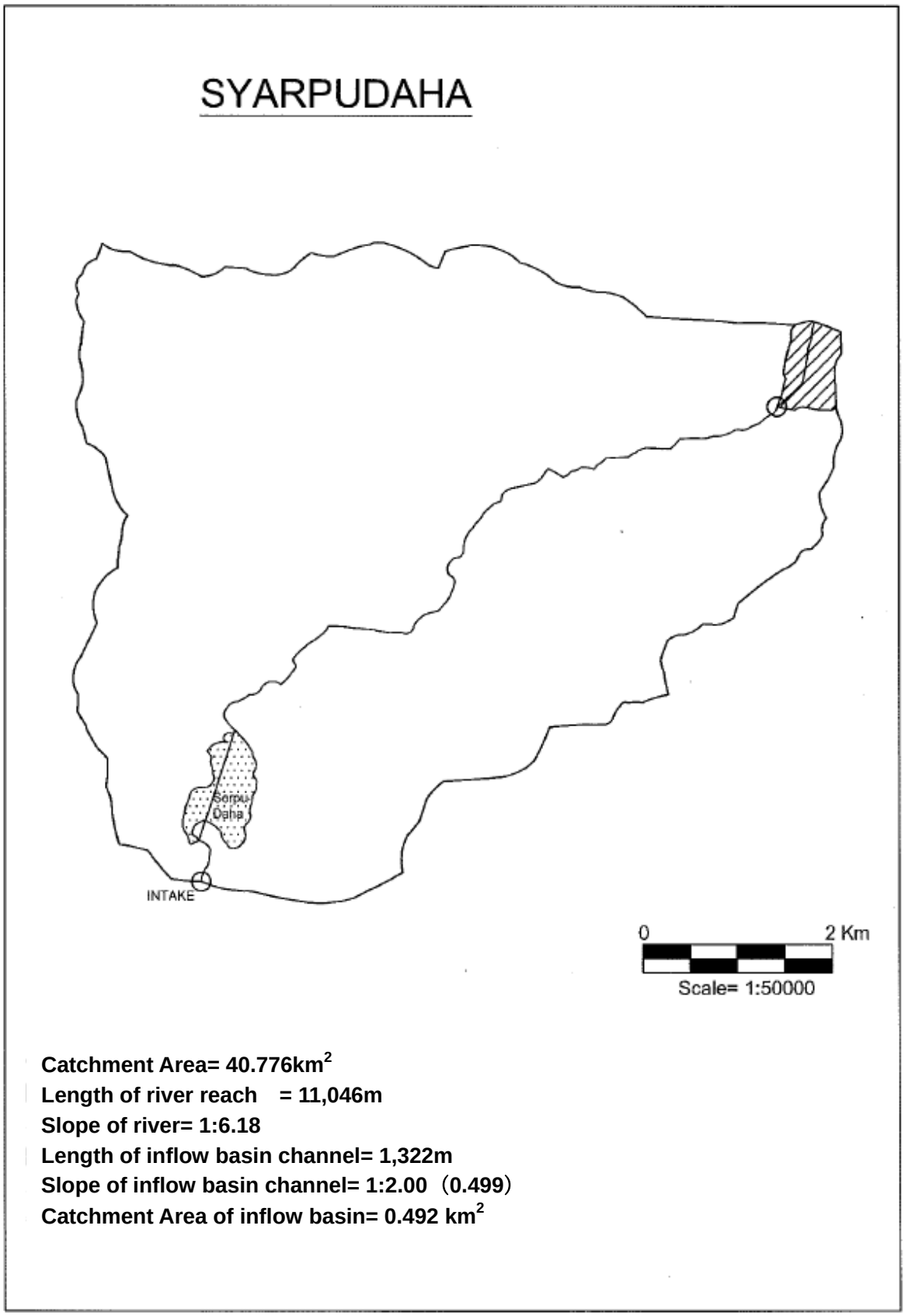


Figure 3.6 River Profile (BAJURA)



Catchment Area= 40.776km^2
Length of river reach = 11,046m
Slope of river= 1:6.18
Length of inflow basin channel= 1,322m
Slope of inflow basin channel= 1:2.00（0.499）
Catchment Area of inflow basin= 0.492 km^2

Figure 3.7 Basin Dimension at SYARPUDAHA

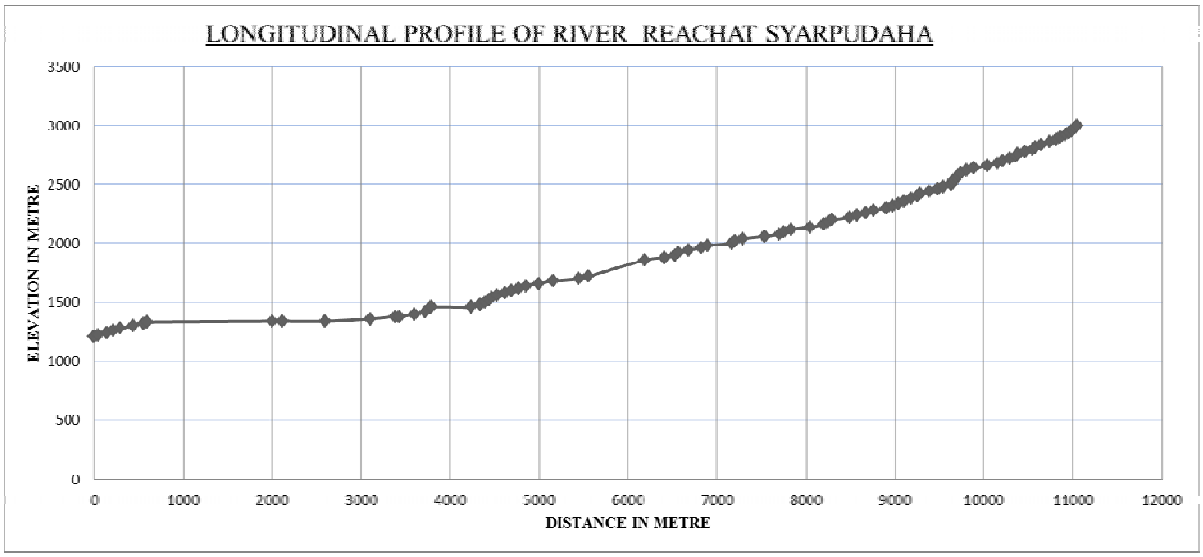


Figure 3.8 River Profile (SYARPUDAHA)

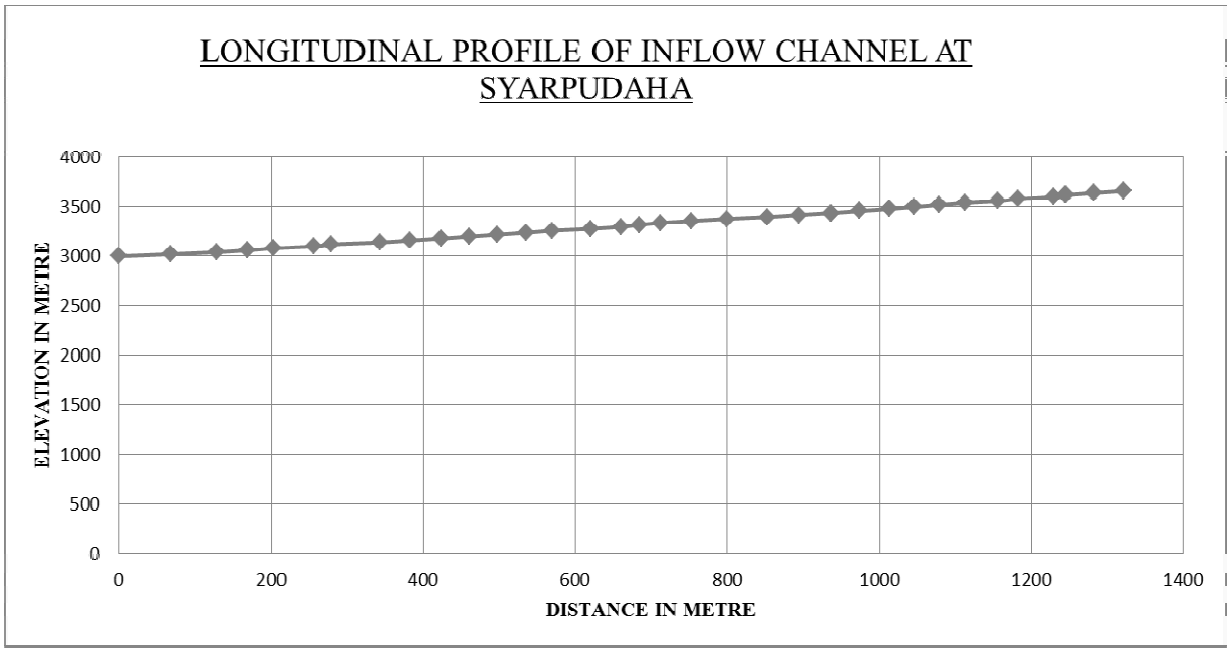


Figure 3.9 River Profile (SYARPUDAHA)

(3) Runoff Coefficient

The runoff coefficient of 0.8 was used in accordance with the relationship between the land use and runoff coefficient as shown in the Table below since almost the whole basin area is mountainous. The runoff coefficient, suitable for lesser Himalayan zone project sites, was determined based on the appropriateness of applying existing metrics standards that are difficult to determine. Also no rainfall and flow data were observed in the basin of the project area for validation. Therefore, the uncertainty as to the applicability of the runoff coefficient was assumed. Even if the runoff coefficient is 0.8, the design discharge rate of 10% or more would be thoroughly evaluated. Therefore, to ensure the safety of intake weir structures when the water peak flow exceeds the planning peak flow, the width of overflow dike adjacent to intake weir was set large for curbing the rising river water level in the submitted structural designs to account for these uncertainties.

Table3.4 Runoff Coefficient for Each Land-use Condition

Land-use Condition	Runoff Coefficient
Steep mountainous area	0.75 - 0.90
Tertiary mountainous area	0.70 - 0.80
Undulating land and forest	0.50 - 0.75
Flat cultivated land	0.45 - 0.60
Irrigated paddy field	0.70 - 0.80
River in highland	0.75 - 0.85
Small river in plain	0.45 - 0.75
Large river mostly plain	0.50 - 0.75

Source: Technical Criteria for River Works in Japan

(4) Flood Concentration Time

The flood concentration time was calculated as the total of inflow time to the river upstream end and flow time from river upstream end to downstream end.

1) Inflow Time of Top Basin Area

The typical formulas for calculating inflow time are Kerby Formula and Kraven Formula. The Kerby Formula is used in a large number of erosion control projects in the mountainous areas. On the other hand, the Kraven formula is used two methods, the one is square root method and the another one is choice fixed inflow time depending on inflow status as following.

Sewerage Area : 30 minutes

Steep Sloping Land: 20 minutes (Applied for all project sites)

The inflow times of all project sites are applied 20 minutes as steep sloping land, because the inflow areas of all project sites are less than 2km2 and the average slope of basin are very steep more than 1/2.

2) River Flow Time

The applicable calculation methods for river flow time to the project sites are Kraven and Rziha. The coverage of the two methods is as follows:

- Kraven Formula : Average river slope I ≦1/20,
- Rziha Formula : Average river slope I > 1/20.

The Rziha Formula was applied for all project sites, because the average river slope of all project sites are more than 1/10. The result of river flow time was shown below.

(a) Rziha formula

$$T = \frac{l}{W}$$

$$W = 20\left(\frac{h}{I}\right)^{0.6}$$

where,

T : Total concentration time (s)
h : Elevation difference from top of river to downstream point (m)
I : Horizontal distance from top of river to downstream point (m)
W : Flood Concentration Time (m/s)

【River Flow Time (Rziha formula)】

Site	River length (m)	(1) Toe of Upstream (El.m)	(2) Toe of Downstream (El.m)	(1) – (2) (m)	Slope (1 / I)	Flood Velocity (m/s)	River Flow Time (min)
BAJHANG	18,992	3,820	1,638	2,182	8.7	5.5	58.0
BAJURA	10,032	3,060	1,596	1,464	6.9	6.3	26.5
SYARPUDAHA	11,046	3,000	1,212	1,788	6.2	6.7	27.5

3) Concentration Time

The total concentration times of inflow time and river flow time are calculated 78.0min at Bajhang site, 46.5min at Bajura site and 47.5min at Syarpudaha site as shown in table 3.5.

The uncertainty as to the applicability of the concentration time to the project rivers was assumed. Therefore, to ensure the safety of intake weir structures when the water peak flow exceeds the planning peak flow, the width of overflow dike adjacent to intake weir was set large for curbing the rising river water level in the submitted structural designs to account for these uncertainties.

Table 3.5 Result of Concentration Time

S.N	Inflow time T1 (min)	River flow time T2 (min)	Total concentration time TC (min)
BAJHANG	20.0	58.0	78.0
BAJURA	20.0	26.5	46.5
SYARPUDAHA	20.0	27.5	47.5

(5) Rainfall Intensity

Rainfall intensity was estimated from the daily rainfall by using the common method of Mononobe and Itou A Formula. The formulas of both methods are shown below. The number of uncertainly parameter are compared, Mononobe Formula has one uncertainly parameter as exponent for T member and Itou A Formula has three parameter as each denominator, numerator and exponent for T member. Therefore, the Mononobe Formula which has less uncertainly parameter was applied for all project sites. The rainfall intensity by Mononobe Formula was calculated to be 59.4 mm/hr at Bjhang, 83.9 mm/hr at Bajura, and 82.7 mm/hr at Syarpudaha as shown in Table 3.6.

$$R_T = \frac{R_{24}}{24}\left(\frac{24}{T}\right)^{\frac{2}{3}} \qquad \text{(Mononobe Formula)}$$

where, R_t : Average rainfall intensity (mm/hr)
R_{24} : Daily rainfall (mm/day)
T : Total concentration time (hr)

$$R_T = \frac{347.1}{T^{1.35}+1{,}502} * R_{24} \qquad \text{(Itou A Formula)}$$

where, R_t : Average rainfall intensity (mm/hr)
R_{24} : Daily rainfall (mm/day)
T : Total concentration time (min)

Table 3.6 Rainfall Intensity

	Concentration Time (min)	Daily Rainfall (mm/day)	Average Rainfall Intensity (mm/hr)	
			(1)	(2)
Bajhang	78.0	204	59.4	38.1
Bajura	46.5	204	83.9	42.2
Syarpudaha	47.5	204	82.7	42.1

(1) Mononobe Formula
(2) Itou A Formula

(6) Mixed Sediment Ratio in Flow

The ratio of mixed sediment in flow was applied 10% refer to Manual for River Works in Japan (Contents 6.6.2).

3.2. Design Flood

(1) Plan Scale

The project target rivers had not been included in the river development plan, and the plan scale has not been set. The plan scale needs to be set in terms of power generation structures. The useful life of power generation structures is generally about 50 years. The plan scale for this project structure was set 50 years from the probable flood expected to occur once during 50 years of useful life.

Plan Scale: 50 years (at Bajhang, Bajura, Syarpudaha Site)

(2) Calculated Design Flood

The design floods were calculated by using Rational Formula as shown in Table 3.7. The value of calculated design floods were rounded up to the nearest tens. The values of the design flood are 1,520 m^3/s at Bajhang, 560 m^3/s at Bajura, and 830 m^3/s at Syarpudaha.

Table 3.7 Calculated Result of Design Flood

S.N	Calculation of T			Calculation of Rt		Catchment Area in km^2 (A)	Runoff Coefficent (f)	Peak runoff discharge in m^3/s (Qp)	water-sediment complex(10%) Peak runoff discharge in m^3/s (Qp)	round value water-sediment complex(10%) Peak runoff discharge in m^3/s (Qp)	Remarks
	Basin Inflow (min)	River Flow (min)	Total concentration time (min)	Daily rainfall in mm/day (R24)	rainfall intensity in mm/hr (RT)						
Bajhang	20	58.0	78.0	204.0	59.4	104.020	0.80	1373.1	1510.4	1520	Bajhang
Bajura	20	26.5	46.5	204.0	83.9	27.270	0.80	508.4	559.3	560	Bajura
Syarpudaha	20	27.5	47.5	204.0	82.7	40.776	0.80	749.4	824.3	830	Syarpudaha

3.3. Design Flood for River Diversion Construction

The flood occurrence probability of one or two times a year was supplied for the design flood of river diversion construction in accordance with the manual for multipurpose dams in Japan. The probability of two times a year was supplied as design flood for river diversion construction. The time period for statistics analysis was set as through a whole year include wet and dry season, because the construction work of river diversion was assumed to be implemented in dry and wet season.

(1) Probability Daily Rainfall for River Diversion Construction

The probability daily rainfall of one to three times a year was calculated as shown in Table 3.8. The daily rainfall that occurred two times a year was 51.1 mm/day at Musikot (Syarpudaha). This value was rounded up to 52 mm/day and was used as design floods of all sites, because the other sites' average basin elevations are more than El. 2,000m and it is judged as validity.

Table 3.8 Result of Statistical Analysis

Return Period	Probable Daily Rainfall (mm/day)		
	Chainpur (Bajhang)	Bajura (Bajura)	Musikot (Syarpudaha)
1/year	52.8	63.2	60.6
2/year	43.7	46.7	51.1
3/year	41.2	40.9	46.9

Table 3.9 Selected Method of Statistical Analysis

Evaluation standard	Return Period	Chainpur (Bajhang)	Bajura (Bajura)	Musikot (Syarpudaha)
SLSC of Minimum	1/year	GEV	Gumbel	Gumbel
	2/year	GEV	GEV	GEV
	3/year	GEV	GEV	GEV

(2) Design Flood for River Diversion Construction

The design flood for river diversion construction was calculated by using the Rational Formula as shown in Table 3.10. The values of calculated design flood were rounded up to the nearest tens. The values of the design flood for river diversion construction are 390 m^3/s at Bajhang, 150 m^3/s at Bajura, and 220 m^3/s at Syarpudaha.

Table 3.10 Calculated Result of Design Flood for River Diversion Construction

S.N	Calculation of T			Calculation of Rt		Catchment Area in km^2 (A)	Runoff Coefficent (f)	Peak runoff discharge in m3/s (Qp)	water-sediment complex(10%) Peak runoff discharge in m^3/s (Qp)	round value water-sediment complex(10%) Peak runoff discharge in m^3/s (Qp)	Remarks
	Basin Inflow (min)	River Flow (min)	Total concentration time (min)	Daily rainfall in mm/day (R24)	Average rainfall intensity in mm/hr (RT)						
Bajhang	20	58.0	78.0	52.0	15.2	104.020	0.80	351.4	386.5	390	Bajhang
Bajura	20	26.5	46.5	52.0	21.4	27.270	0.80	129.7	142.7	150	Bajura
Syarpudaha	20	27.5	47.5	52.0	21.1	40.776	0.80	191.2	210.3	220	Syarpudaha

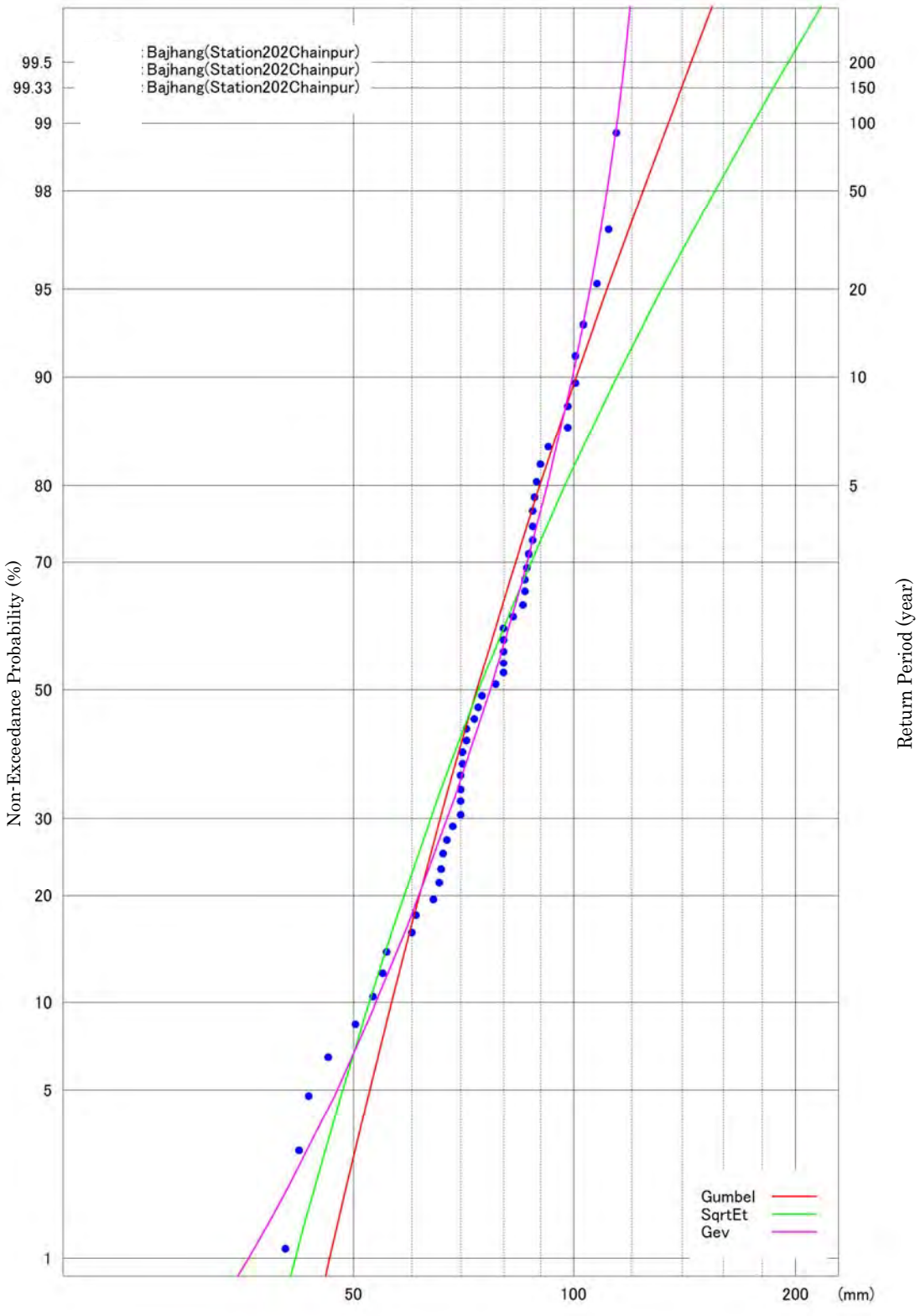


Figure 3.10 Frequency Curve of Annual Maximum Daily Rainfall

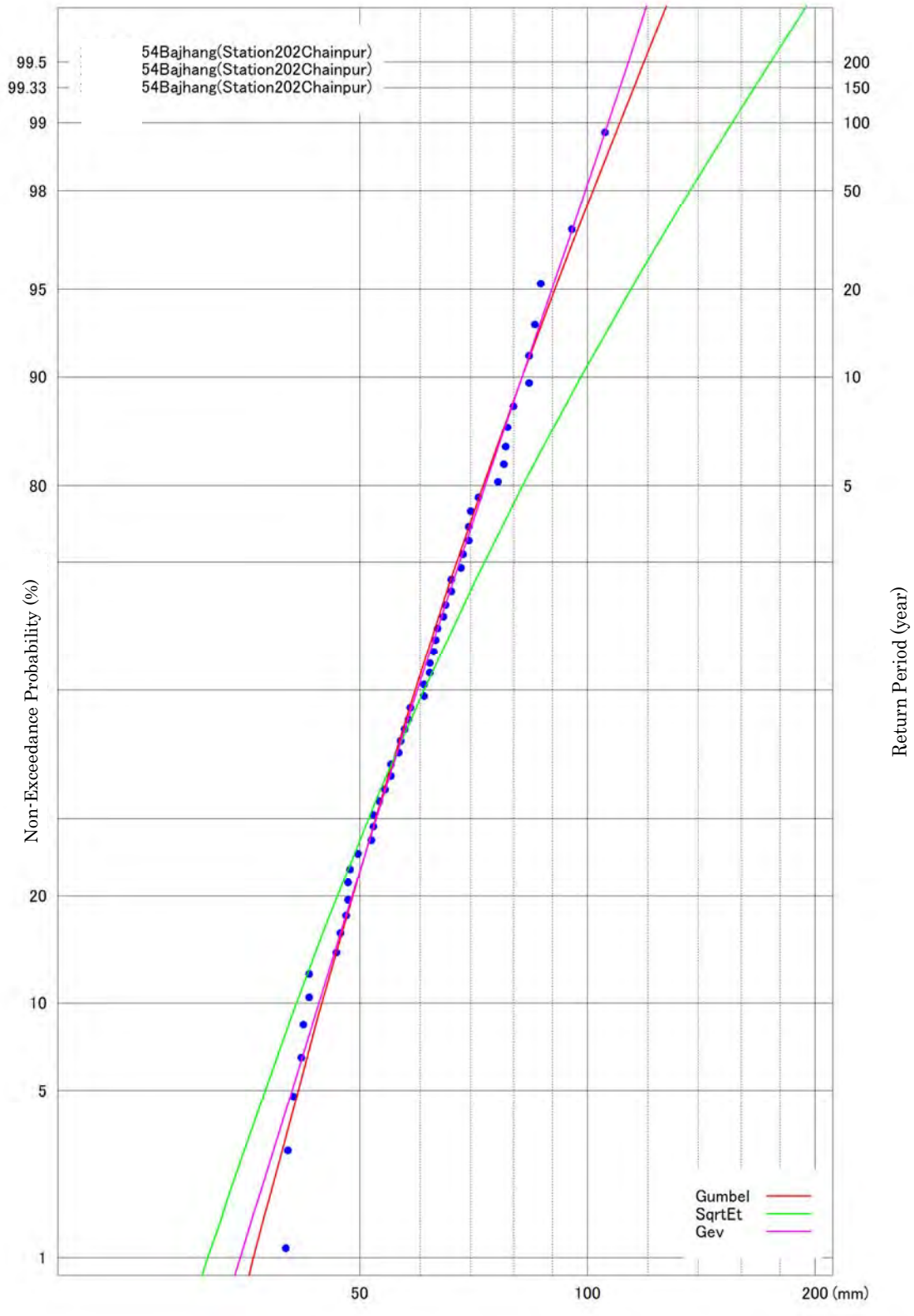


Figure 3.11 Frequency Curve of Annual Maximum Daily Rainfall

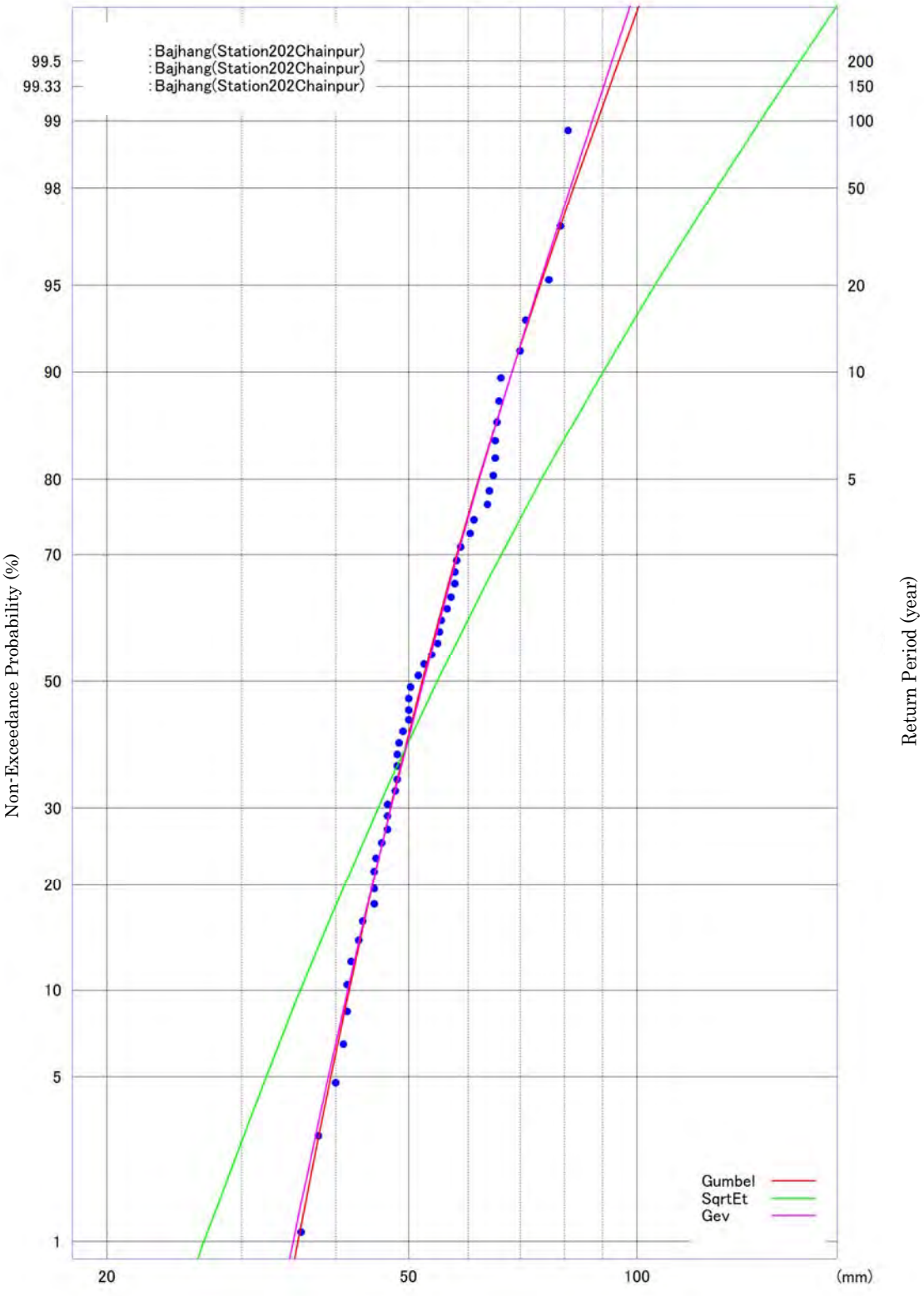


Figure 3.12 Frequency Curve of Annual Maximum Daily Rainfall

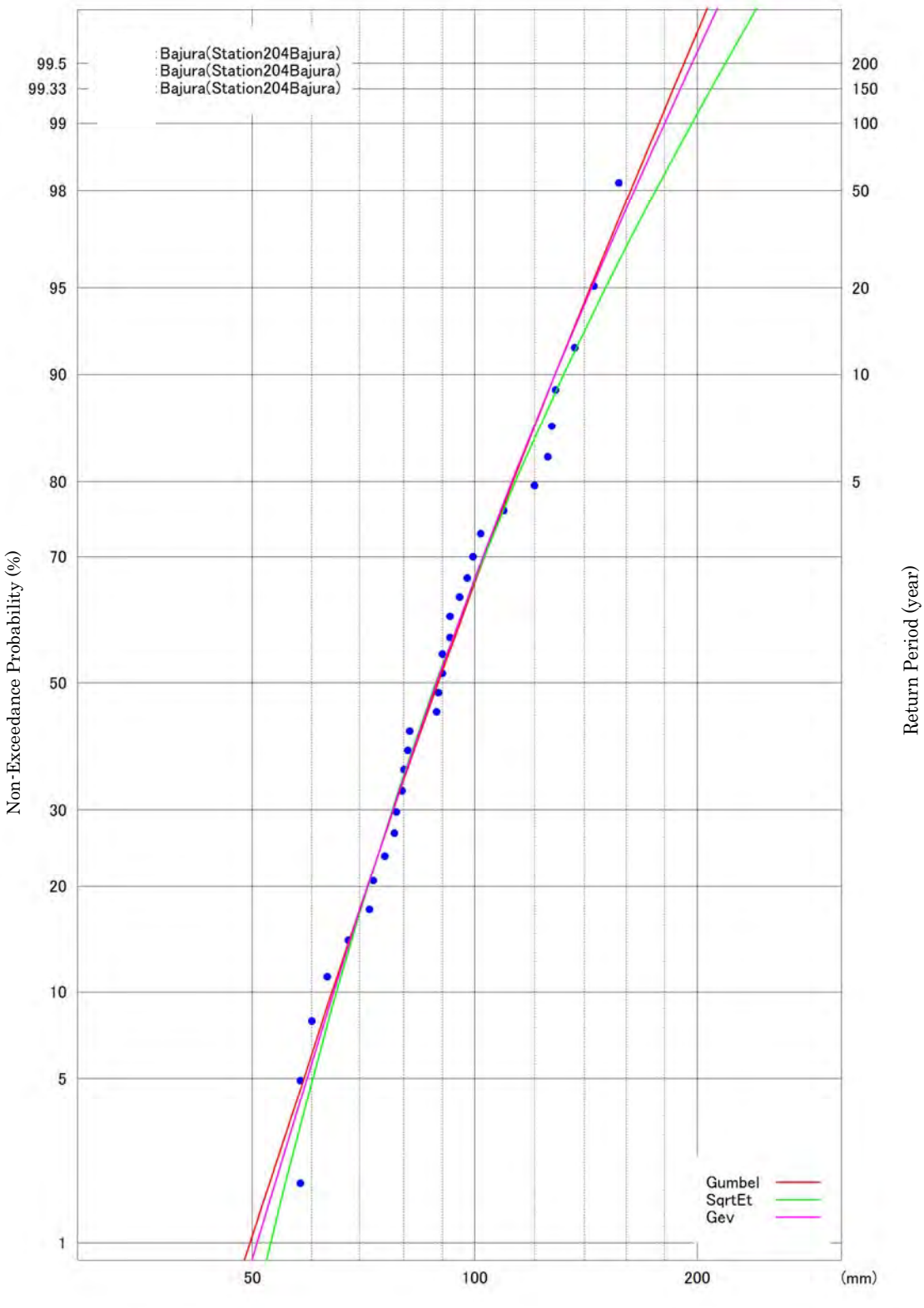


Figure 3.13 Frequency Curve of Annual Maximum Daily Rainfall

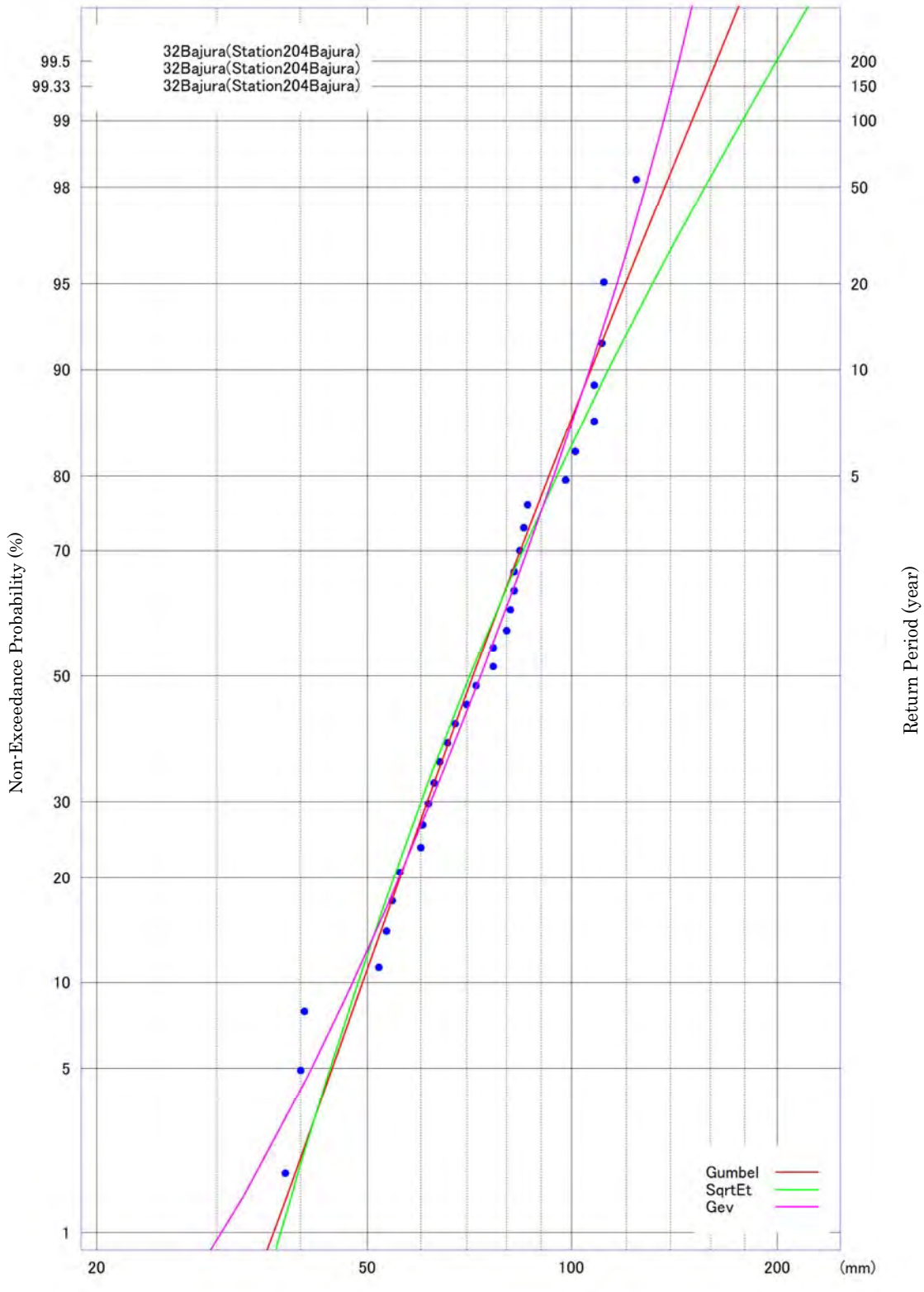


Figure 3.14 Frequency Curve of Annual Maximum Daily Rainfall

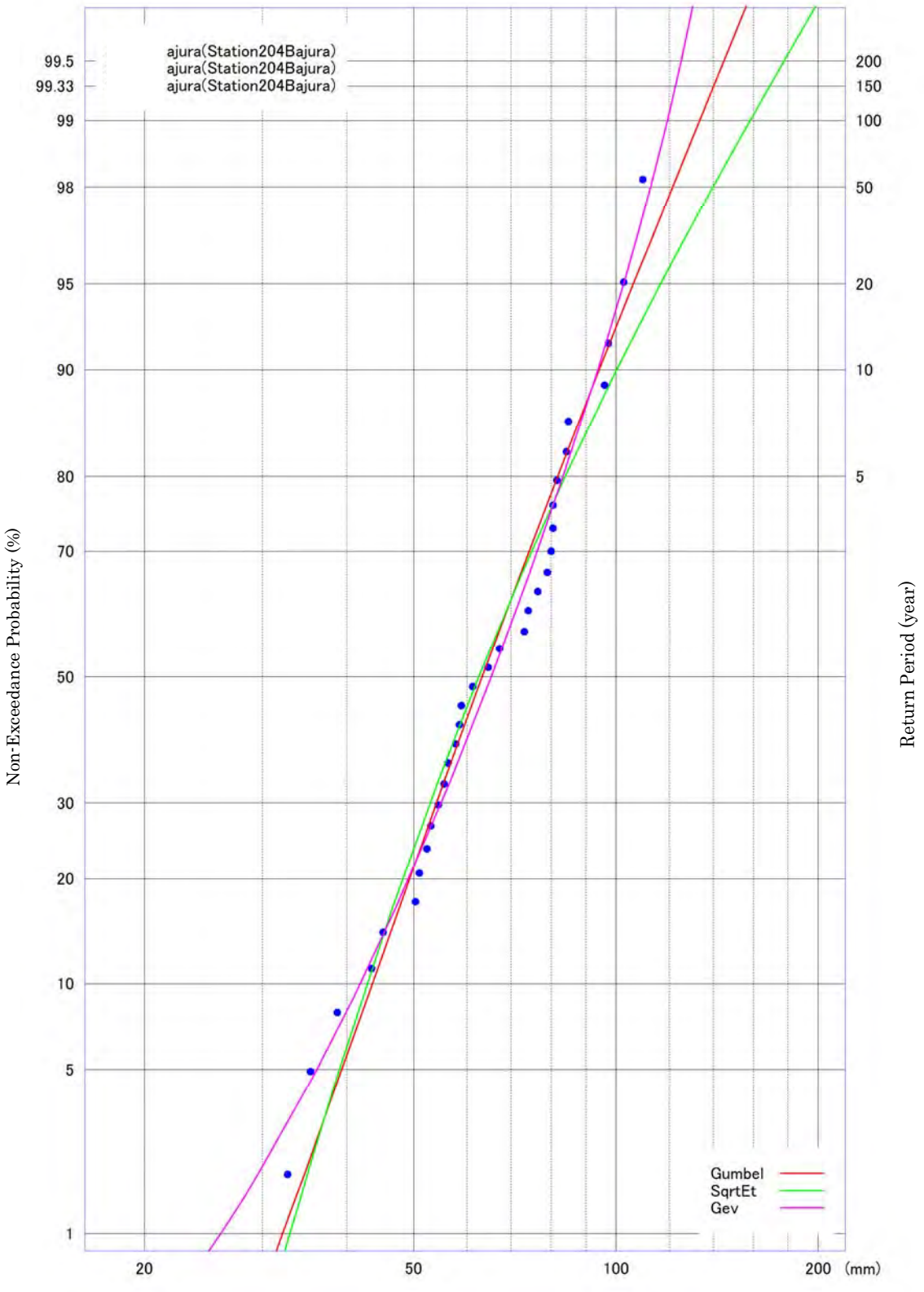


Figure 3.15 Frequency Curve of Annual Maximum Daily Rainfall

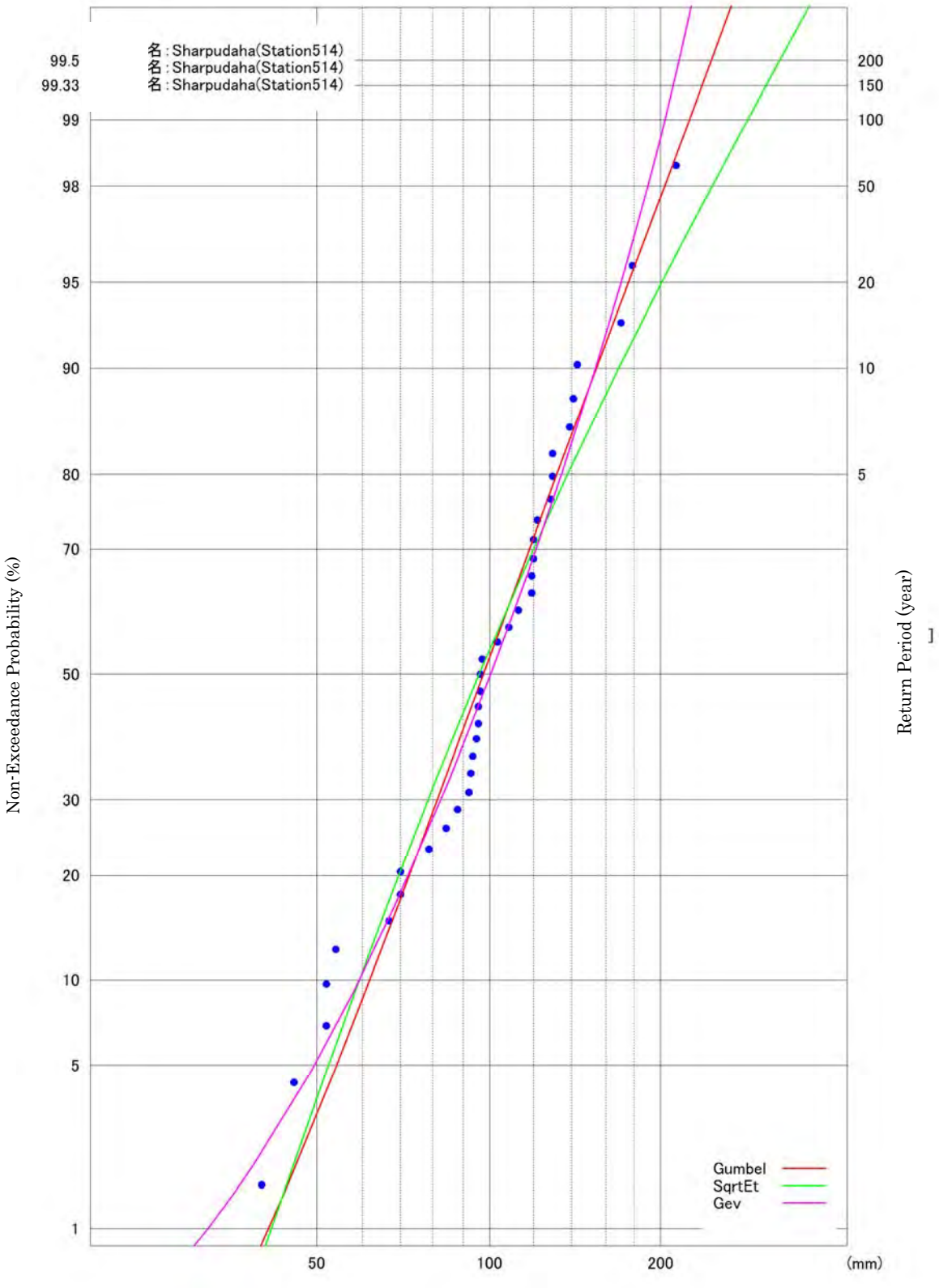


Figure 3.16 Frequency Curve of Annual Maximum Daily Rainfall

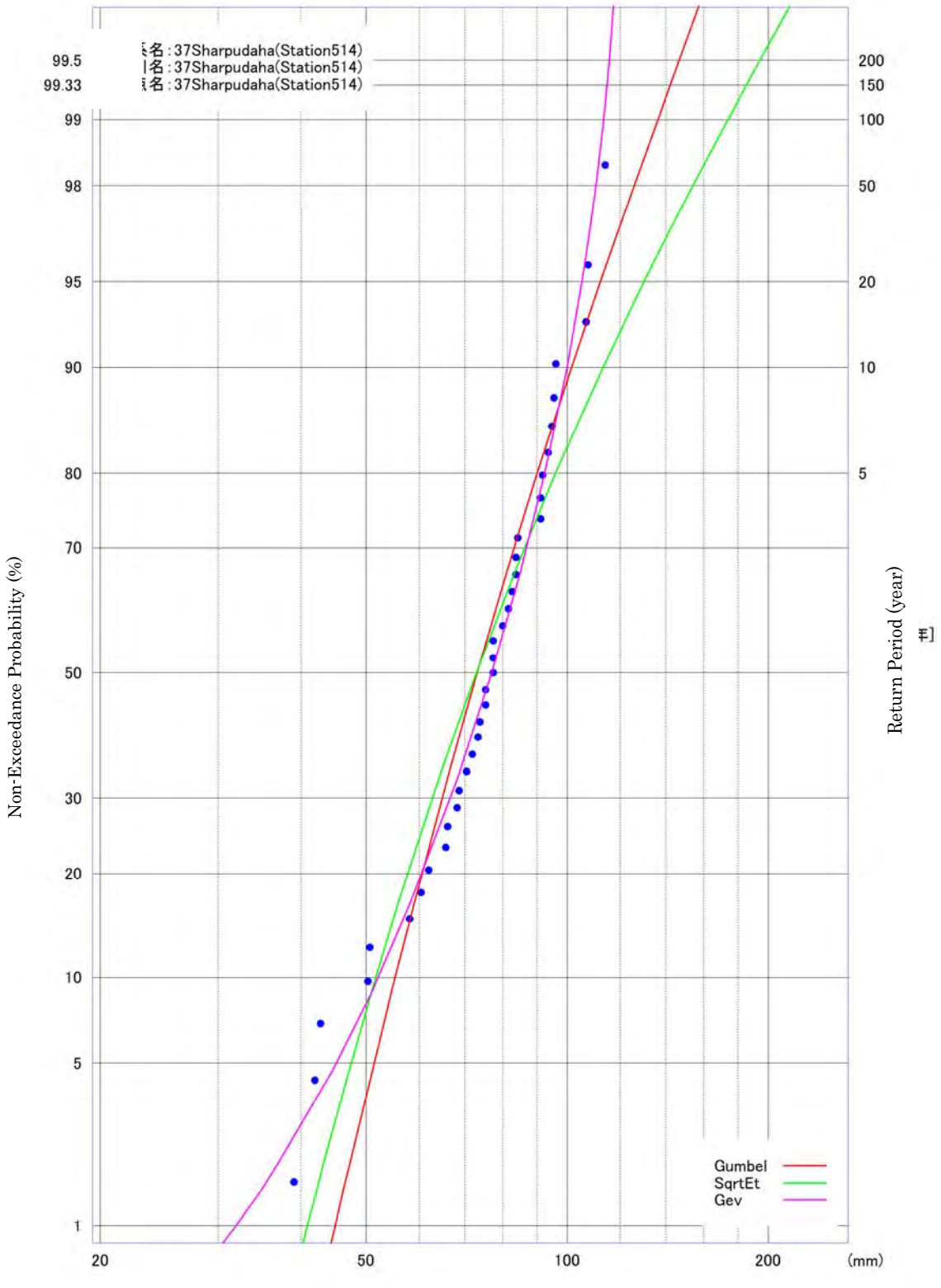


Figure 3.17 Frequency Curve of Annual Maximum Daily Rainfall

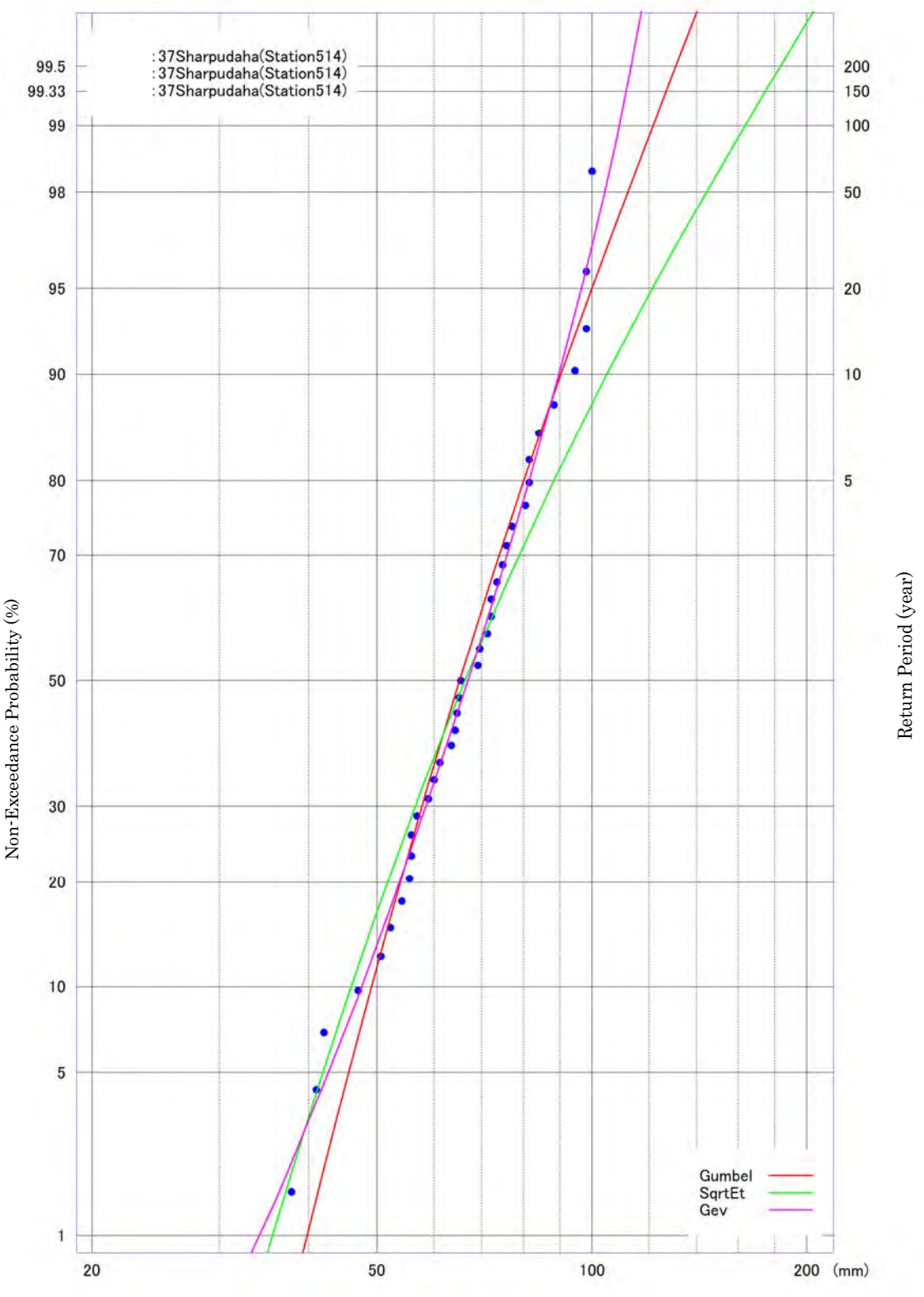


Figure 3.18 Frequency Curve of Annual Maximum Daily Rainfall

Table 3.11　Probable Daily Rainfall for River Diversion Construction（Bajhang）

1/year

Name of River System	Bajhang(Station202Chainpur)
Name river	Bajhang(Station202Chainpur)
Name Spot	Bajhang(Station202Chainpur)
number of data	54
α	0.4
Bootstrap number of the samples	2000
LN4PM of upper limit Value g	−9999
LN4PM of lower limit Value b	0
K(Every year)　= (Xp − X)/S	1.78
K(Non-every year) = (Xp − X)/S	1.78

	Gumbel	SqrtEt	Gev
X-COR(99%)	0.968	0.944	0.994
P-COR(99%)	0.987	0.981	0.995
SLSC(99%)	0.05	0.078	0.023
Logarithm likelihood	−236.2	−237.2	−230.2
pAIC	476.5	478.3	466.3
X-COR(50%)	0.983	0.975	0.986
P-COR(50%)	0.986	0.98	0.983
SLSC(50%)	0.081	0.152	0.041

probable rainfall	return period	Gumbel	SqrtEt	Gev
	1.1	55.8	51.9	52.8

2/year

Name of River System	54Bajhang(Station202Chainpur)
Name river	54Bajhang(Station202Chainpur)
Name Spot	54Bajhang(Station202Chainpur)
number of data	54
α	0.4
Bootstrap number of the samples	2000
LN4PM of upper limit Value g	−9999
LN4PM of lower limit Value b	0
K(Every year)　= (Xp − X)/S	2.42
K(Non-every year) = (Xp − X)/S	2.42

	Gumbel	SqrtEt	Gev
X-COR(99%)	0.995	0.985	0.996
P-COR(99%)	0.997	0.997	0.998
SLSC(99%)	0.02	0.078	0.017
Logarithm likelihood	−219	−224.4	−219
pAIC	441.9	452.9	444.1
X-COR(50%)	0.993	0.989	0.994
P-COR(50%)	0.995	0.988	0.994
SLSC(50%)	0.034	0.155	0.026

probable rainfall	return period	Gumbel	SqrtEt	Gev
	1.1	44.1	40.7	43.7

3/year

Name of River System	ajhang(S2Chainpur)
Name river	ajhang(S2Chainpur)
Name Spot	ajhang(S2Chainpur)
number of data	54
α	0.4
Bootstrap number of the samples	2000
LN4PM of upper limit Value g	−9999
LN4PM of lower limit Value b	0
K(Every year)　= (Xp − X)/S	2.24
K(Non-every year) = (Xp − X)/S	2.24

	Gumbel	SqrtEt	Gev
X-COR(99%)	0.991	0.979	0.993
P-COR(99%)	0.996	0.992	0.996
SLSC(99%)	0.026	0.111	0.025
Logarithm likelihood	−200.7	−215.3	−200.7
pAIC	405.4	434.6	407.4
X-COR(50%)	0.98	0.969	0.982
P-COR(50%)	0.987	0.987	0.988
SLSC(50%)	0.051	0.215	0.047

probable rainfall	return period	Gumbel	SqrtEt	Gev
	1.1	41.4	35.4	41.2

Table 3.12　Probable Daily Rainfall for River Diversion Construction（Bajura）

1/year

Name of River System	32Bajura(Station204Bajura)
Name river	32Bajura(Station204Bajura)
Name Spot	32Bajura(Station204Bajura)
number of data	32
α	0.4
Bootstrap number of the samples	32
LN4PM of upper limit Value g	-9999
LN4PM of lower limit Value b	0
K(Every year)　= (Xp - X)/S	2.1
K(Non-every year) = (Xp - X)/S	2.1

	Gumbel	SqrtEt	Gev
X-COR(99%)	0.99	0.985	0.989
P-COR(99%)	0.994	0.995	0.994
SLSC(99%)	0.028	0.032	0.029
Logarithm likelihood	-146.3	-146.3	-146.2
pAIC	296.6	296.5	298.5
X-COR(50%)	0.975	0.966	0.972
P-COR(50%)	0.982	0.983	0.982
SLSC(50%)	0.053	0.059	0.053

probable rainfall	return period	Gumbel	SqrtEt	Gev
	1.1	63.2	64.2	63.6

2/year

Name of River System	32Bajura(Station204Bajura)
Name river	32Bajura(Station204Bajura)
Name Spot	32Bajura(Station204Bajura)
number of data	32
α	0.4
Bootstrap number of the samples	32
LN4PM of upper limit Value g	-9999
LN4PM of lower limit Value b	0
K(Every year)　= (Xp - X)/S	1.79
K(Non-every year) = (Xp - X)/S	1.79

	Gumbel	SqrtEt	Gev
X-COR(99%)	0.981	0.964	0.99
P-COR(99%)	0.995	0.992	0.995
SLSC(99%)	0.038	0.05	0.03
Logarithm likelihood	-144.3	-145.2	-143.8
pAIC	292.7	294.4	293.6
X-COR(50%)	0.958	0.946	0.969
P-COR(50%)	0.975	0.975	0.972
SLSC(50%)	0.072	0.097	0.058

probable rainfall	return period	Gumbel	SqrtEt	Gev
	1.1	48.5	47.8	46.7

3/year

Name of River System	ajura(Station204Bajura)
Name river	ajura(Station204Bajura)
Name Spot	ajura(Station204Bajura)
number of data	32
α	0.4
Bootstrap number of the samples	32
LN4PM of upper limit Value g	-9999
LN4PM of lower limit Value b	0
K(Every year)　= (Xp - X)/S	1.77
K(Non-every year) = (Xp - X)/S	1.77

	Gumbel	SqrtEt	Gev
X-COR(99%)	0.982	0.964	0.992
P-COR(99%)	0.991	0.99	0.992
SLSC(99%)	0.037	0.051	0.026
Logarithm likelihood	-140.7	-141.5	-140.1
pAIC	285.3	287.1	286.1
X-COR(50%)	0.973	0.965	0.98
P-COR(50%)	0.963	0.965	0.97
SLSC(50%)	0.072	0.1	0.046

probable rainfall	return period	Gumbel	SqrtEt	Gev
	1.1	42.9	42.2	40.9

Table 3.13　Probable Daily Rainfall for River Diversion Construction（Syarpudaha）

1/year

Name of River System	Sharpudaha(Station514)
Name river	Sharpudaha(Station514)
Name Spot	Sharpudaha(Station514)
number of data	37
α	0.4
Bootstrap number of the samples	2000
LN4PM of upper limit Value g	−9999
LN4PM of lower limit Value b	0
K(Every year)　= (Xp − X)/S	2.09
K(Non-every year) = (Xp − X)/S	2.09

	Gumbel	SqrtEt	Gev
X-COR(99%)	0.988	0.977	0.988
P-COR(99%)	0.987	0.979	0.991
SLSC(99%)	0.031	0.05	0.038
Logarithm likelihood	−185.4	−186.7	−184.9
pAIC	374.8	377.5	375.7
X-COR(50%)	0.986	0.988	0.978
P-COR(50%)	0.978	0.976	0.981
SLSC(50%)	0.038	0.083	0.071

probable rainfall	return period	Gumbel	SqrtEt	Gev
	1.1	60.6	58.2	57.8

2/year

Name of River System	37Sharpudaha(Station514)
Name river	37Sharpudaha(Station514)
Name Spot	37Sharpudaha(Station514)
number of data	37
α	0.4
Bootstrap number of the samples	2000
LN4PM of upper limit Value g	−9999
LN4PM of lower limit Value b	0
K(Every year)　= (Xp − X)/S	1.69
K(Non-every year) = (Xp − X)/S	1.69

	Gumbel	SqrtEt	Gev
X-COR(99%)	0.962	0.938	0.992
P-COR(99%)	0.983	0.973	0.995
SLSC(99%)	0.054	0.075	0.033
Logarithm likelihood	−164	−164.4	−159
pAIC	332	332.8	323.9
X-COR(50%)	0.978	0.969	0.984
P-COR(50%)	0.986	0.985	0.985
SLSC(50%)	0.077	0.136	0.063

probable rainfall	return period	Gumbel	SqrtEt	Gev
	1.1	54.6	51.0	51.1

3/year

Name of River System	37Sharpudaha(Station514)
Name river	37Sharpudaha(Station514)
Name Spot	37Sharpudaha(Station514)
number of data	37
α	0.4
Bootstrap number of the samples	2000
LN4PM of upper limit Value g	−9999
LN4PM of lower limit Value b	0
K(Every year)　= (Xp − X)/S	1.73
K(Non-every year) = (Xp − X)/S	1.73

	Gumbel	SqrtEt	Gev
X-COR(99%)	0.98	0.96	0.994
P-COR(99%)	0.995	0.993	0.998
SLSC(99%)	0.039	0.075	0.029
Logarithm likelihood	−155.7	−157.8	−154.4
pAIC	315.4	319.7	314.7
X-COR(50%)	0.964	0.95	0.98
P-COR(50%)	0.991	0.99	0.992
SLSC(50%)	0.071	0.149	0.056

probable rainfall	return period	Gumbel	SqrtEt	Gev
	1.1	48.6	45.4	46.9

【Chainpur（Bajhang）】

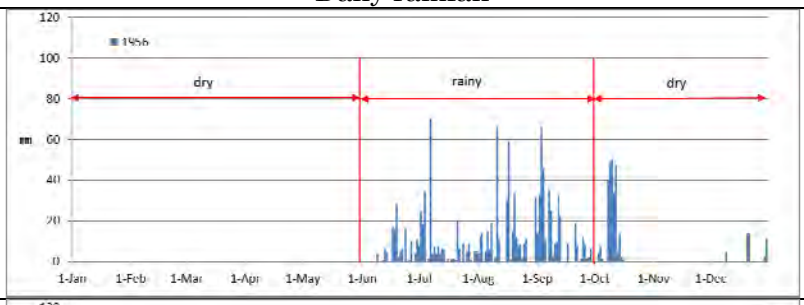
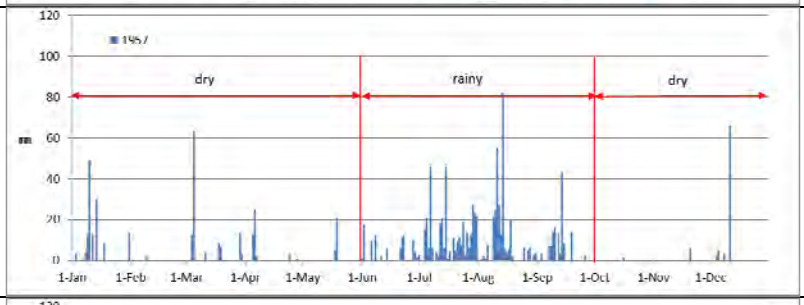
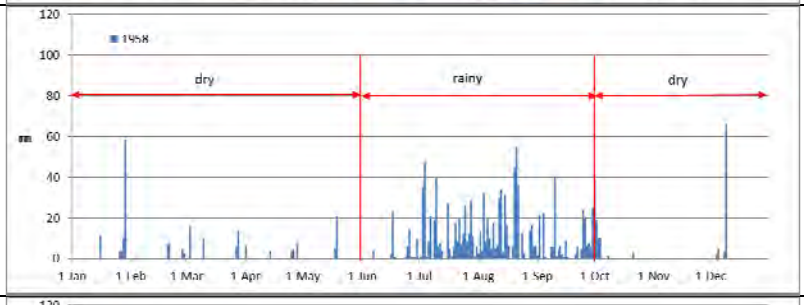
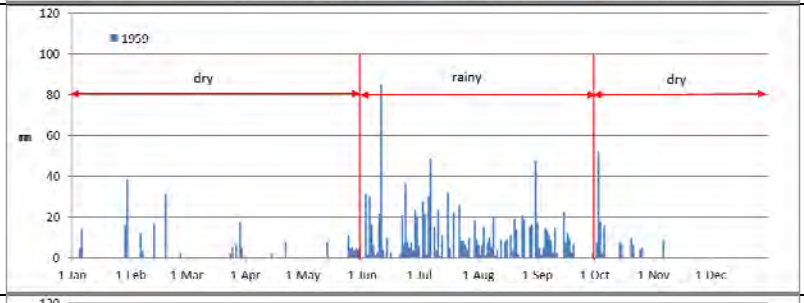
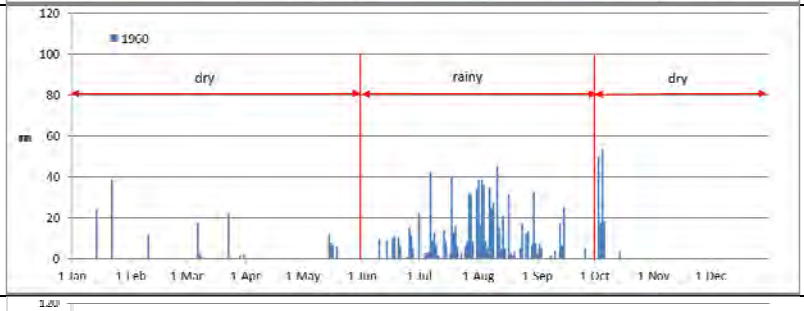
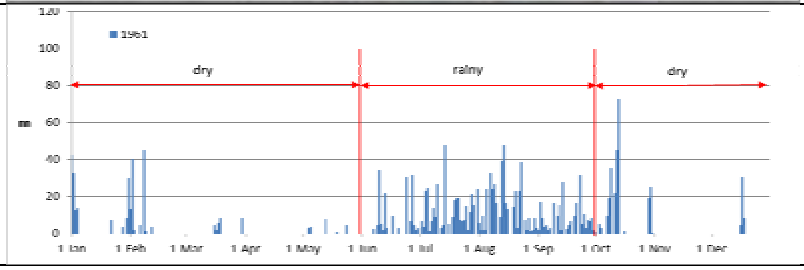
year	Daily rainfall
1956	
1957	
1958	
1959	
1960	
1961	

Figure 3.19 Bar graph of Daily Rainfall

【Chainpur（Bajhang）】

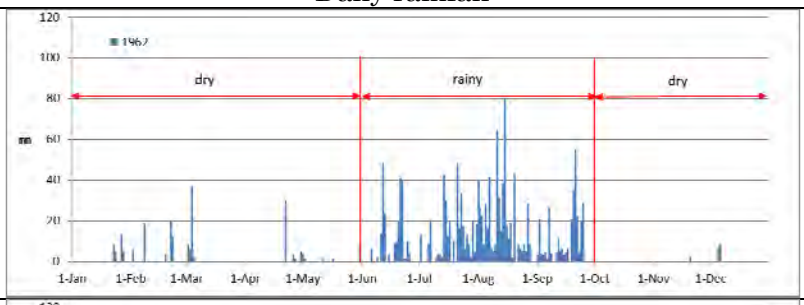
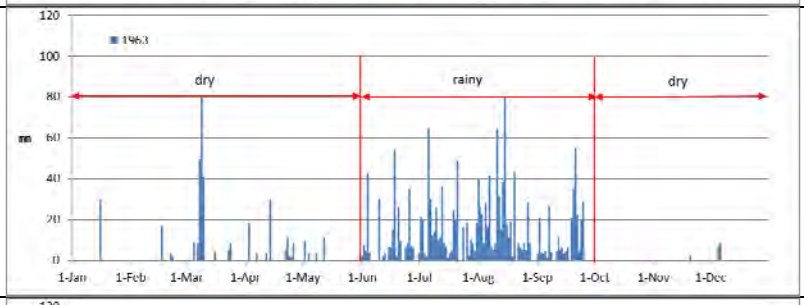
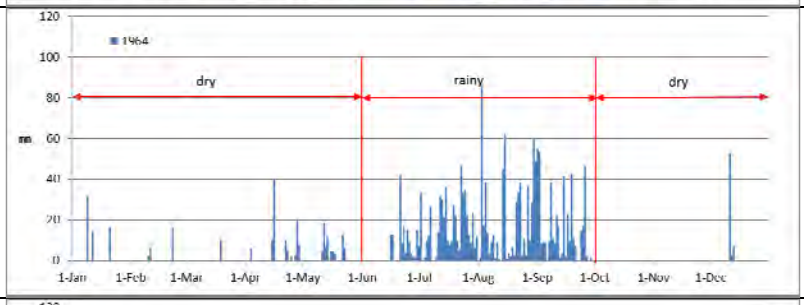
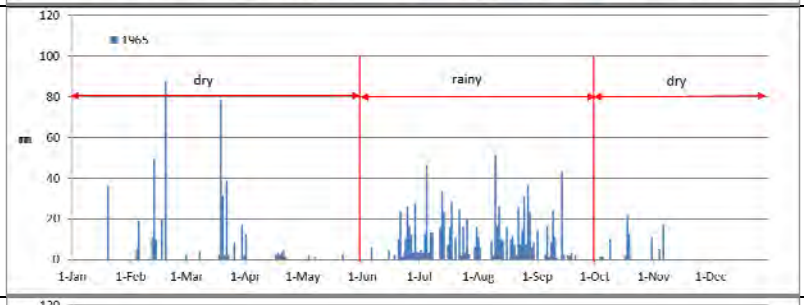
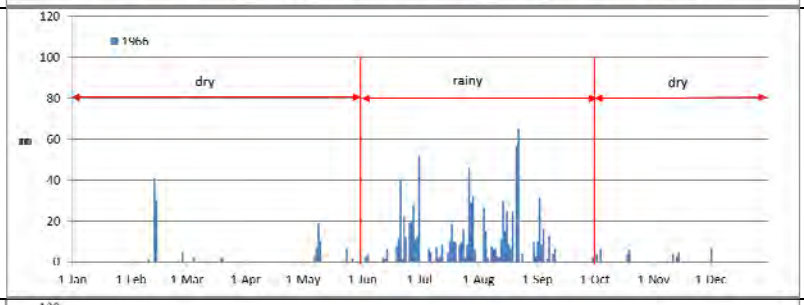
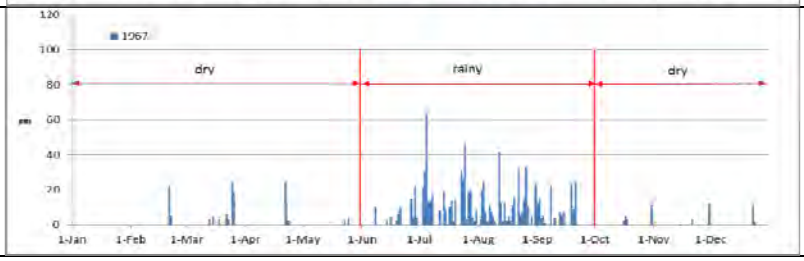
year	Daily rainfall
1962	
1963	
1964	
1965	
1966	
1967	

Figure 3.20　Bar graph of Daily Rainfall

【Chainpur（Bajhang）】

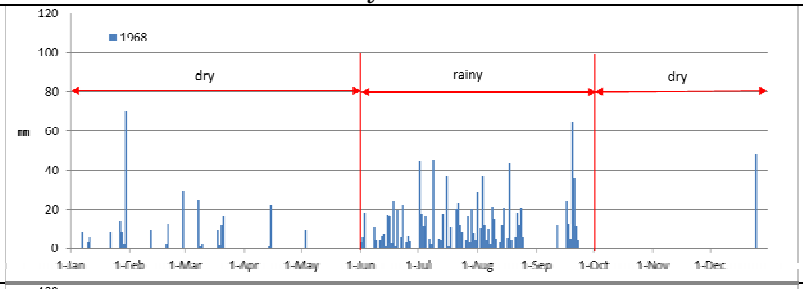
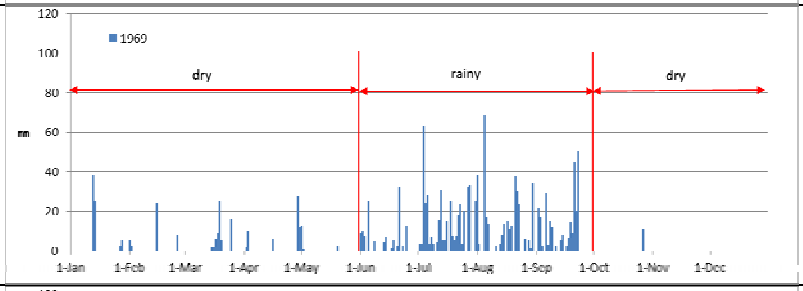
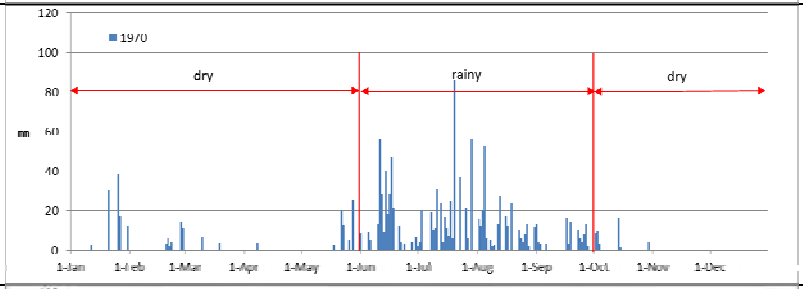
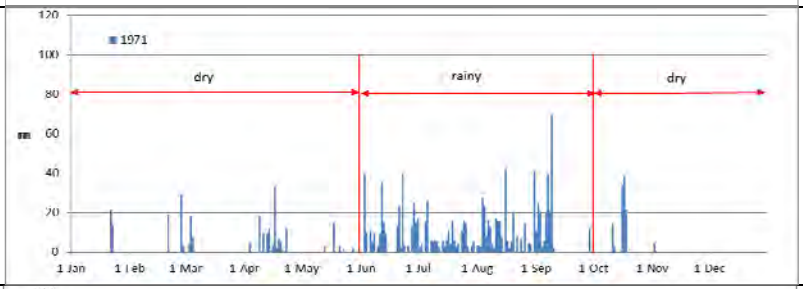
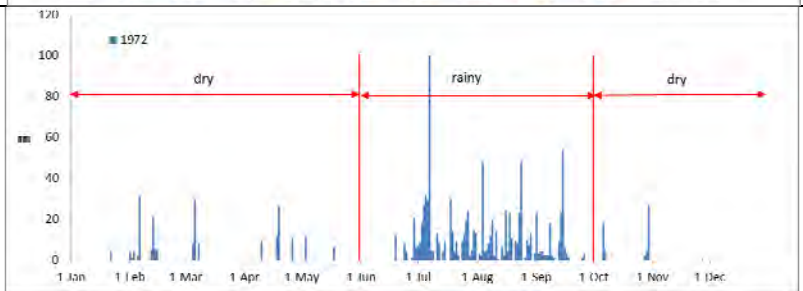
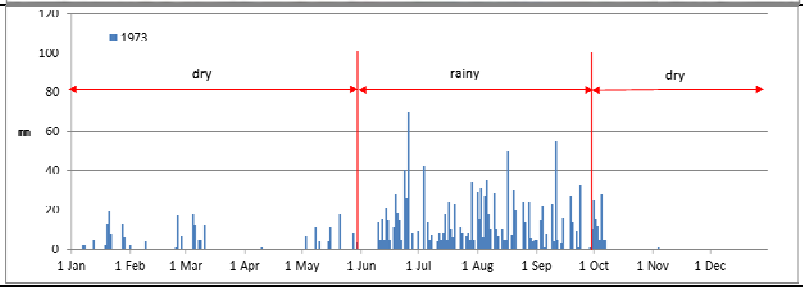
year	Daily rainfall
1968	
1969	
1970	
1971	
1972	
1973	

Figure 3.21　Bar graph of Daily Rainfall

【Chainpur（Bajhang）】

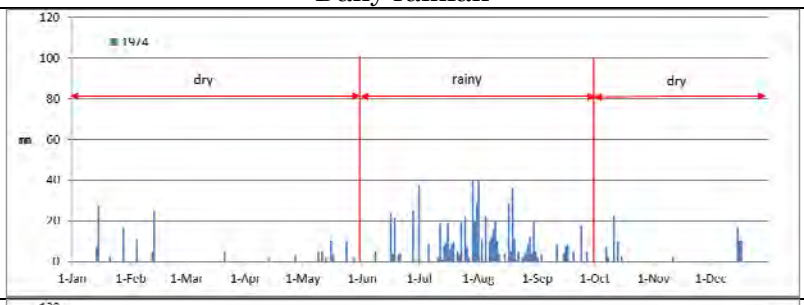
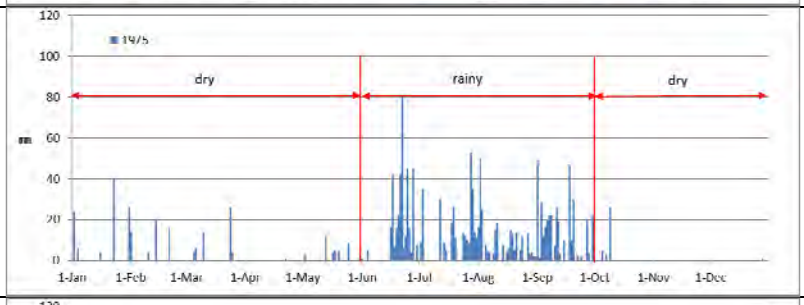
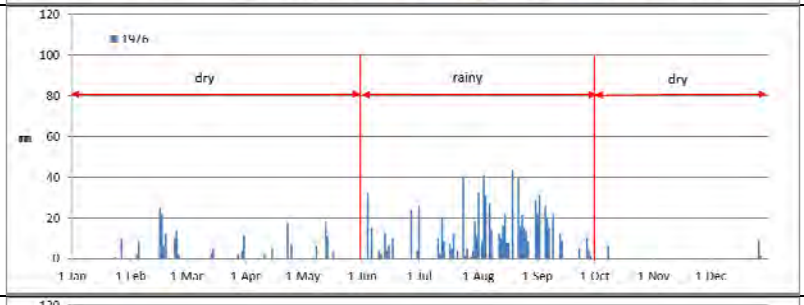
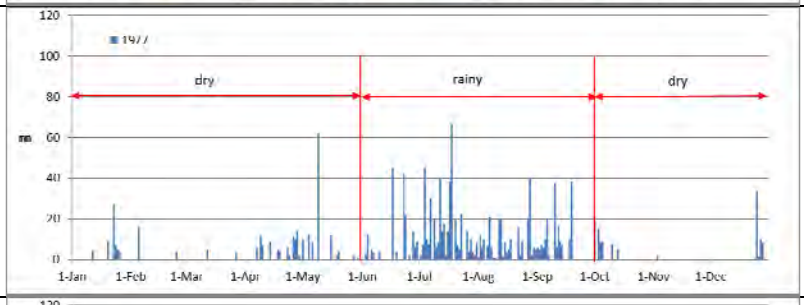
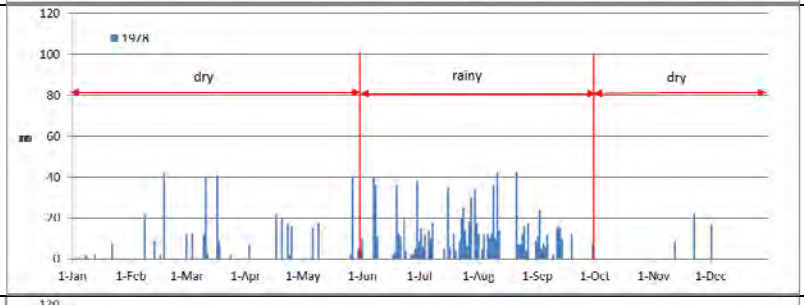
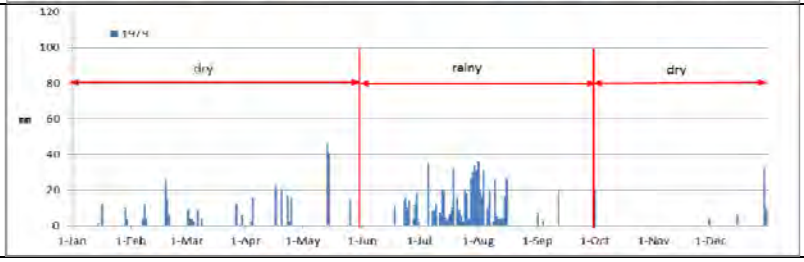
year	Daily rainfall
1974	
1975	
1976	
1977	
1978	
1979	

Figure 3.22　Bar graph of Daily Rainfall

【Chainpur（Bajhang）】

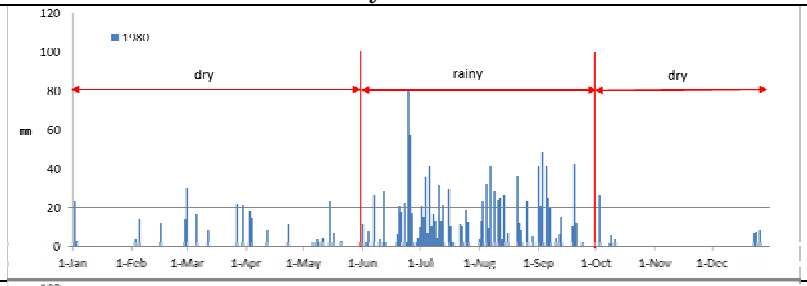
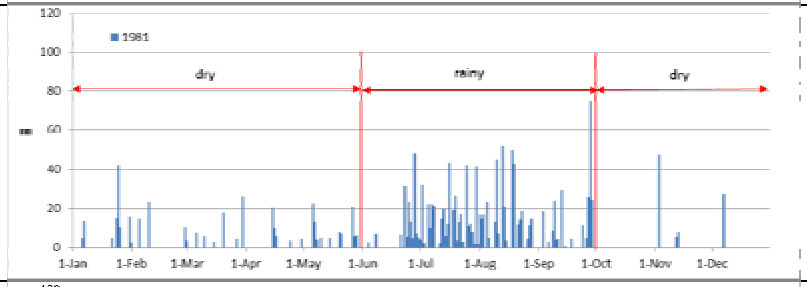
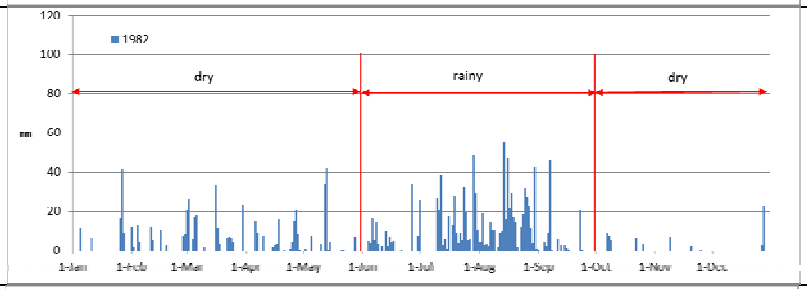
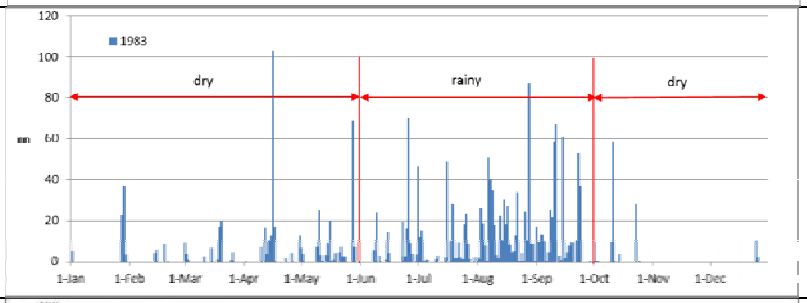
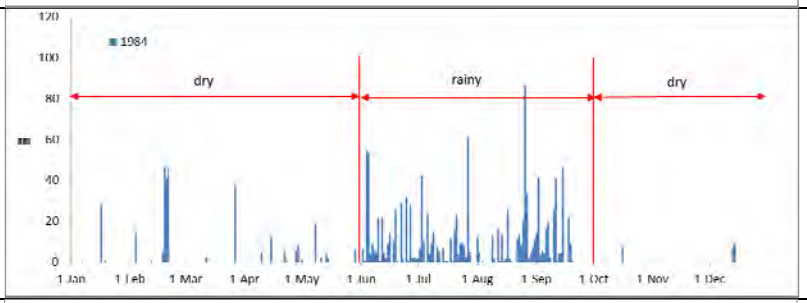
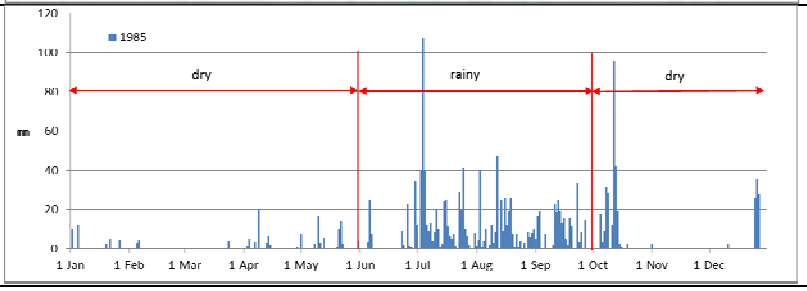
year	Daily rainfall
1980	
1981	
1982	
1983	
1984	
1985	

Figure 3.23　Bar graph of Daily Rainfall

【Chainpur（Bajhang）】

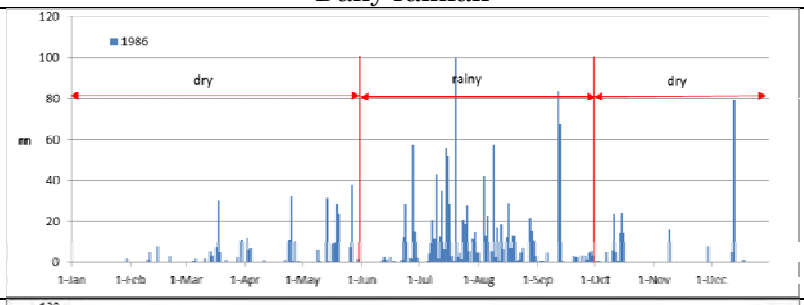
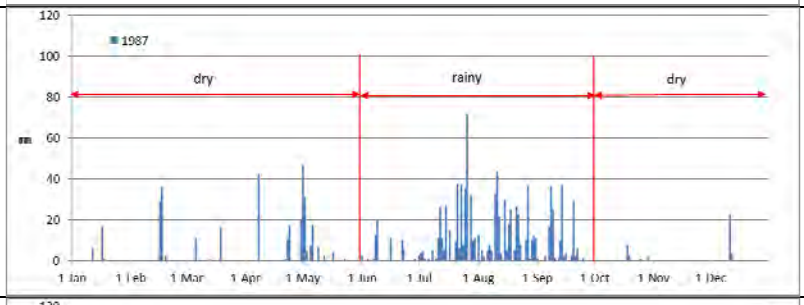
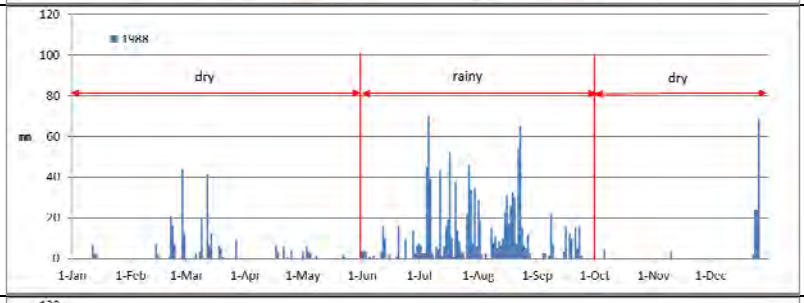
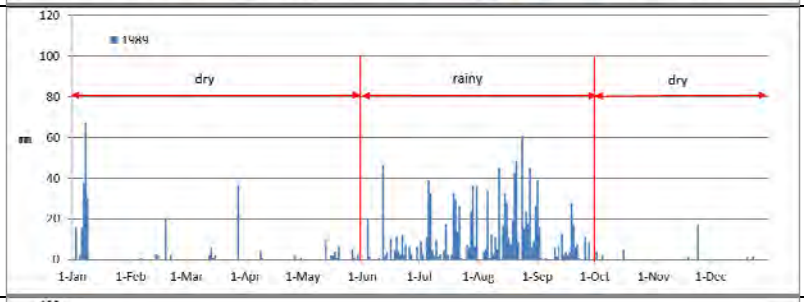
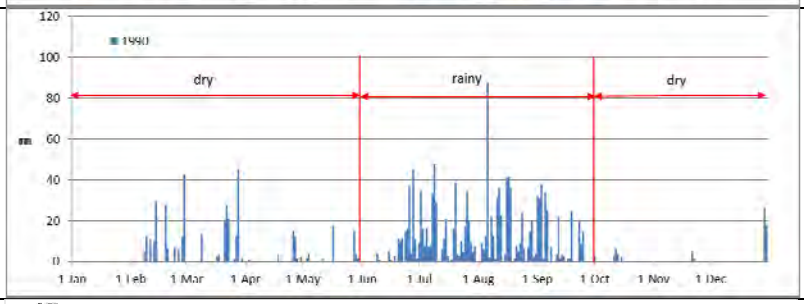
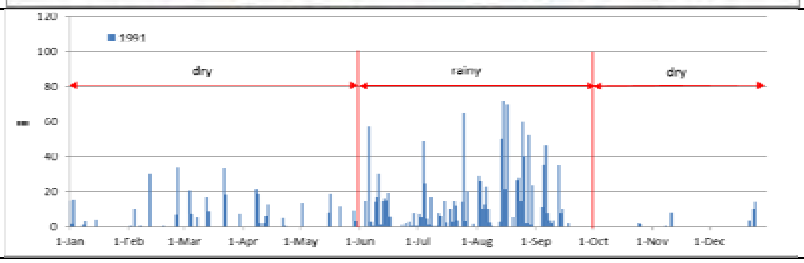
year	Daily rainfall
1986	
1987	
1988	
1989	
1990	
1991	

Figure 3.24　Bar graph of Daily Rainfall

【Chainpur（Bajhang）】

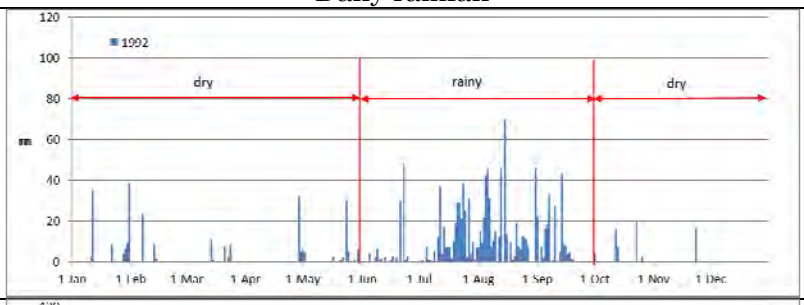
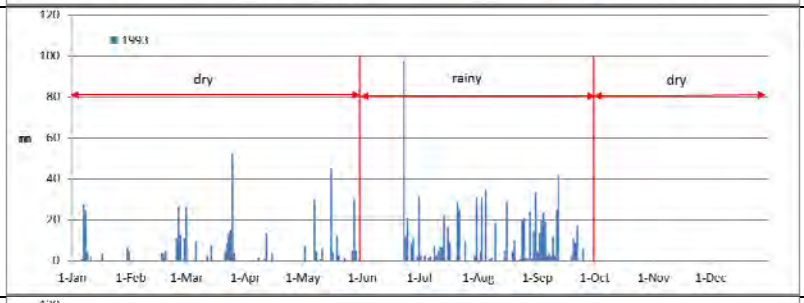
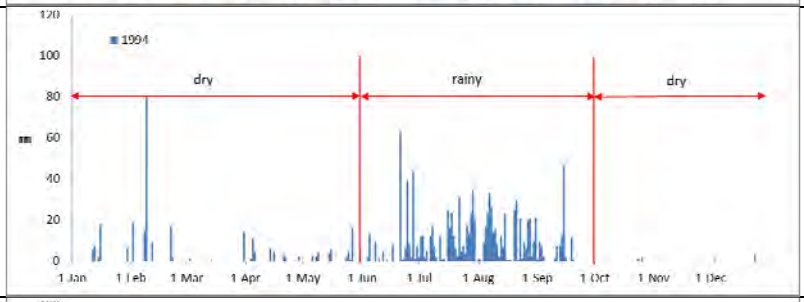
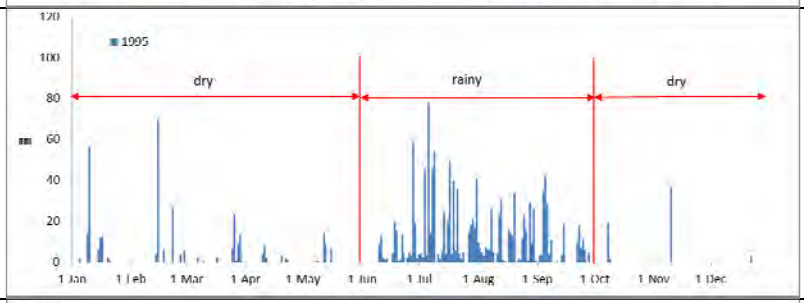
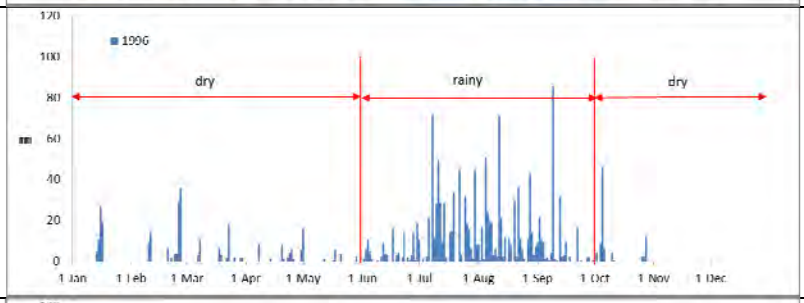
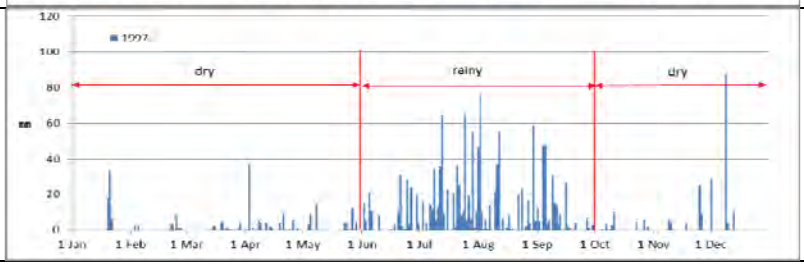
year	Daily rainfall
1992	
1993	
1994	
1995	
1996	
1997	

Figure 3.25　Bar graph of Daily Rainfall

【Chainpur（Bajhang）】

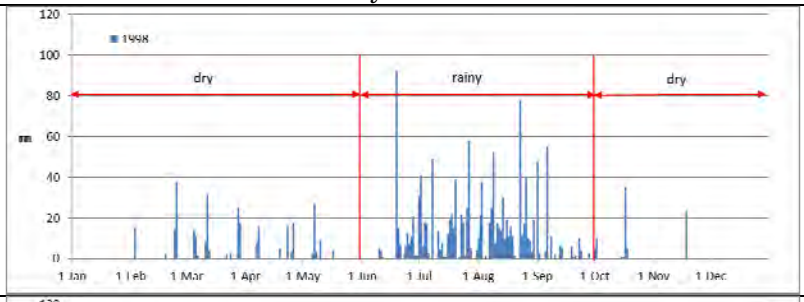
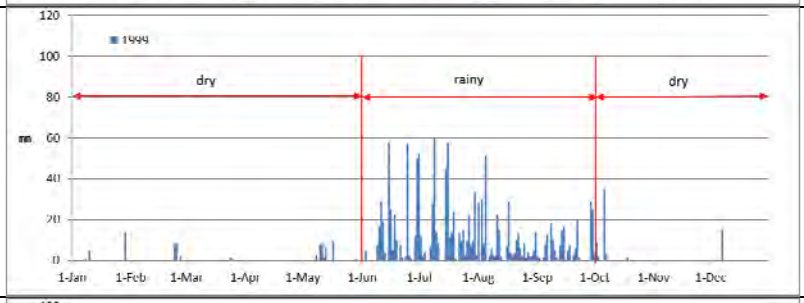
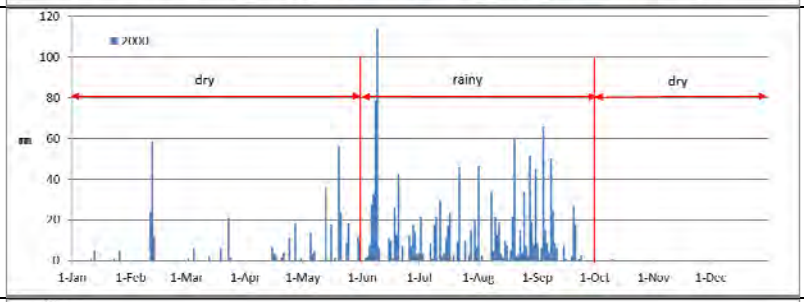
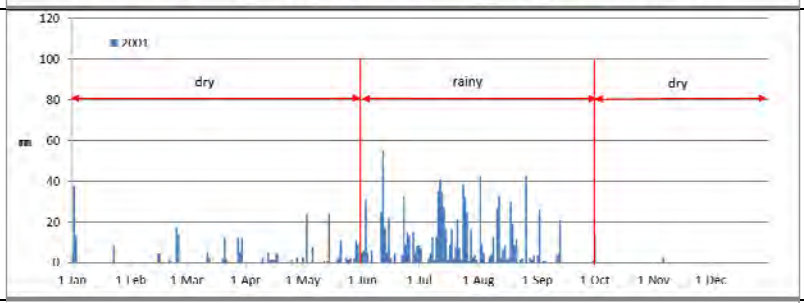
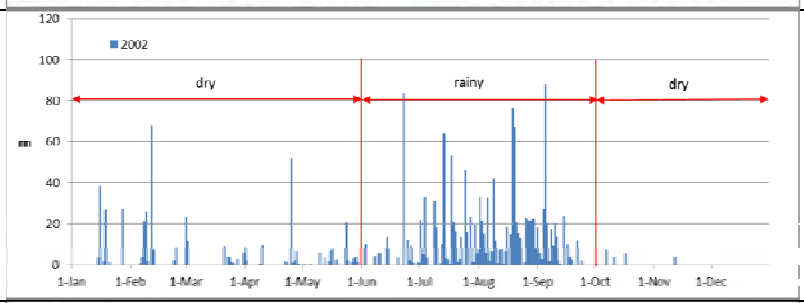
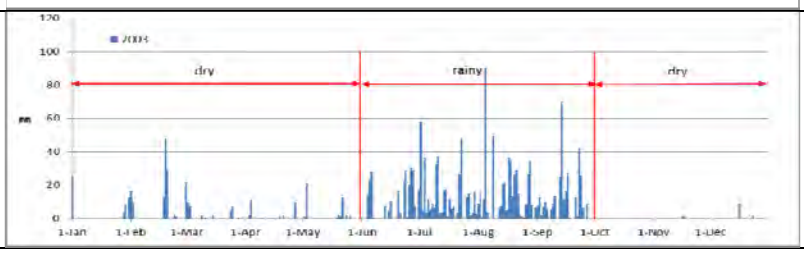
year	Daily rainfall
1998	
1999	
2000	
2001	
2002	
2003	

Figure 3.26　Bar graph of Daily Rainfall

【Chainpur（Bajhang）】

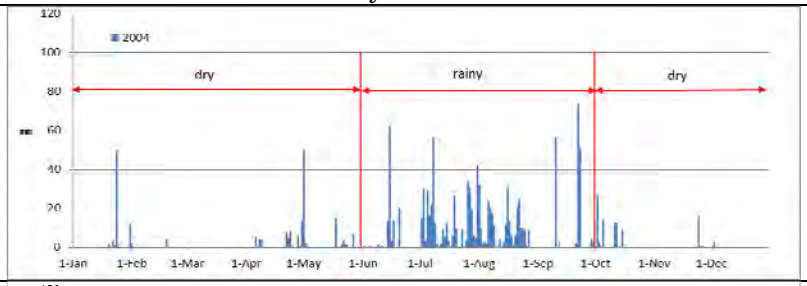
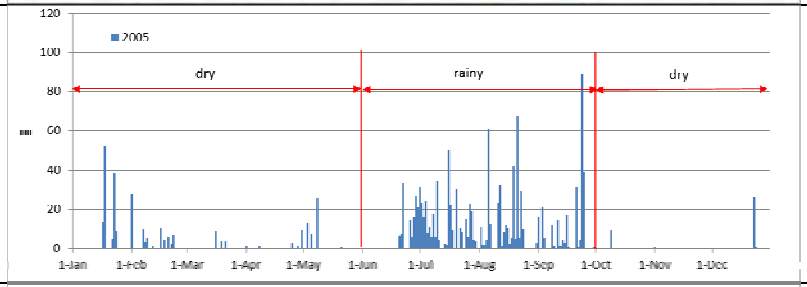
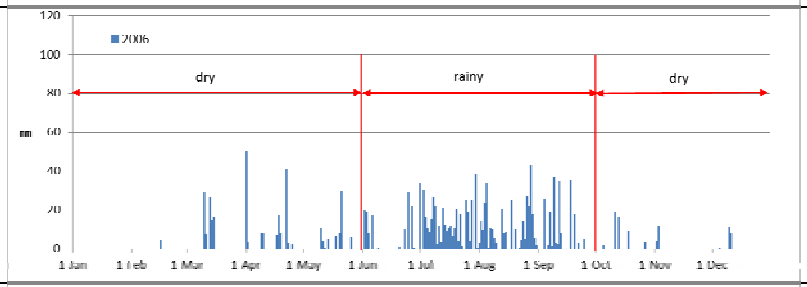
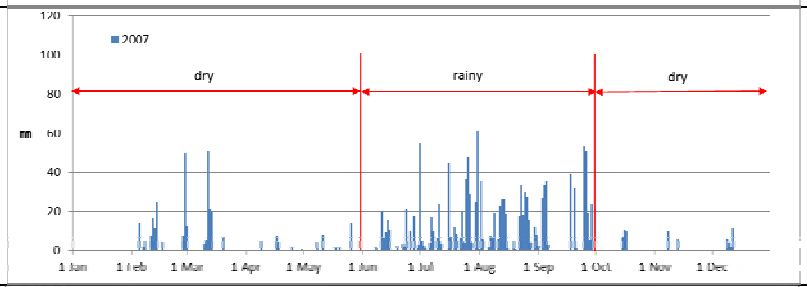
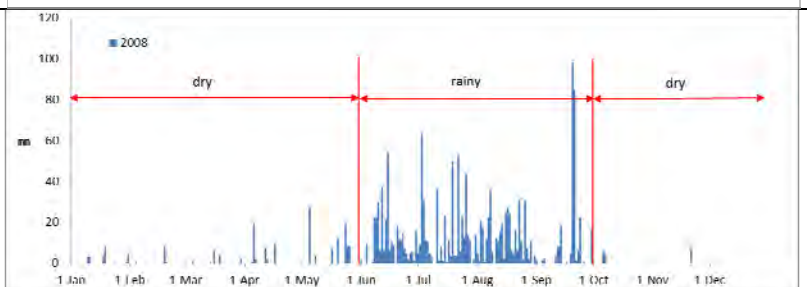
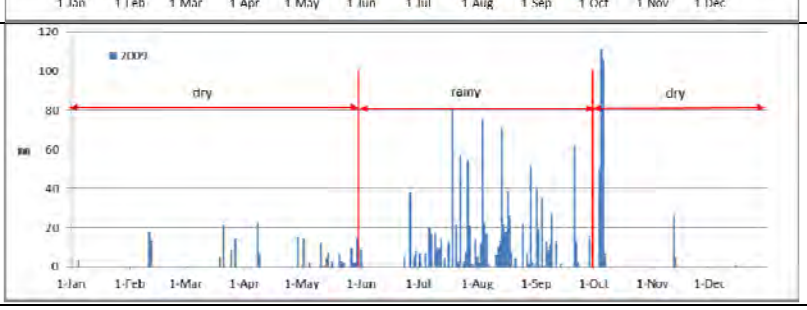
year	Daily rainfall
2004	
2005	
2006	
2007	
2008	
2009	

Figure 3.27　Bar graph of Daily Rainfall

【Chainpur（Bajhang）】

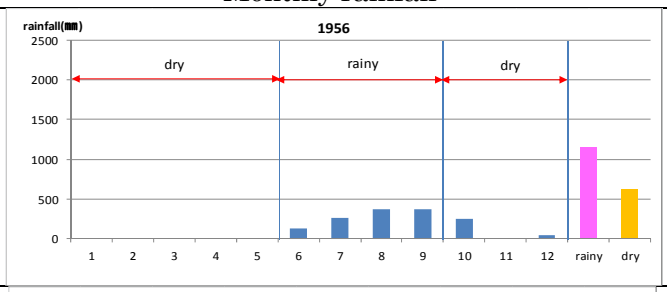
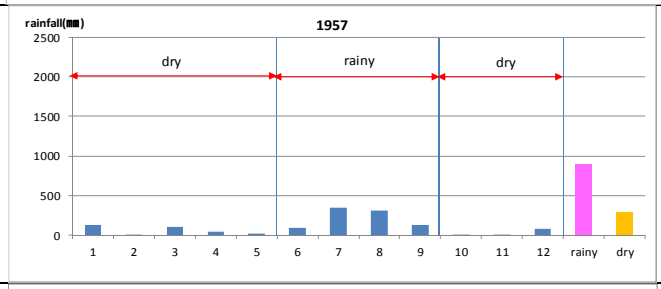
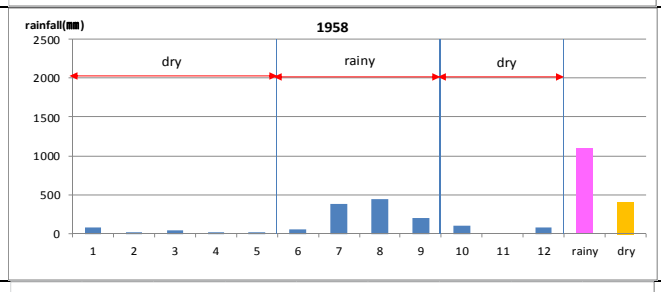
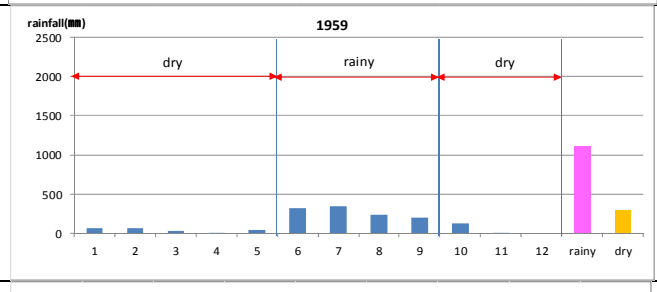
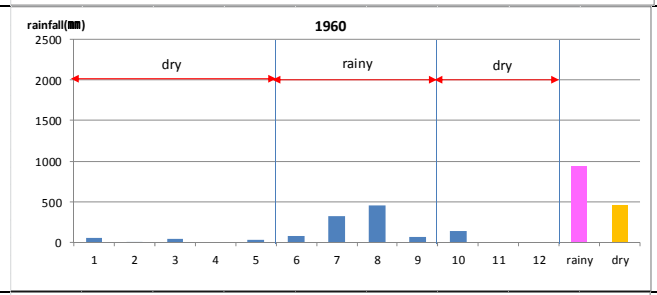
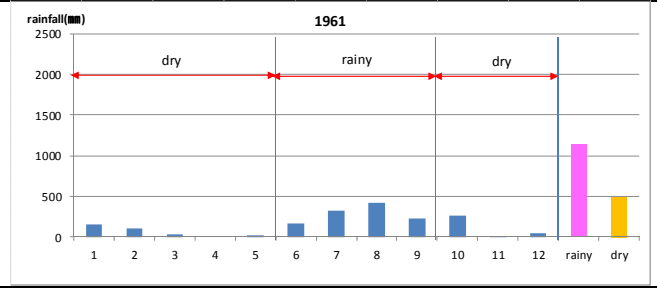
year	Monthly rainfall
1956	
1957	
1958	
1959	
1960	
1961	

Figure 3.28　Bar graph of Monthly Rainfall

【Chainpur（Bajhang）】

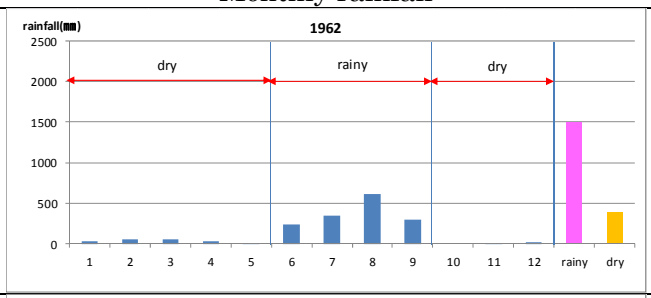
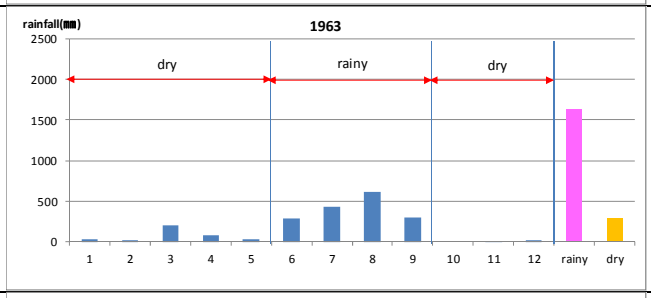
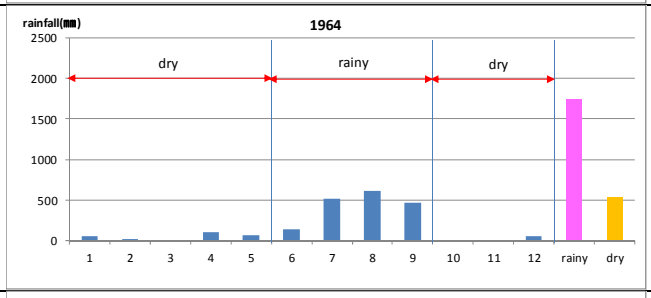
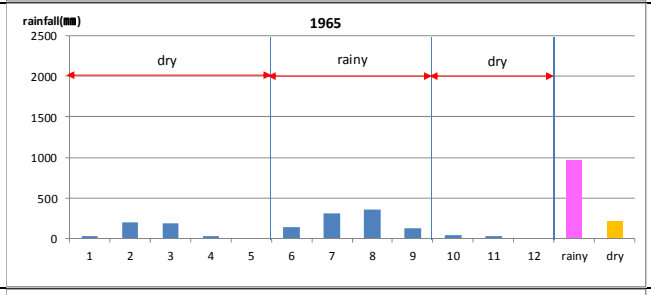
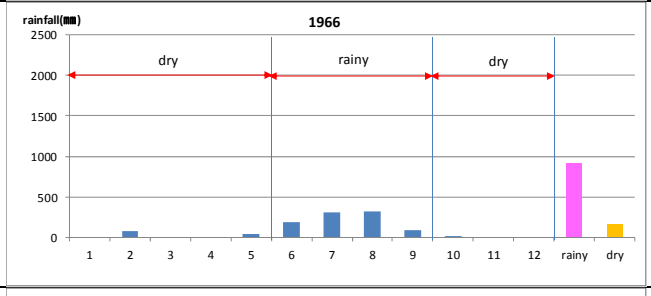
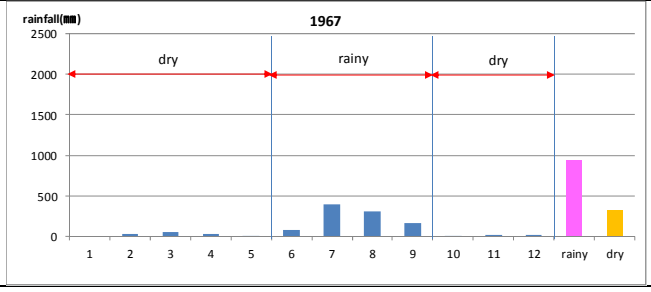
year	Monthly rainfall
1962	
1963	
1964	
1965	
1966	
1967	

Figure 3.29　Bar graph of Monthly Rainfall

【Chainpur（Bajhang）】

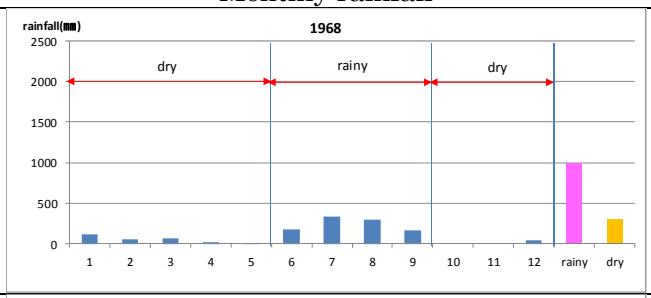
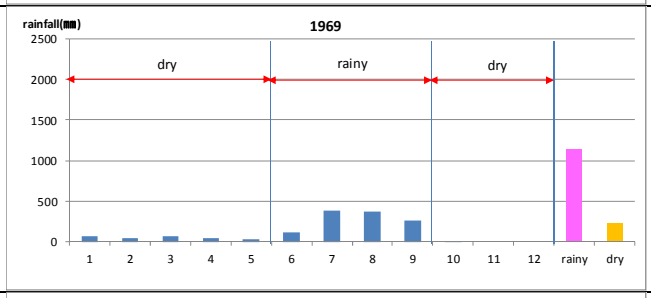
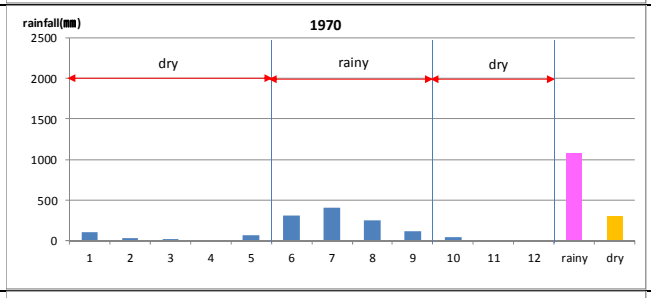
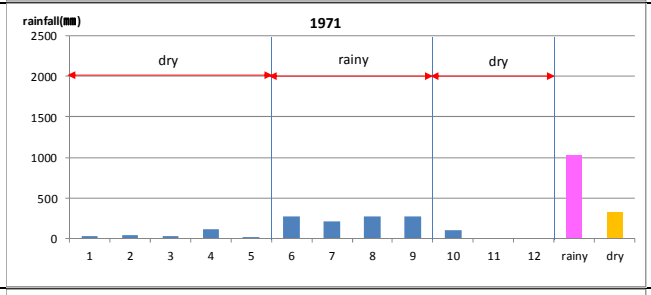
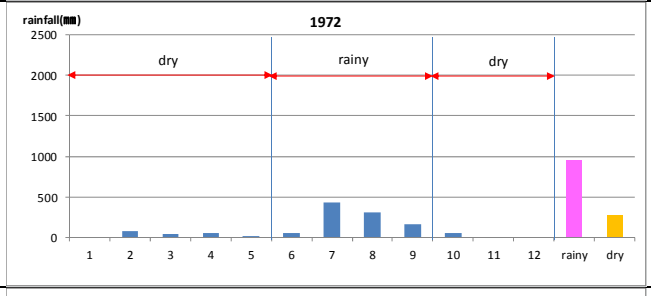
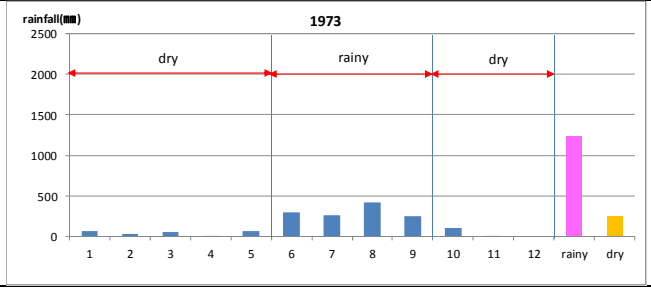
year	Monthly rainfall
1968	
1969	
1970	
1971	
1972	
1973	

Figure 3.30　Bar graph of Monthly Rainfall

【Chainpur（Bajhang）】

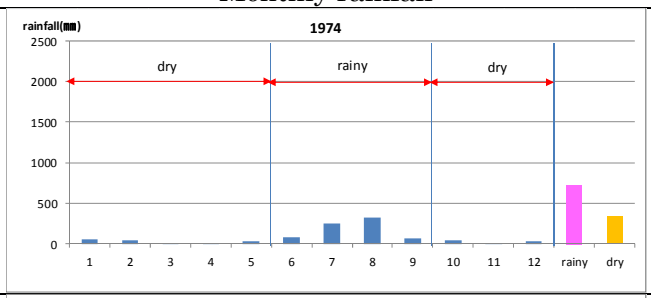
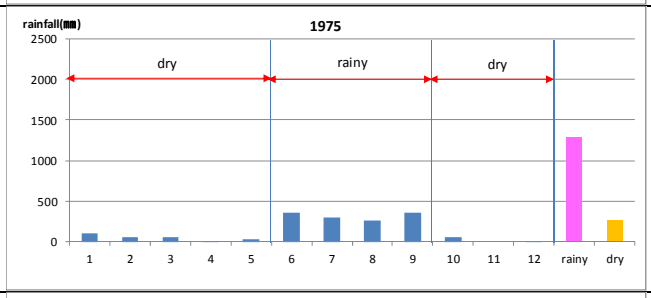
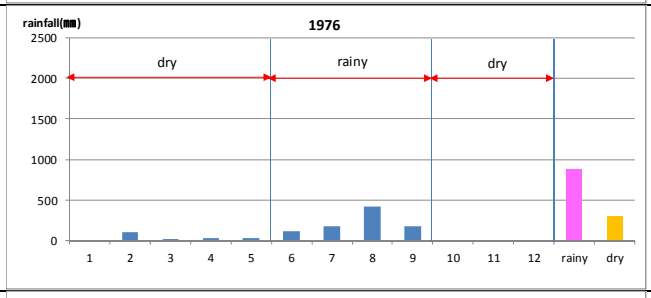
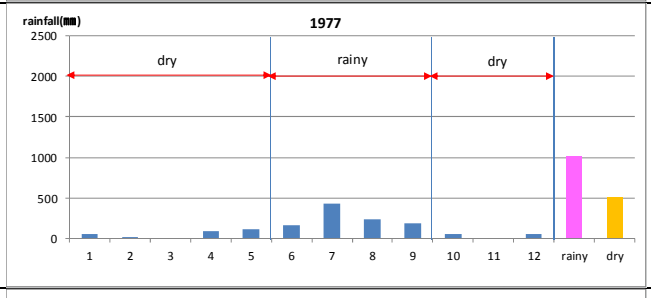
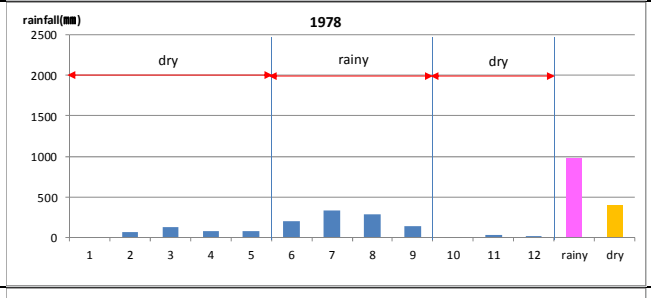
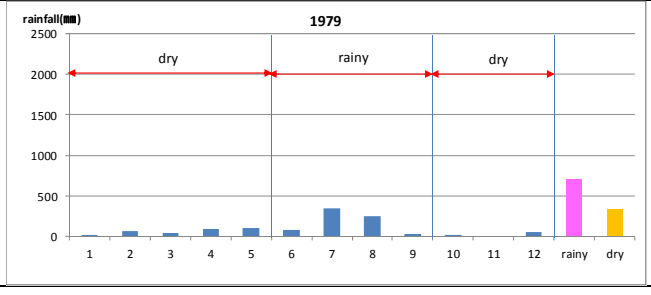
year	Monthly rainfall
1974	
1975	
1976	
1977	
1978	
1979	

Figure 3.31　Bar graph of Monthly Rainfall

【Chainpur（Bajhang）】

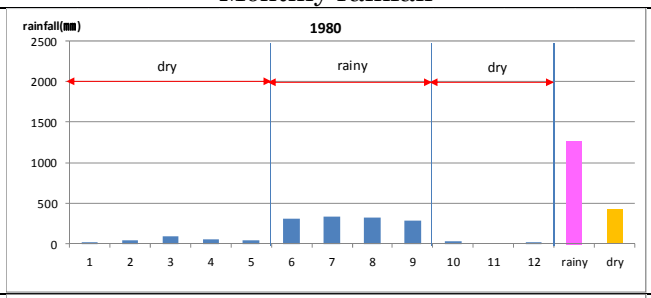
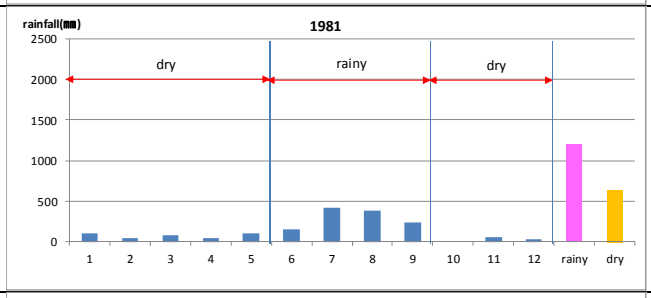
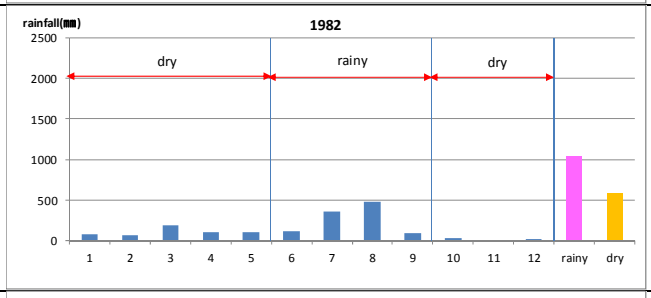
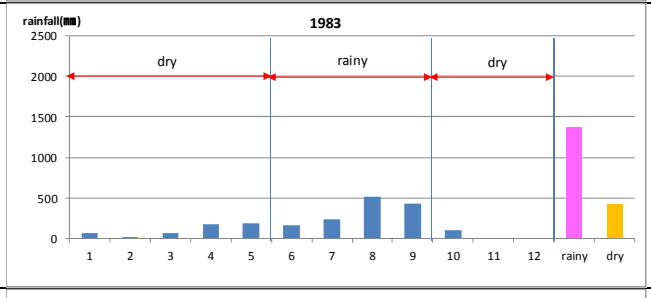
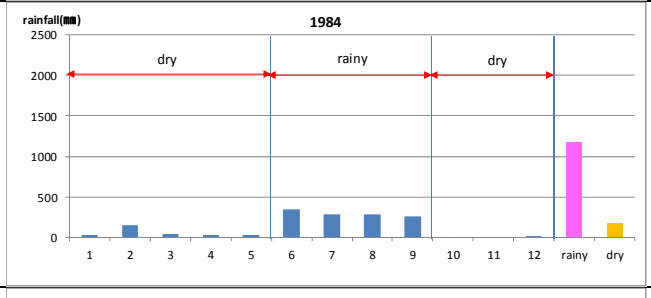
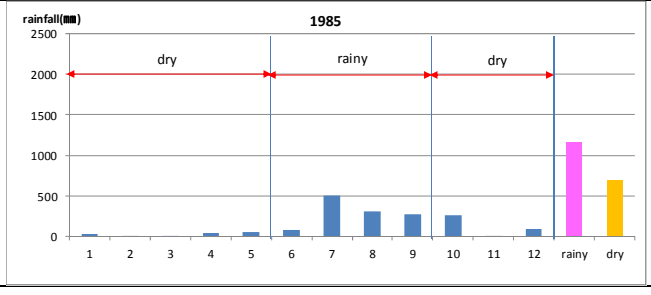
year	Monthly rainfall
1980	
1981	
1982	
1983	
1984	
1985	

Figure 3.32　Bar graph of Monthly Rainfall

【Chainpur（Bajhang）】

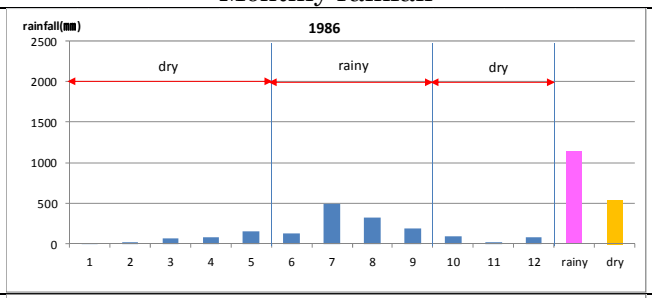
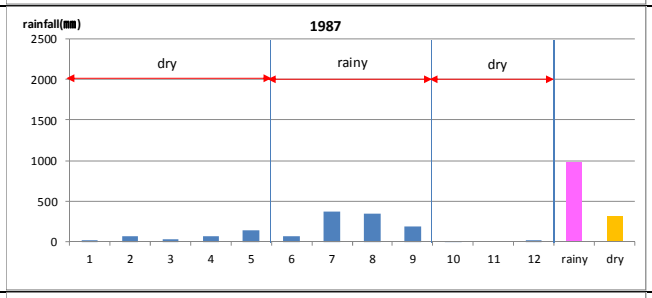
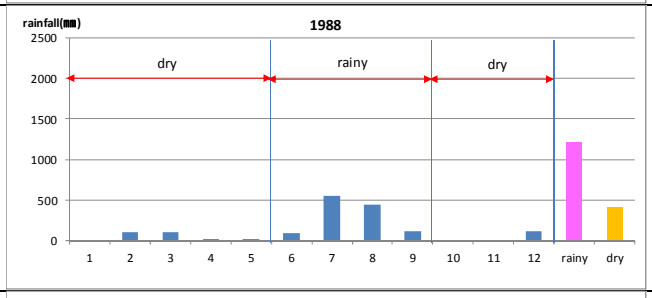
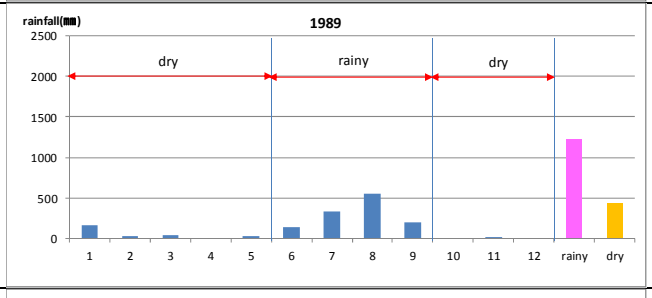
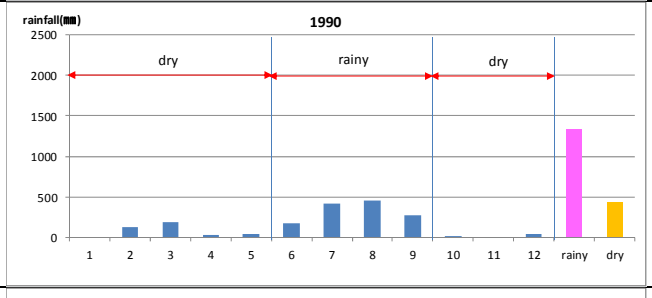
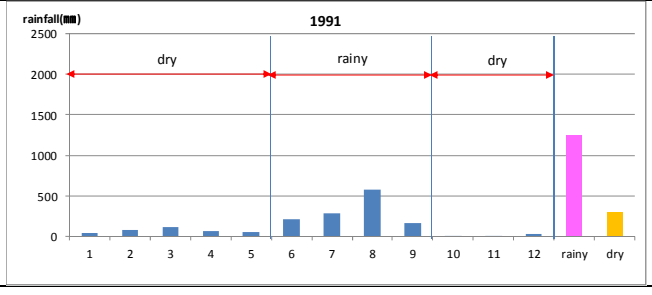
year	Monthly rainfall
1986	
1987	
1988	
1989	
1990	
1991	

Figure 3.33　Bar graph of Monthly Rainfall

【Chainpur（Bajhang）】

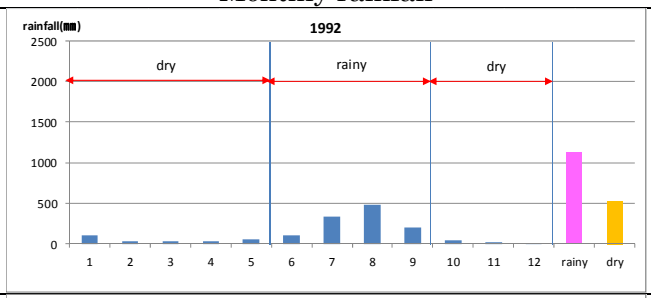
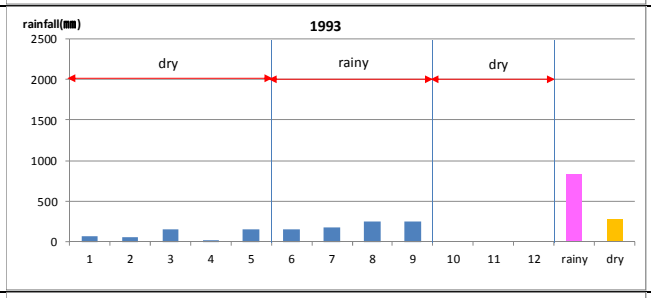
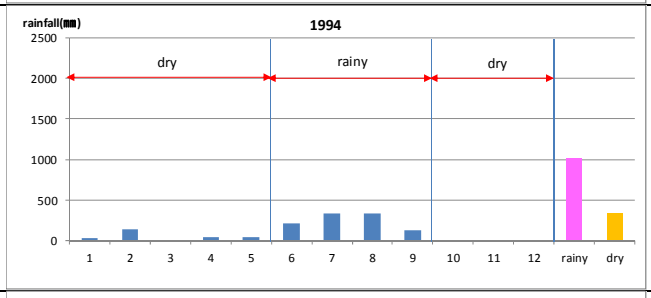
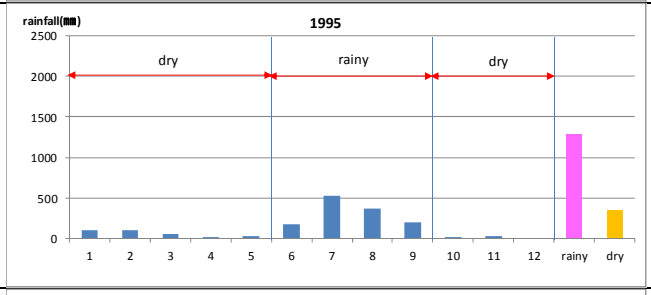
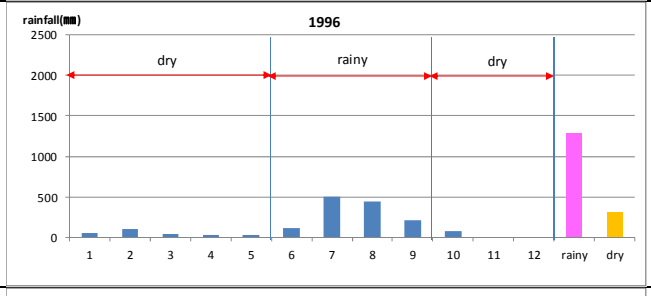
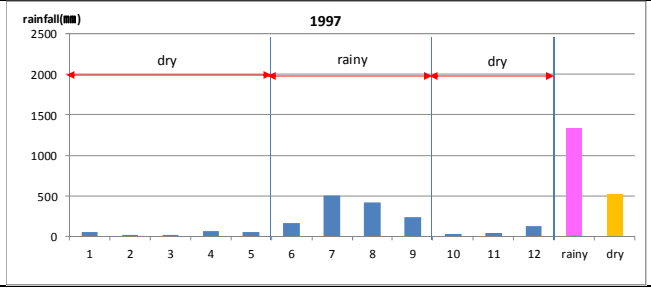
year	Monthly rainfall
1992	
1993	
1994	
1995	
1996	
1997	

Figure 3.34　Bar graph of Monthly Rainfall

【Chainpur（Bajhang）】

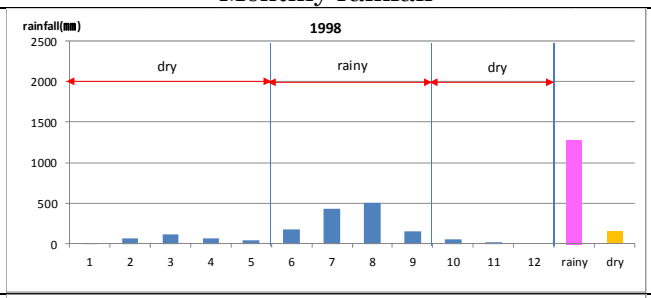
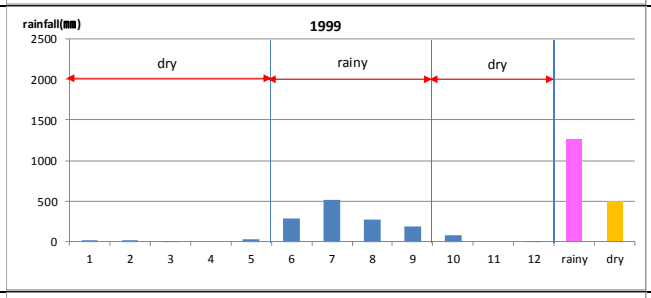
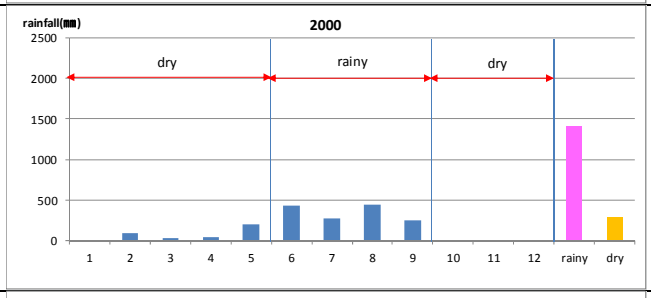
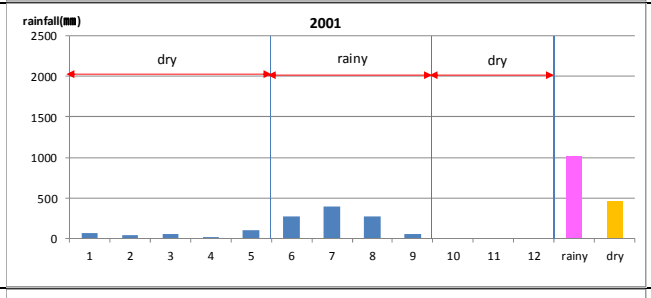
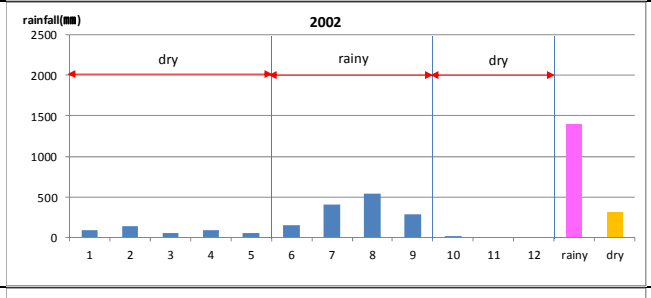
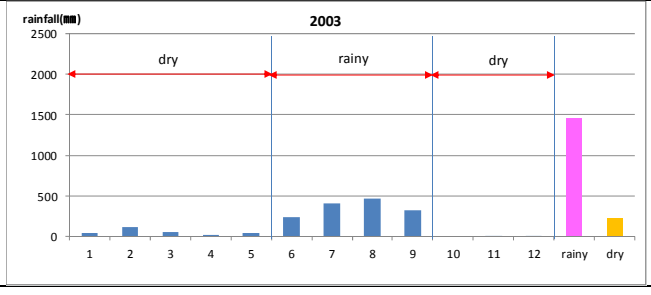
year	Monthly rainfall
1998	
1999	
2000	
2001	
2002	
2003	

Figure 3.35　Bar graph of Monthly Rainfall

【Chainpur（Bajhang）】

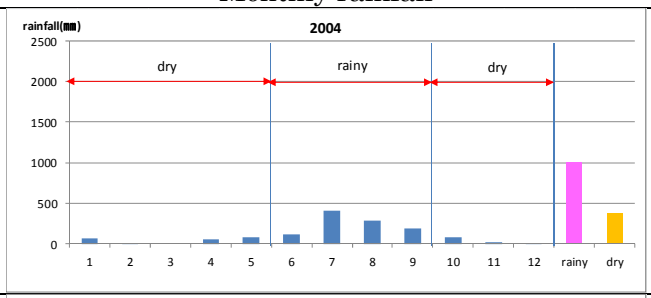
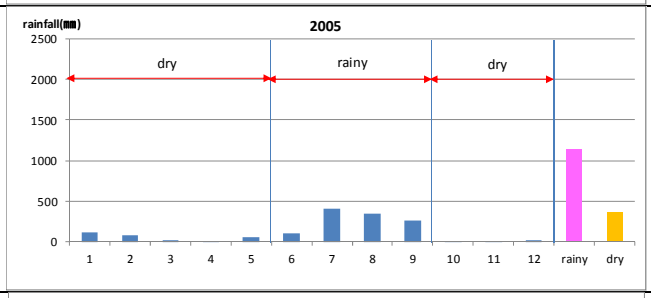
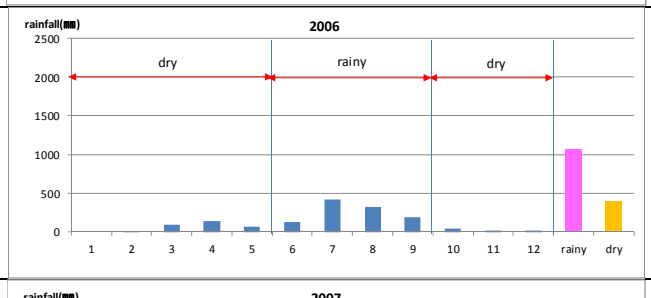
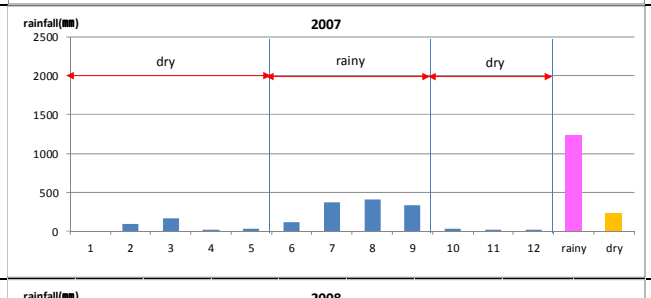
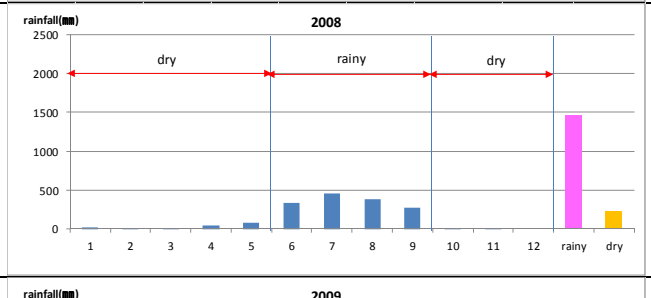
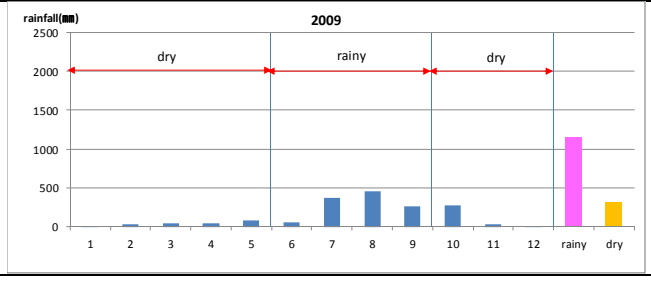
year	Monthly rainfall
2004	
2005	
2006	
2007	
2008	
2009	

Figure 3.36　Bar graph of Monthly Rainfall

【Bajura（Bajura）】

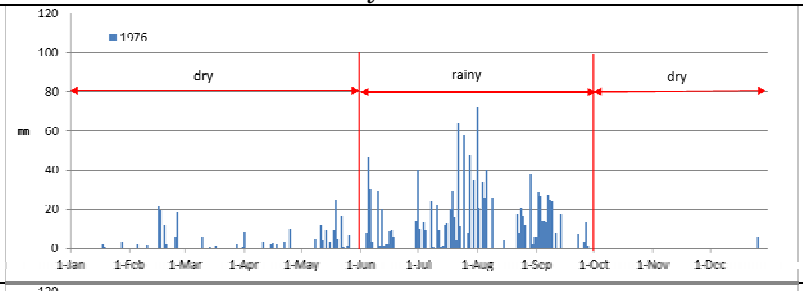
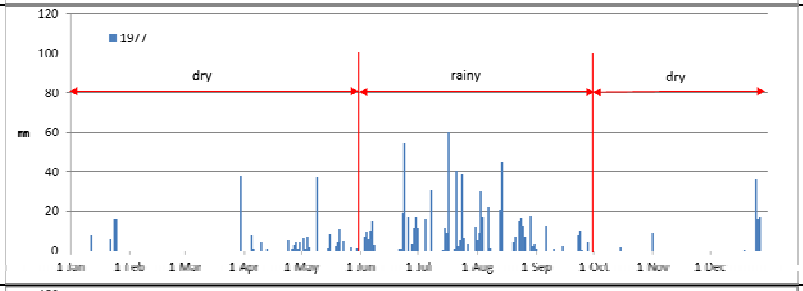
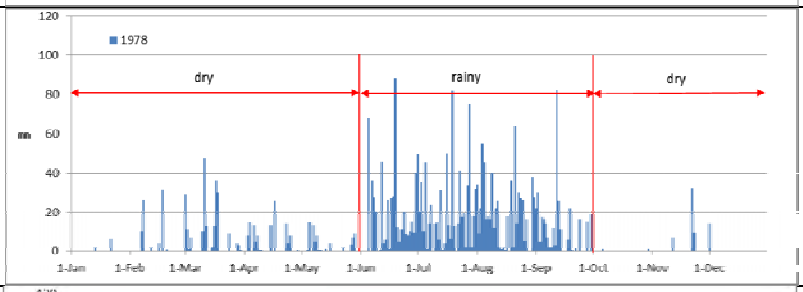
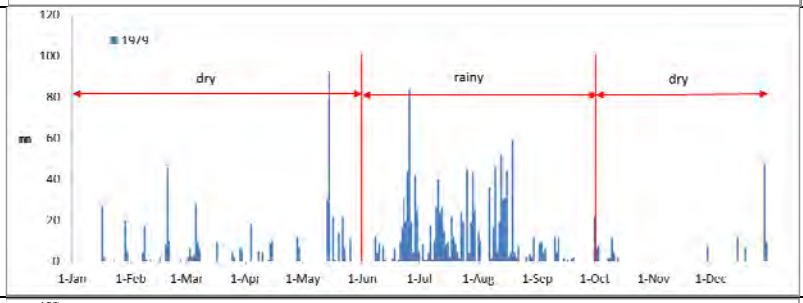
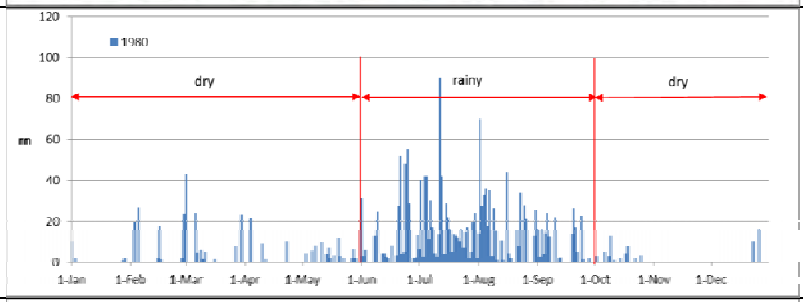
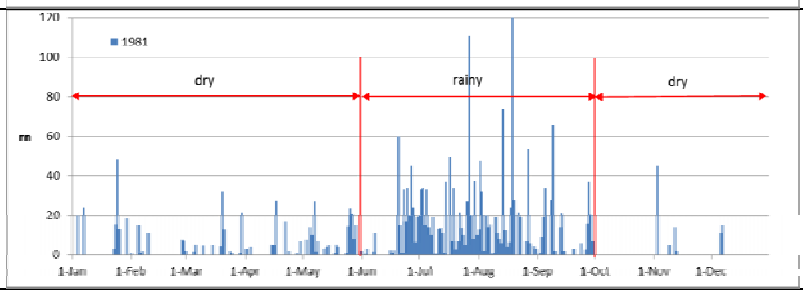
year	Daily rainfall
1976	
1977	
1978	
1979	
1980	
1981	

Figure 3.37　Bar graph of Daily Rainfall

【Bajura（Bajura）】

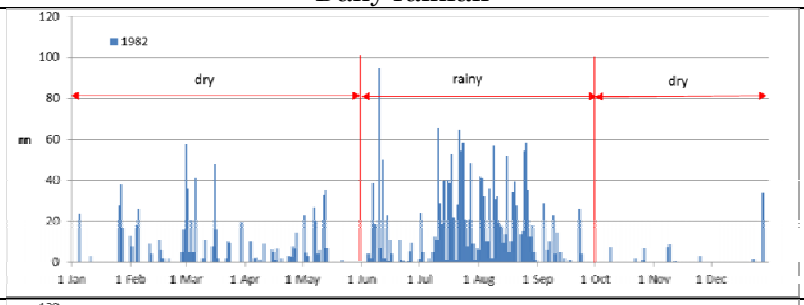
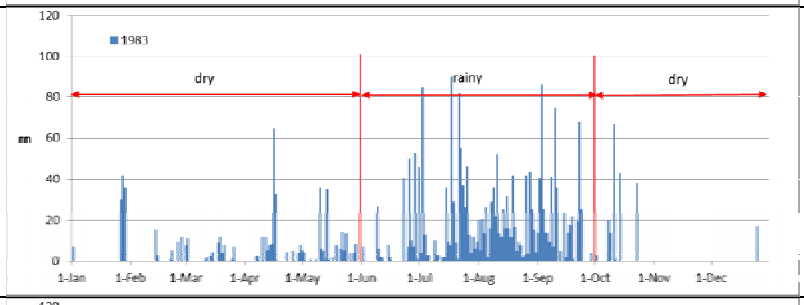
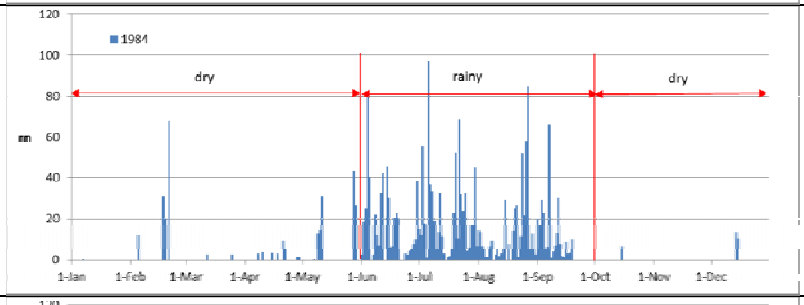
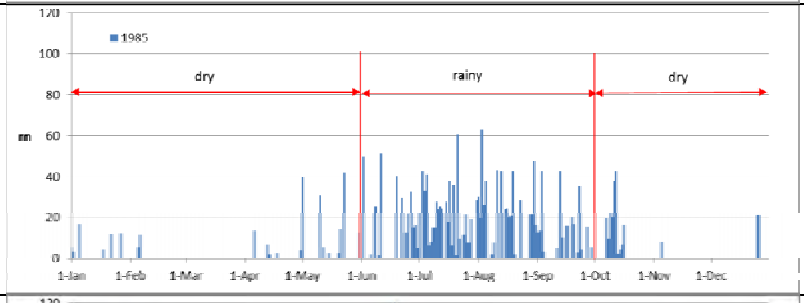
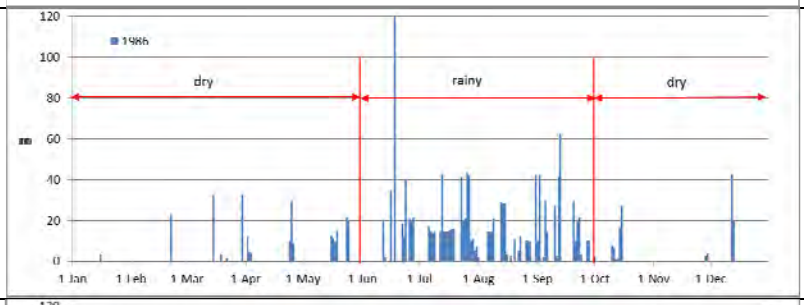
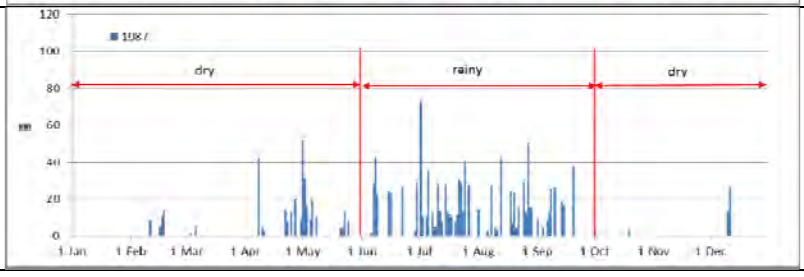
year	Daily rainfall
1982	
1983	
1984	
1985	
1986	
1987	

Figure 3.38　Bar graph of Daily Rainfall

【Bajura（Bajura）】

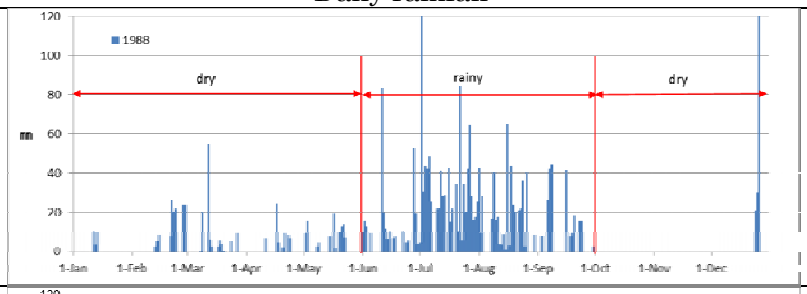
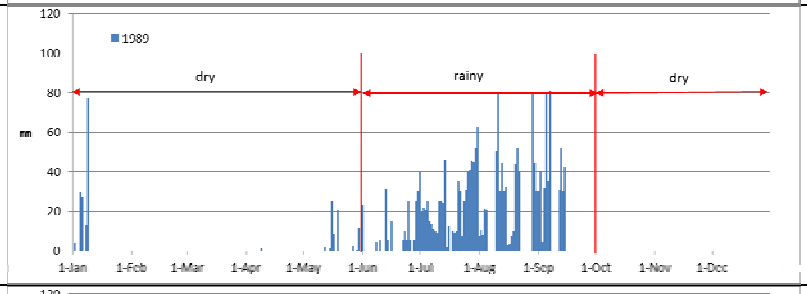
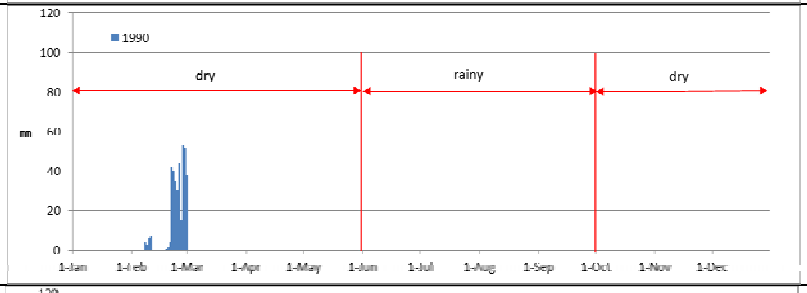
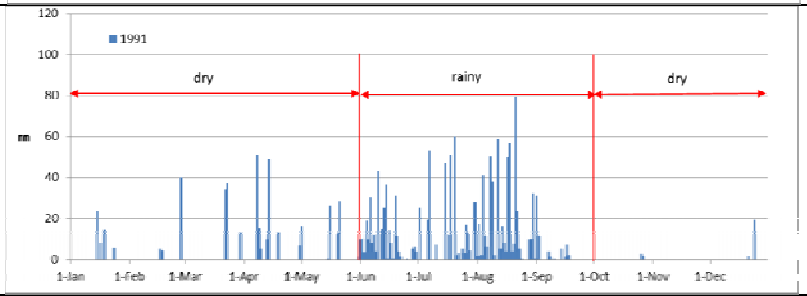
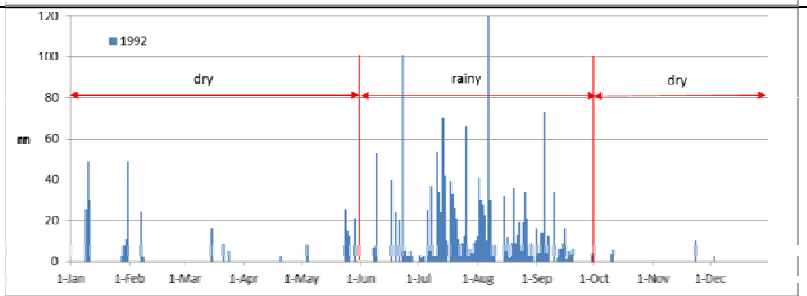
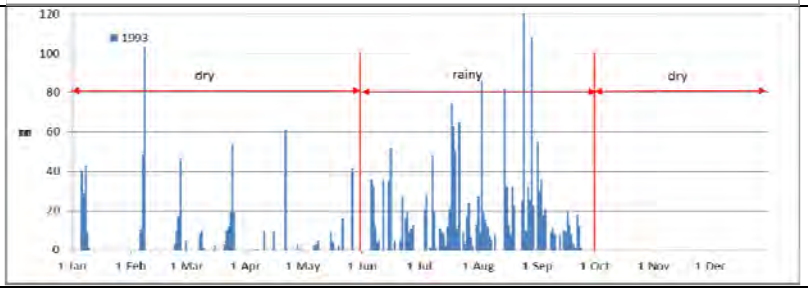
year	Daily rainfall
1988	
1989	
1990	
1991	
1992	
1993	

Figure 3.39　Bar graph of Daily Rainfall

【Bajura（Bajura）】

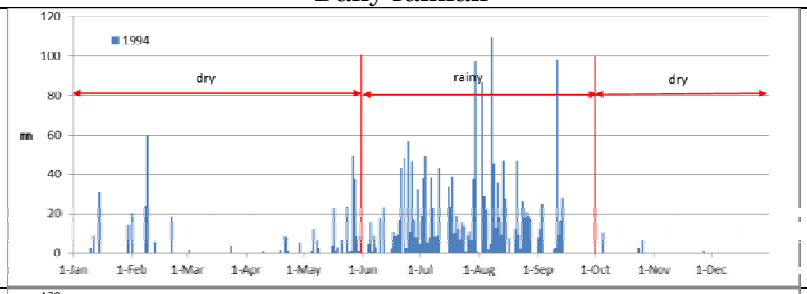
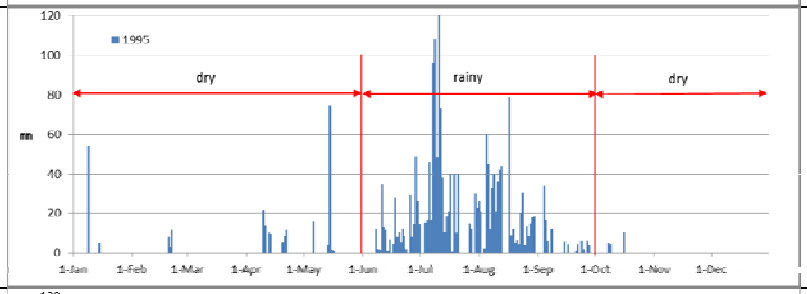
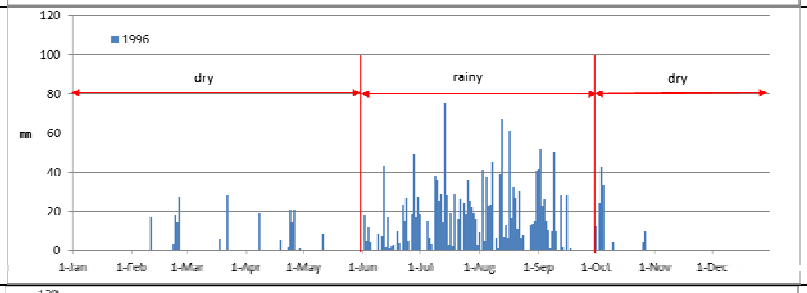
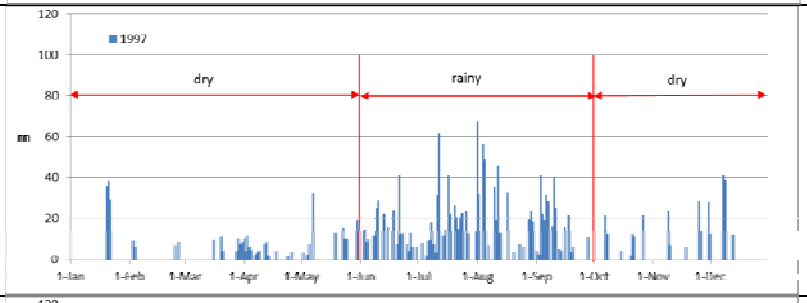
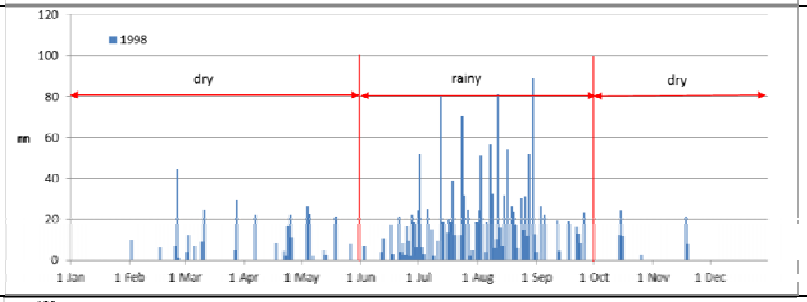
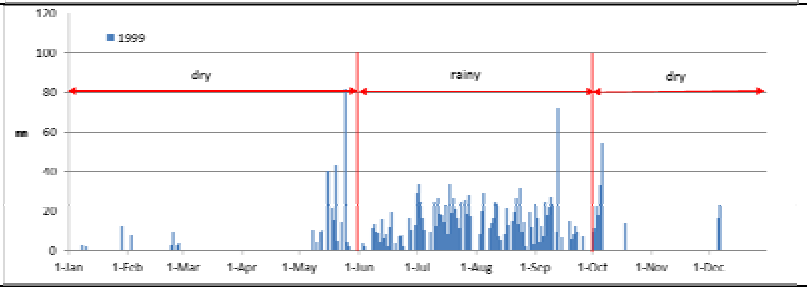
year	Daily rainfall
1994	
1995	
1996	
1997	
1998	
1999	

Figure 3.40　Bar graph of Daily Rainfall

【Bajura（Bajura）】

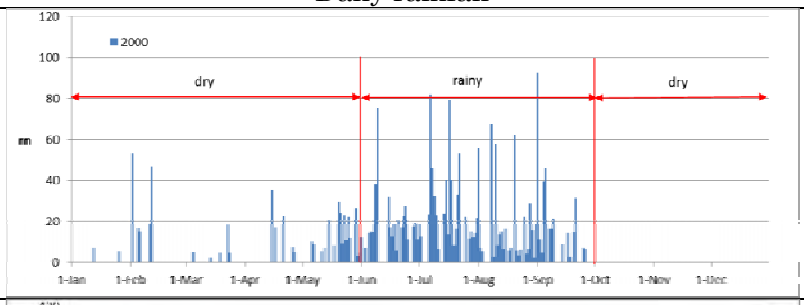
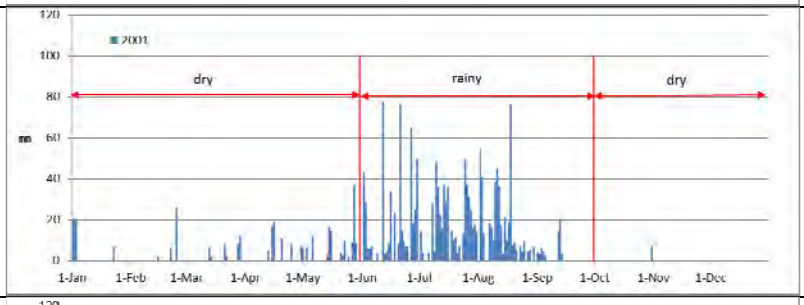
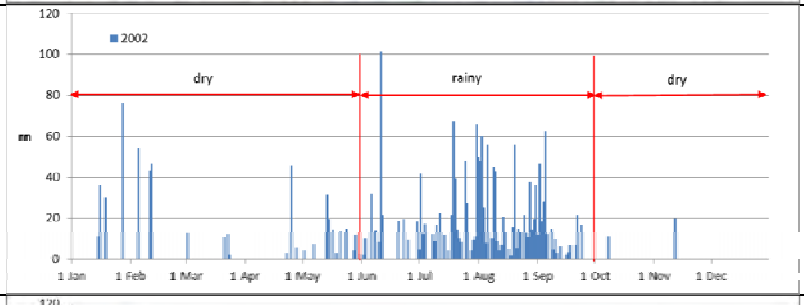
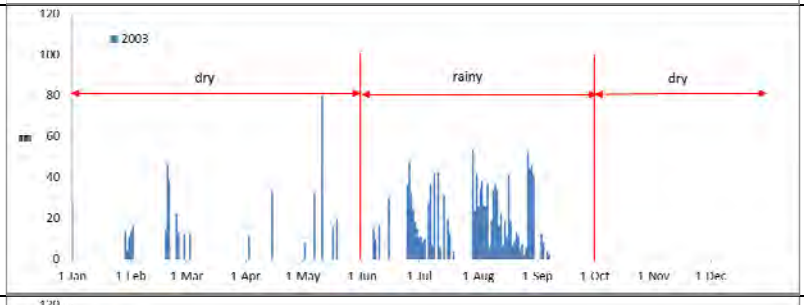
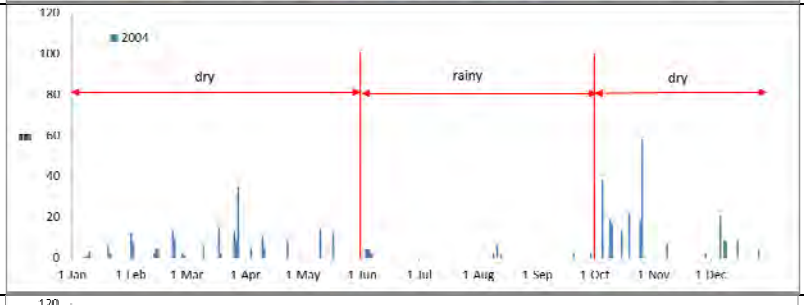
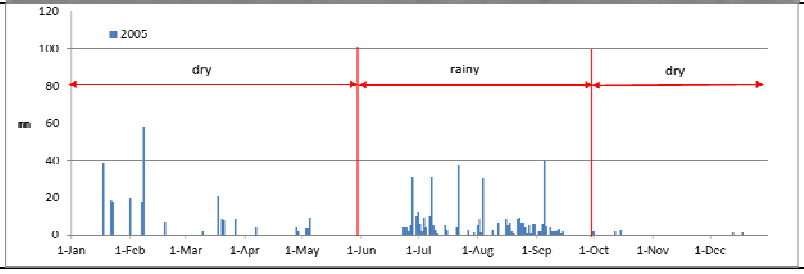
year	Daily rainfall
2000	
2001	
2002	
2003	
2004	
2005	

Figure 3.41　Bar graph of Daily Rainfall

【Bajura（Bajura）】

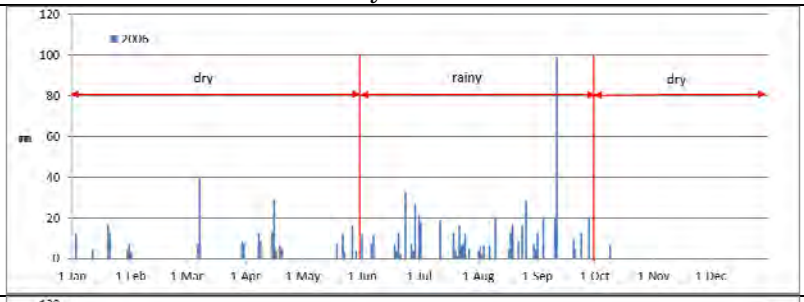
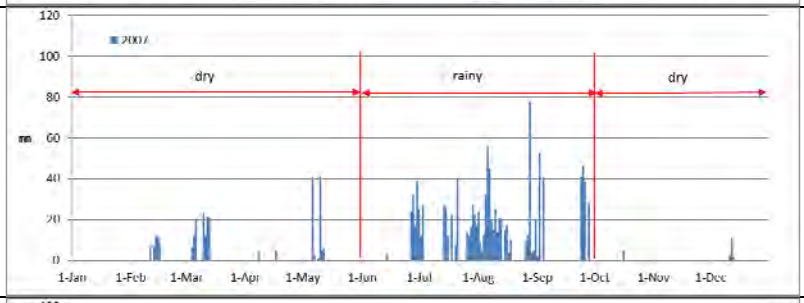
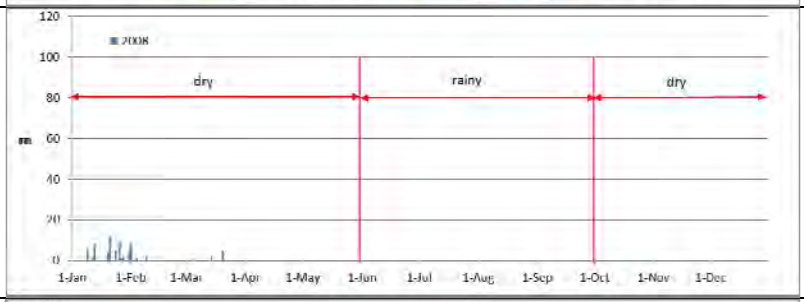
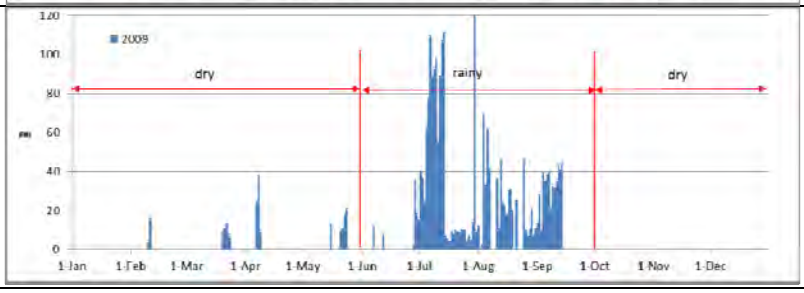
year	Daily rainfall
2006	
2007	
2008	
2009	

Figure 3.42　Bar graph of Daily Rainfall

【Bajura（Bajura）】

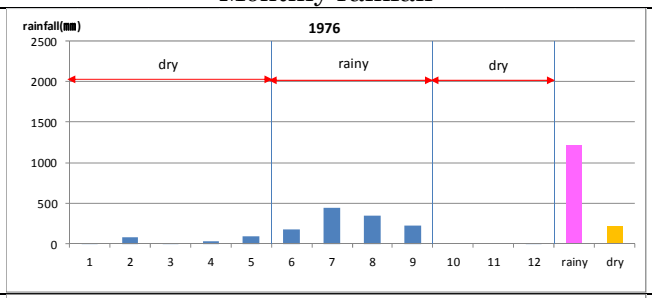
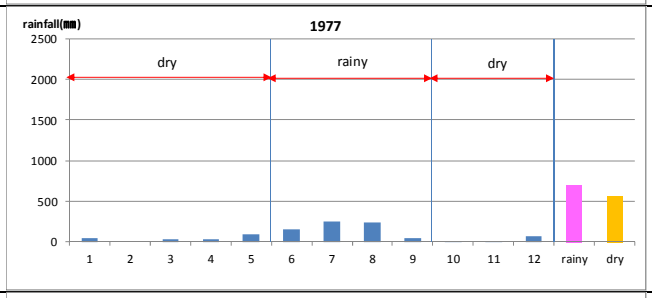
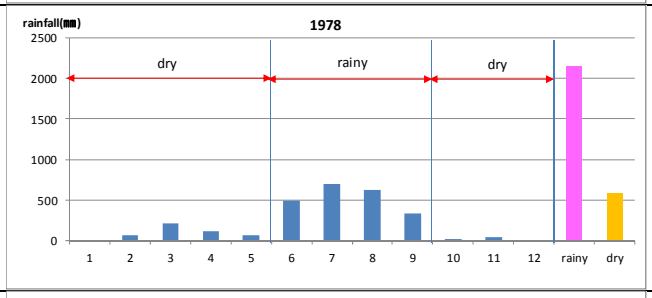
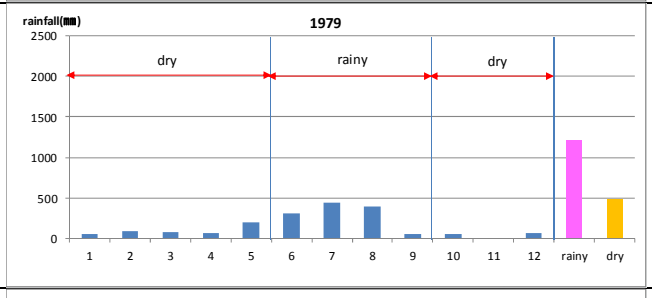
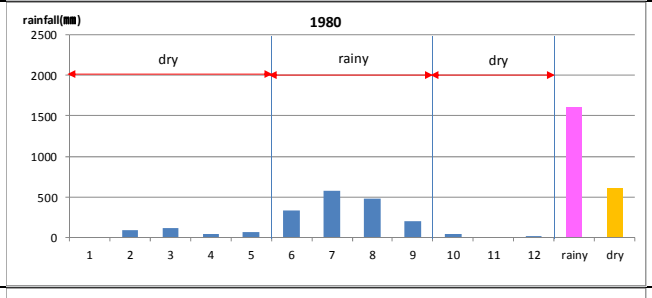
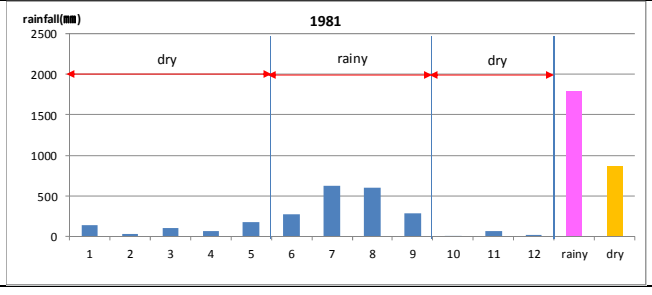
year	Monthly rainfall
1976	
1977	
1978	
1979	
1980	
1981	

Figure 3.43　Bar graph of Monthly Rainfall

【Bajura（Bajura）】

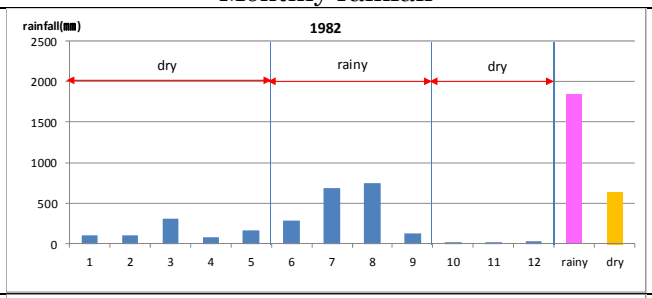
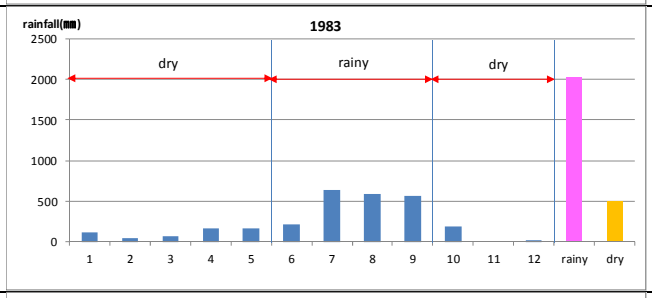
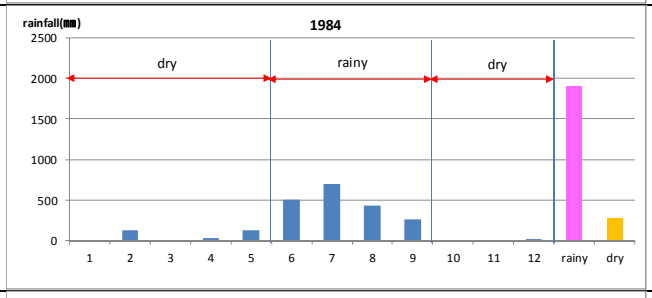
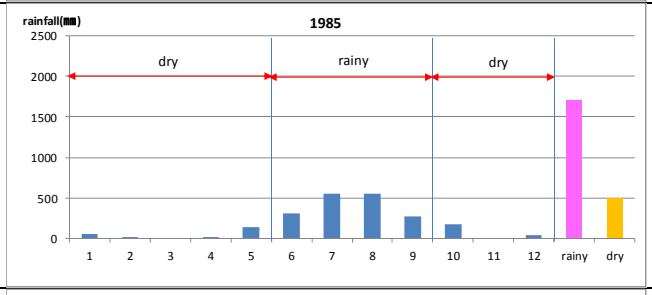
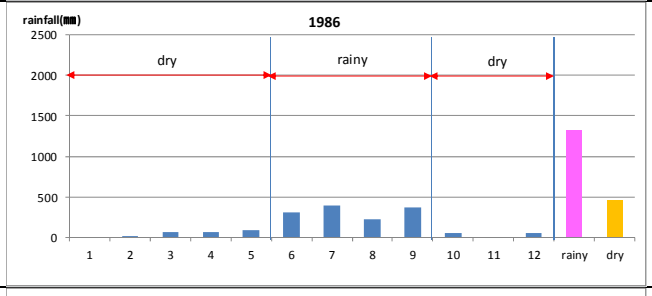
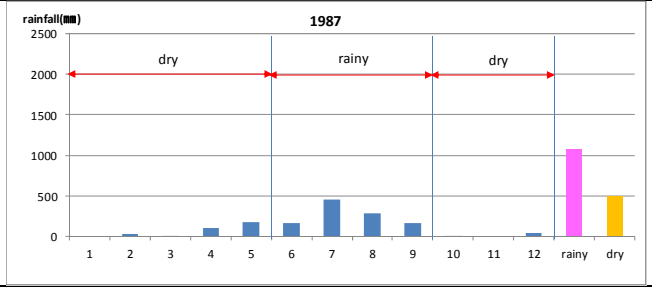
year	Monthly rainfall
1982	
1983	
1984	
1985	
1986	
1987	

Figure 3.44　Bar graph of Monthly Rainfall

【Bajura（Bajura）】

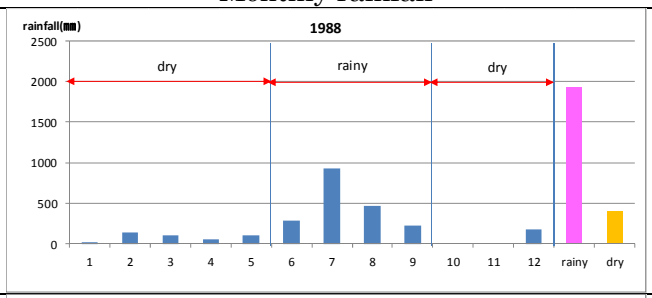
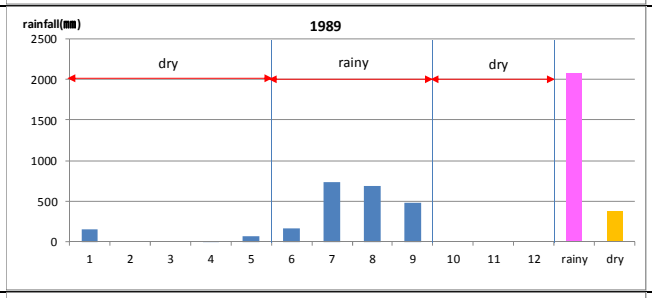
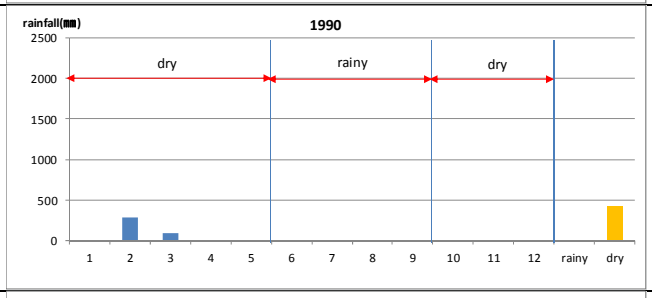
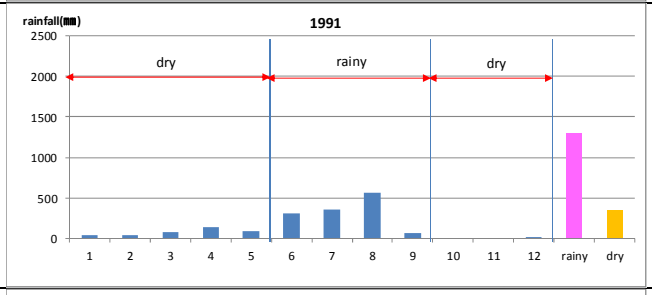
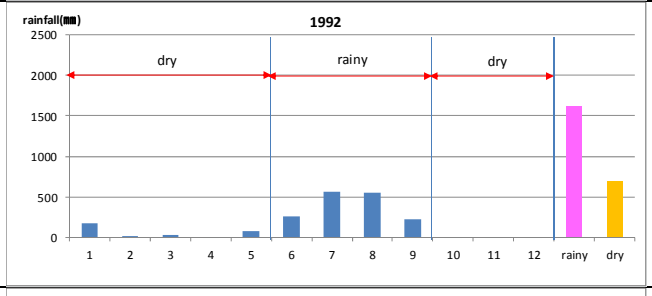
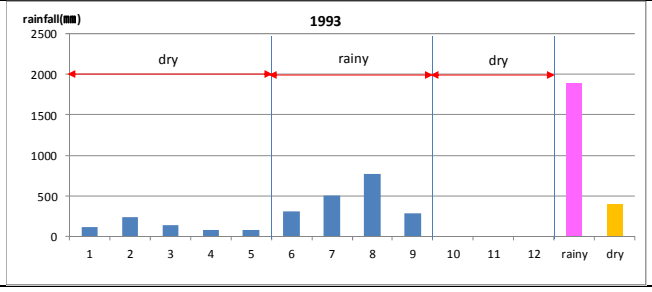
year	Monthly rainfall
1988	
1989	
1990	
1991	
1992	
1993	

Figure 3.45　Bar graph of Monthly Rainfall

【Bajura（Bajura）】

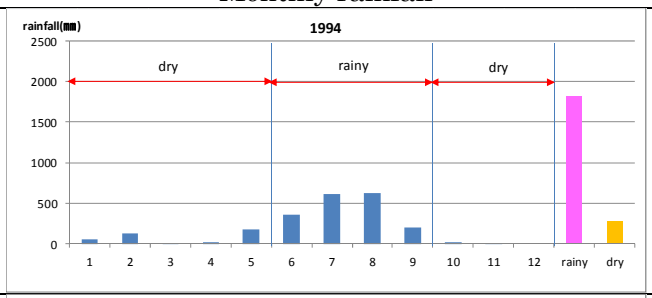
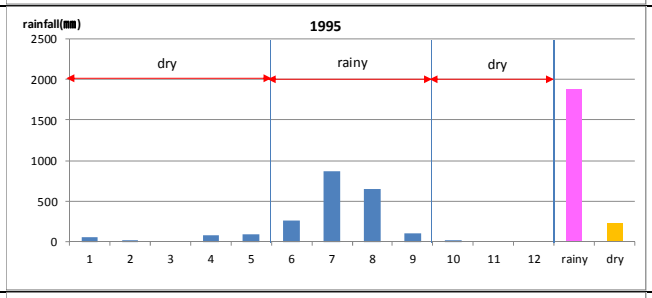
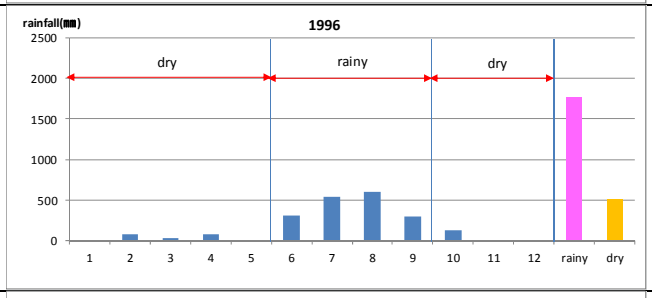
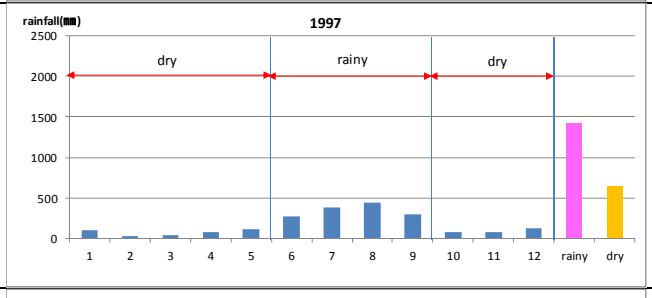
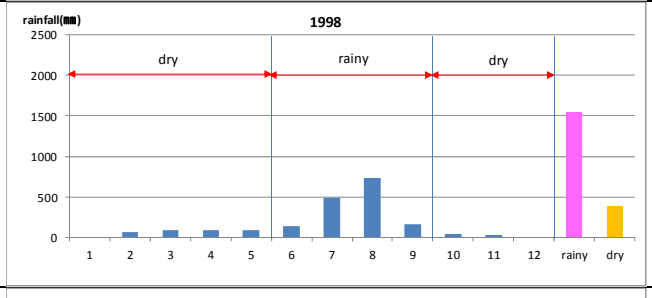
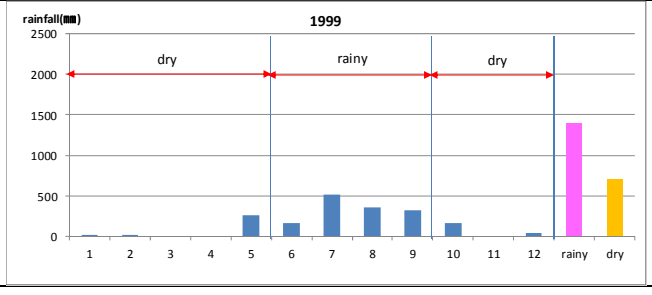
year	Monthly rainfall
1994	
1995	
1996	
1997	
1998	
1999	

Figure 3.46　Bar graph of Monthly Rainfall

【Bajura（Bajura）】

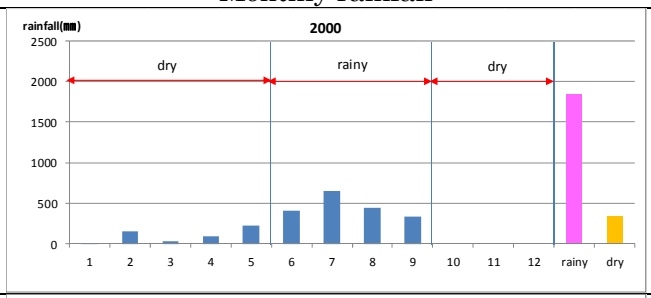
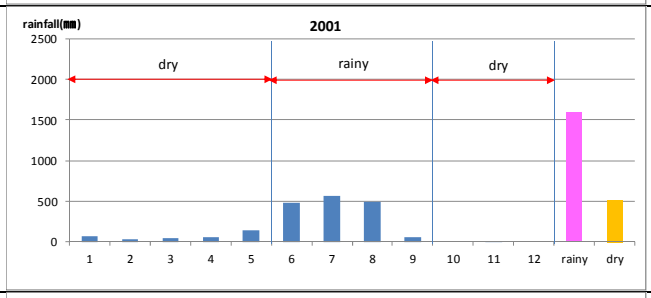
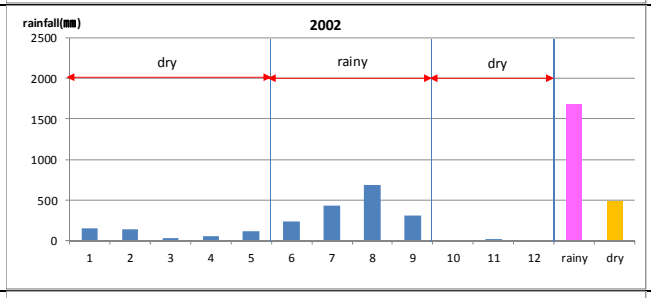
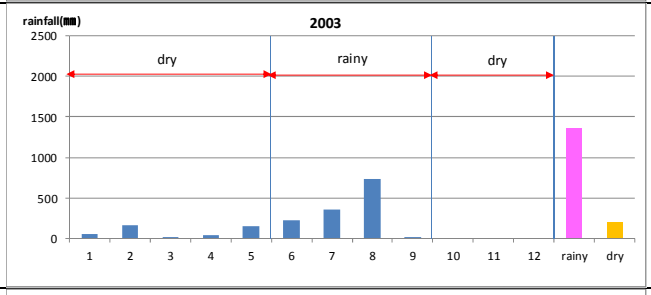
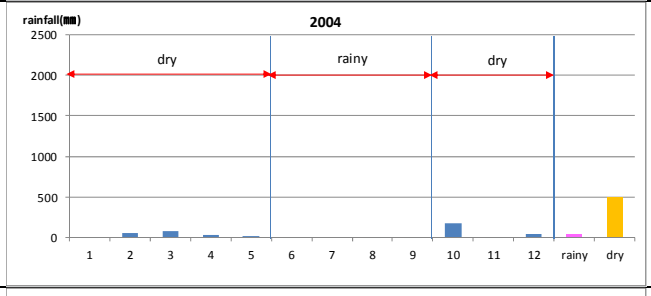
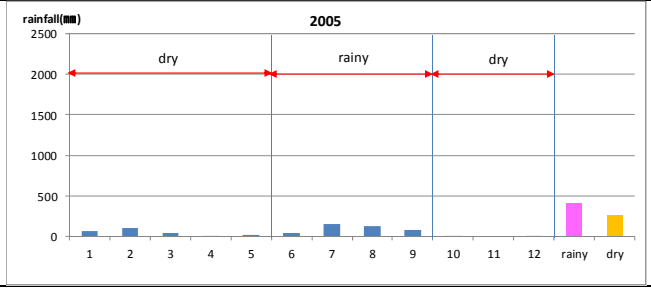
year	Monthly rainfall
2000	
2001	
2002	
2003	
2004	
2005	

Figure 3.47　Bar graph of Monthly Rainfall

【Bajura（Bajura）】

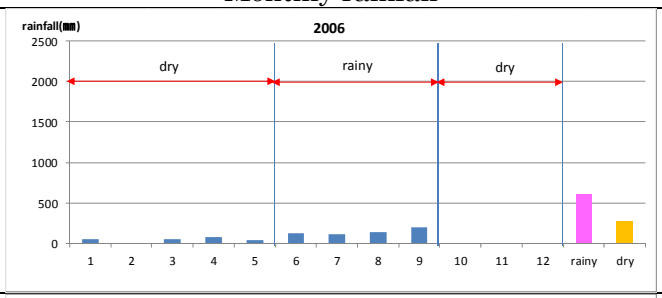
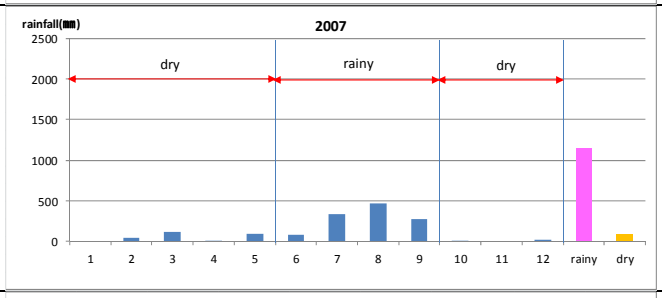
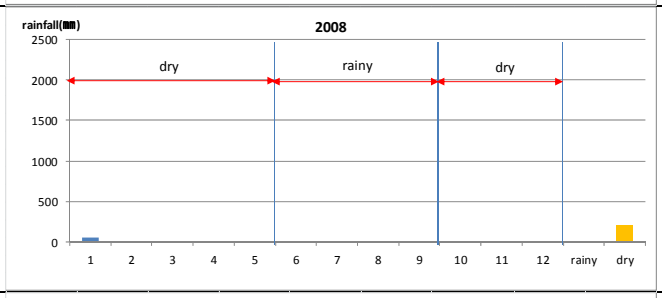
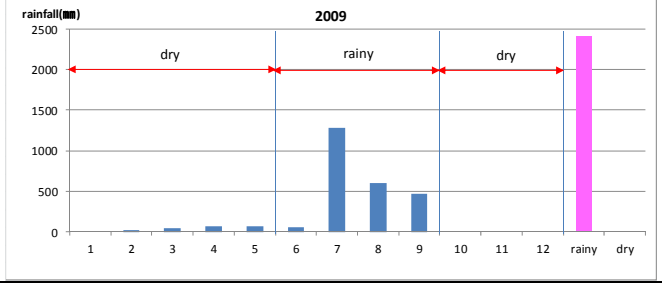
year	Monthly rainfall
2006	
2007	
2008	
2009	

Figure 3.48　Bar graph of Monthly Rainfall

【Musikot（Syarpudaha）】

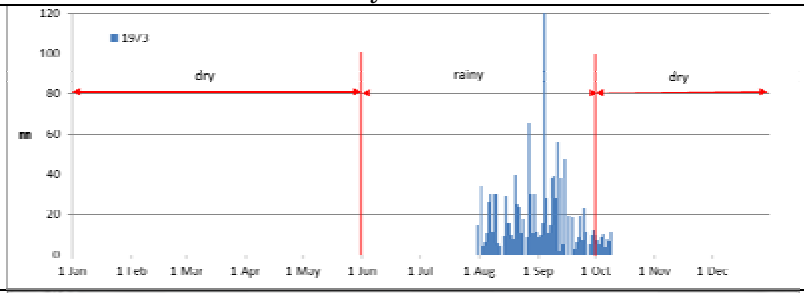
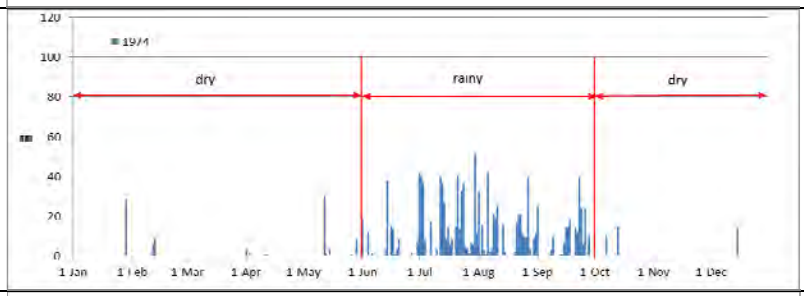
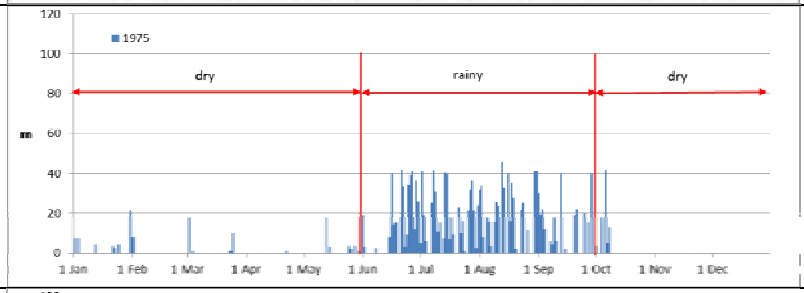
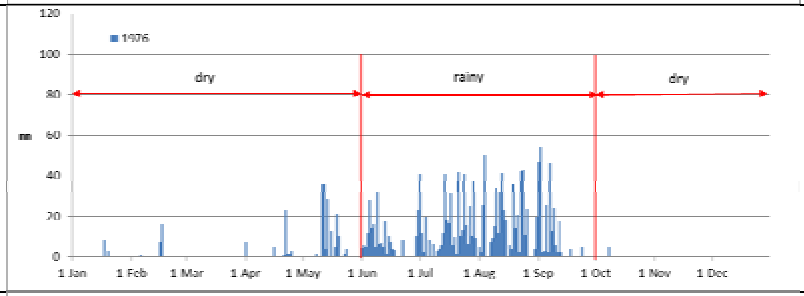
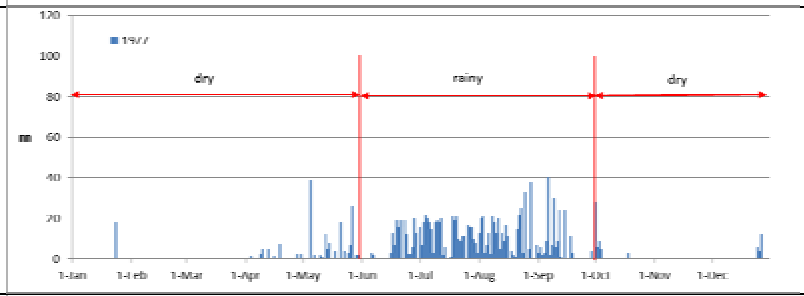
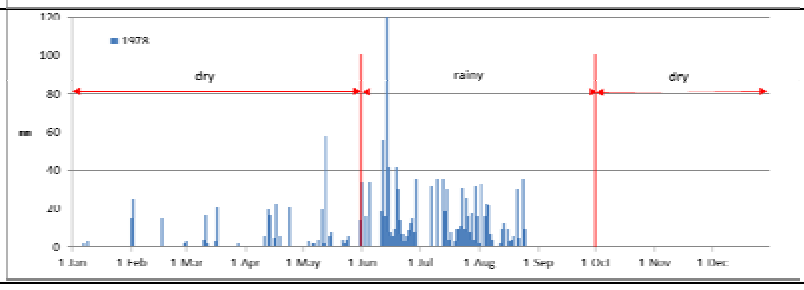
year	Daily rainfall
1973	
1974	
1975	
1976	
1977	
1978	

Figure 3.49　Bar graph of Daily Rainfall

【Musikot（Syarpudaha）】

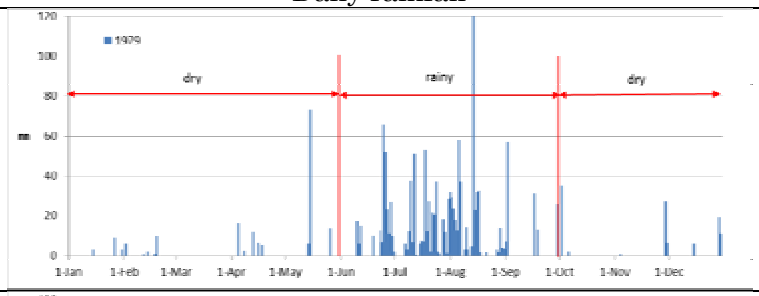
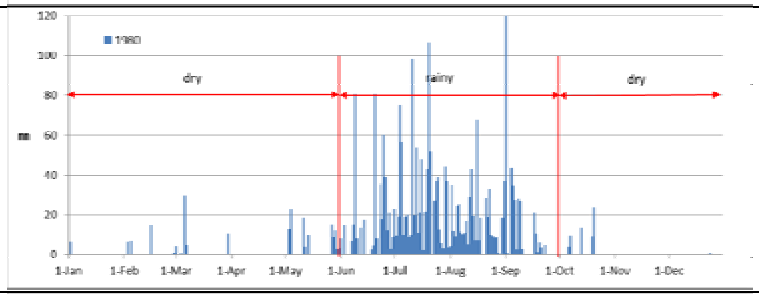
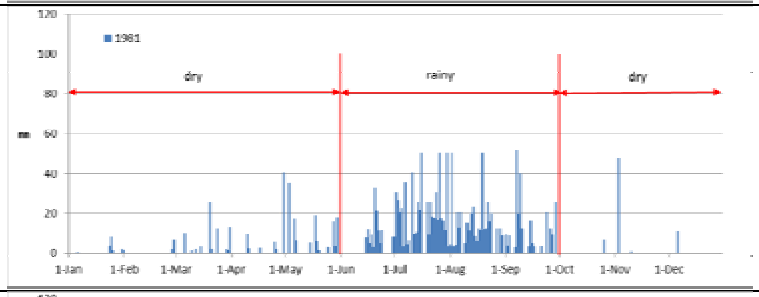
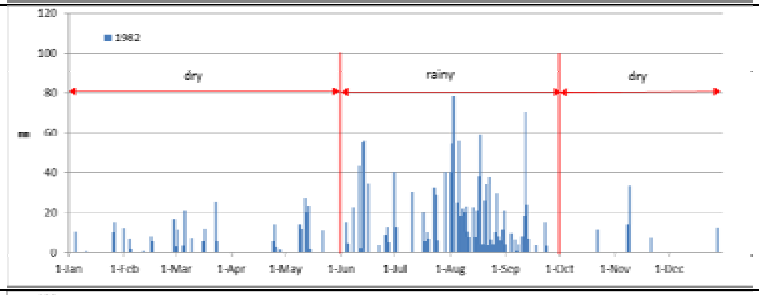
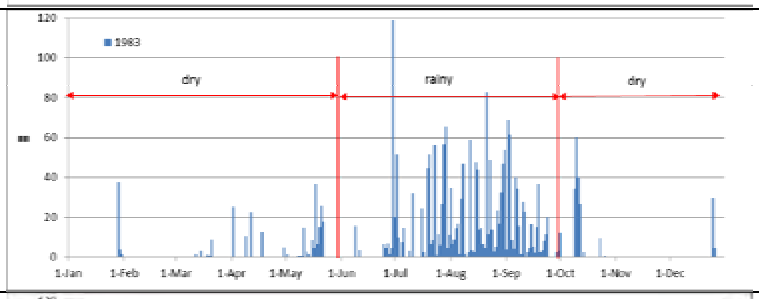
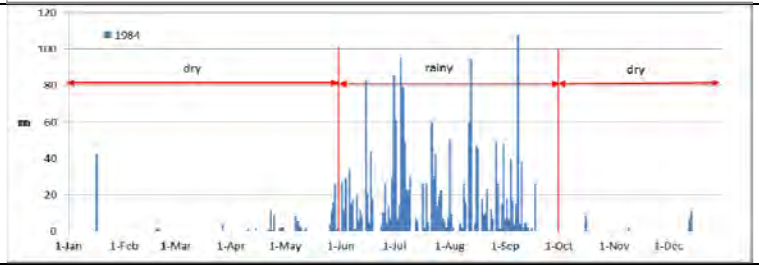
year	Daily rainfall
1979	
1980	
1981	
1982	
1983	
1984	

Figure 3.50　Bar graph of Daily Rainfall

【Musikot（Syarpudaha）】

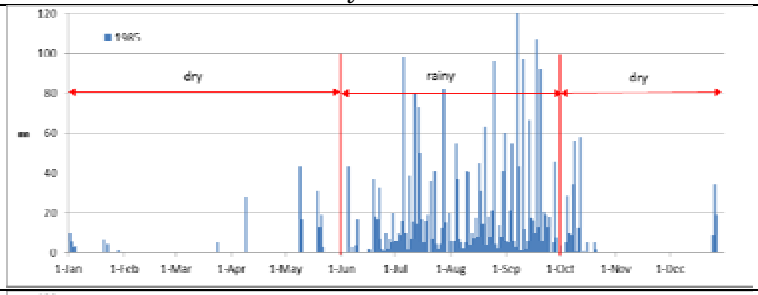
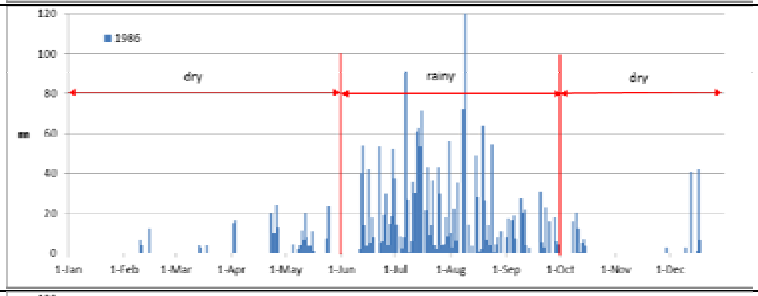
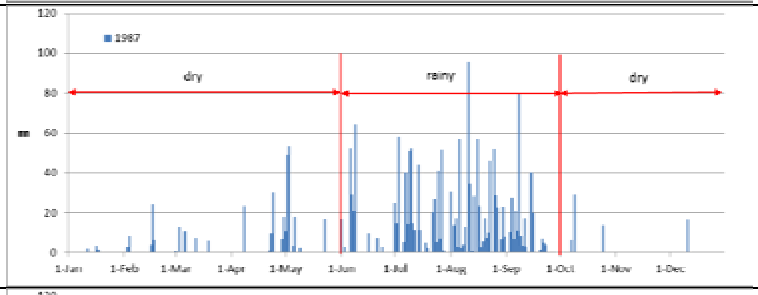
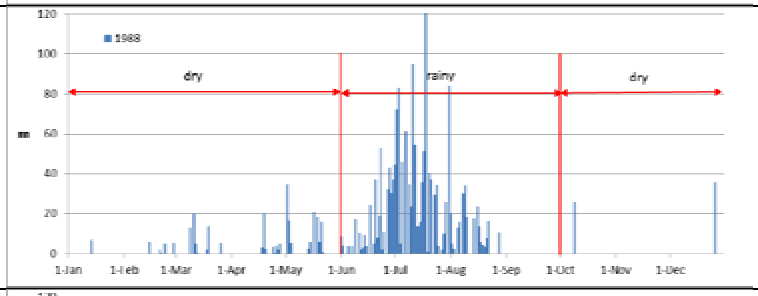
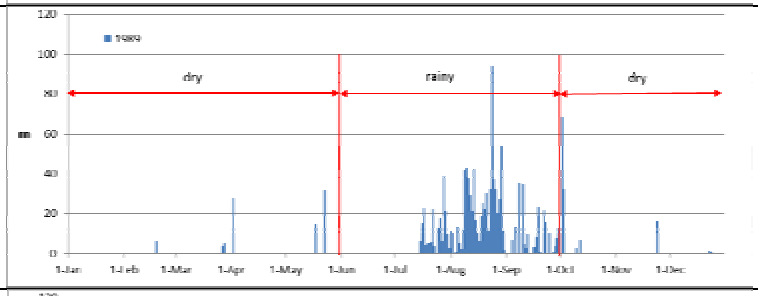
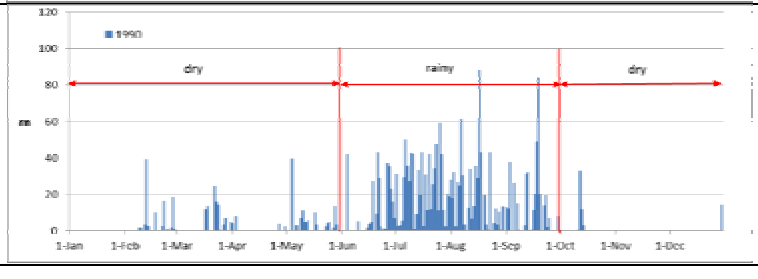
year	Daily rainfall
1985	
1986	
1987	
1988	
1989	
1990	

Figure 3.51　Bar graph of Daily Rainfall

【Musikot（Syarpudaha）】

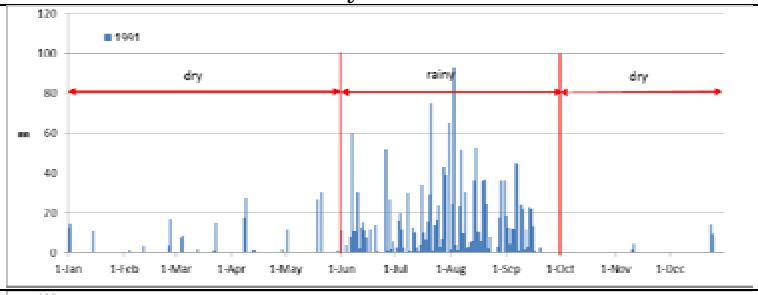
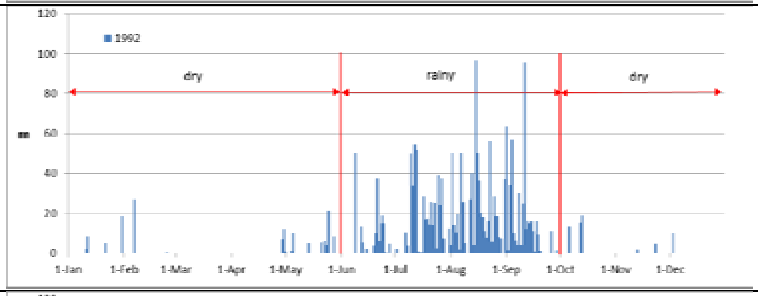
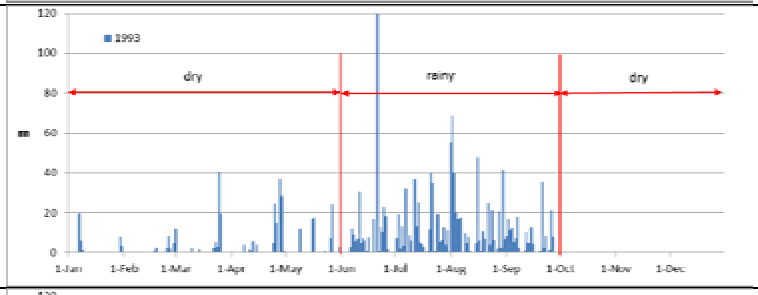
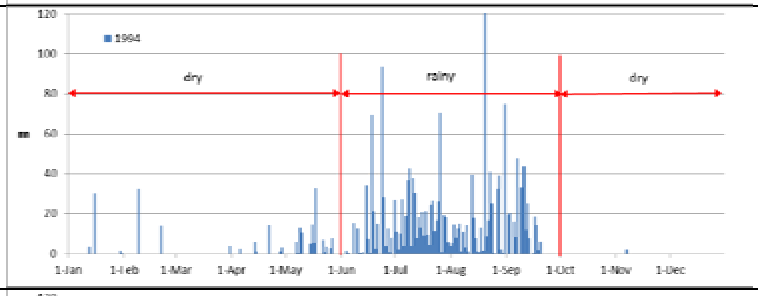
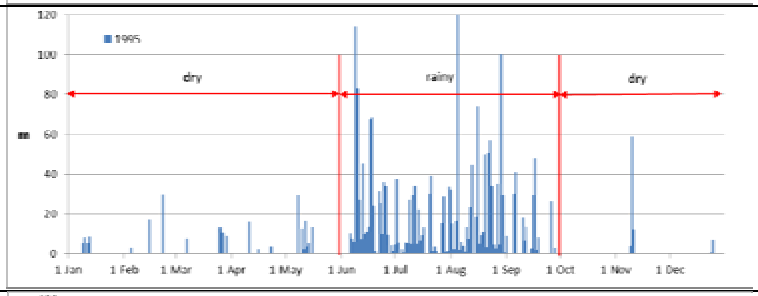
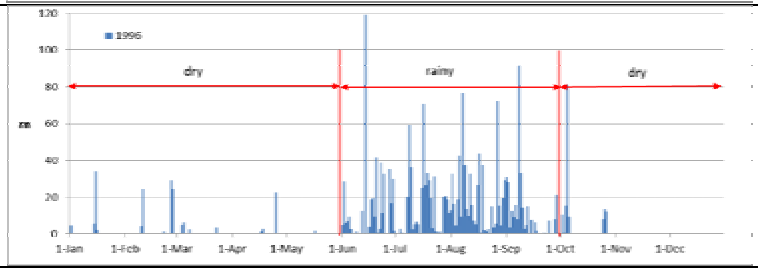
year	Daily rainfall
1991	
1992	
1993	
1994	
1995	
1996	

Figure 3.52　Bar graph of Daily Rainfall

【Musikot（Syarpudaha）】

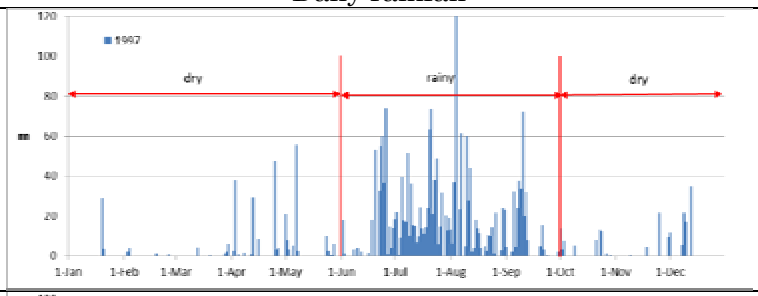
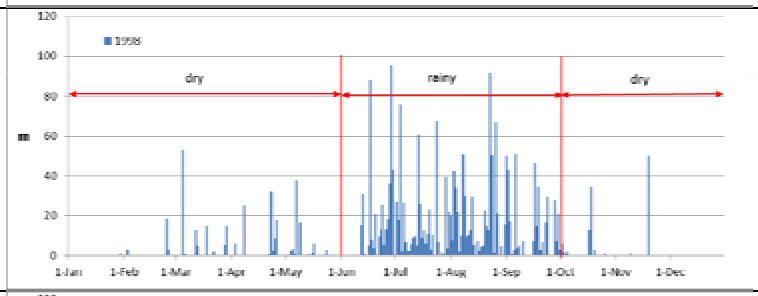
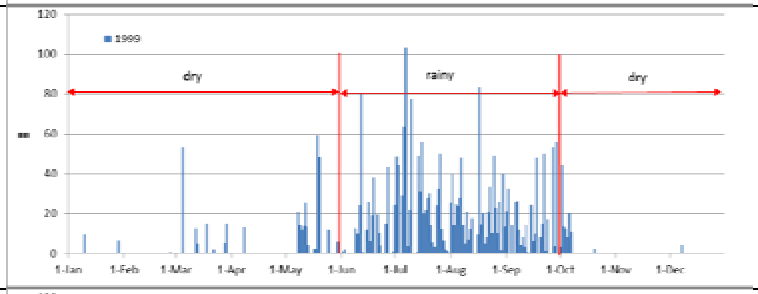
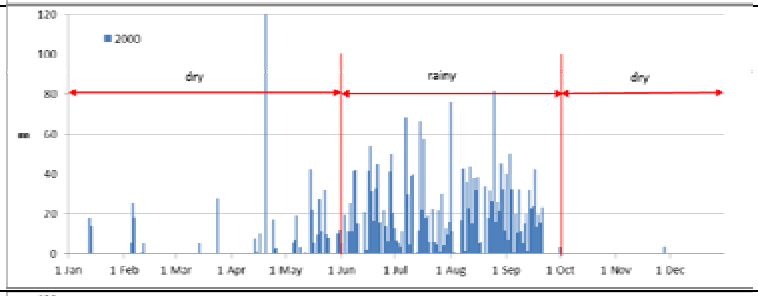
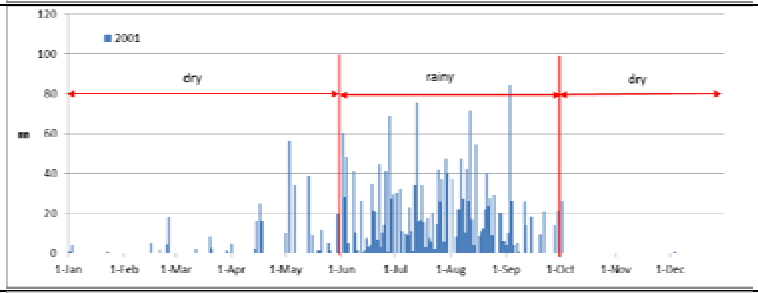
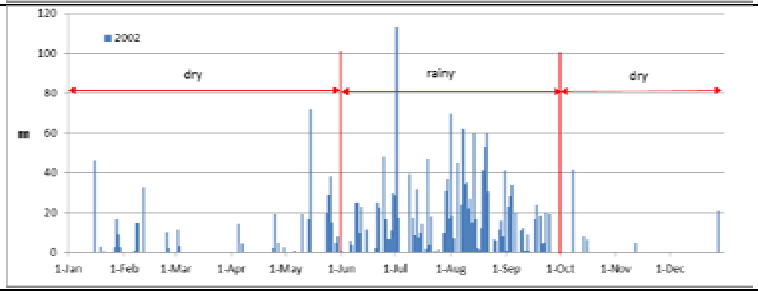
year	Daily rainfall
1997	
1998	
1999	
2000	
2001	
2002	

Figure 3.53　Bar graph of Daily Rainfall

【Musikot（Syarpudaha）】

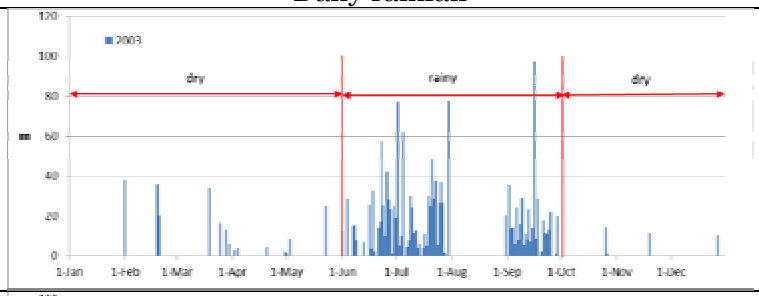
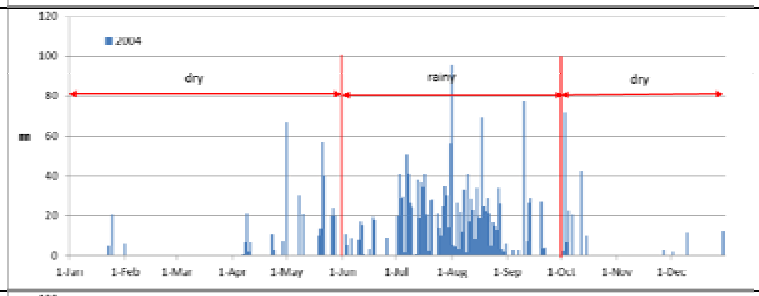
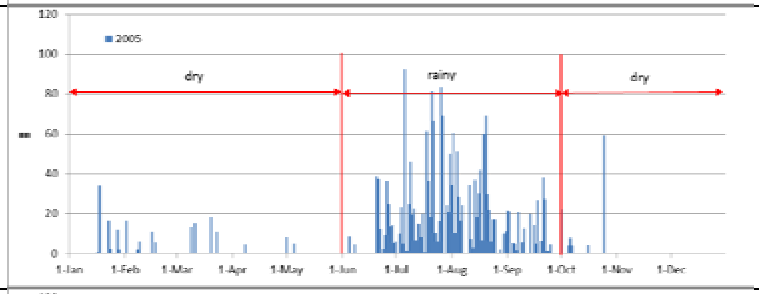
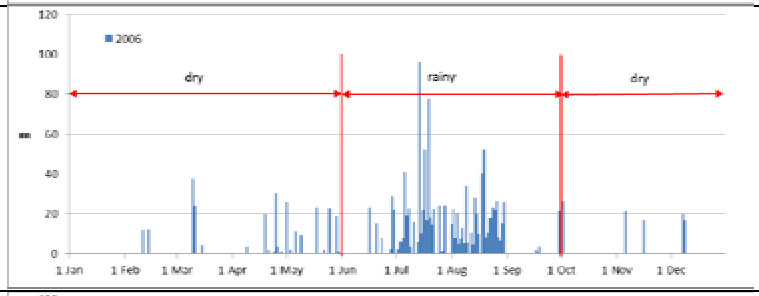
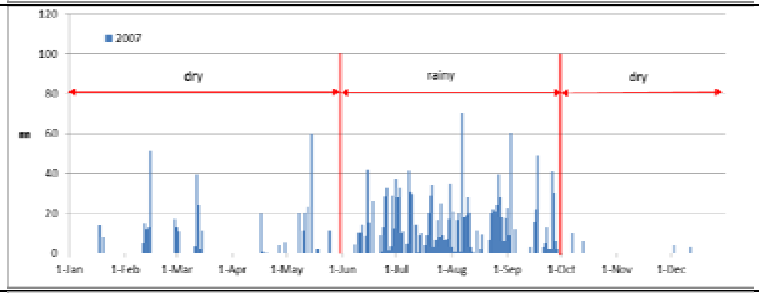
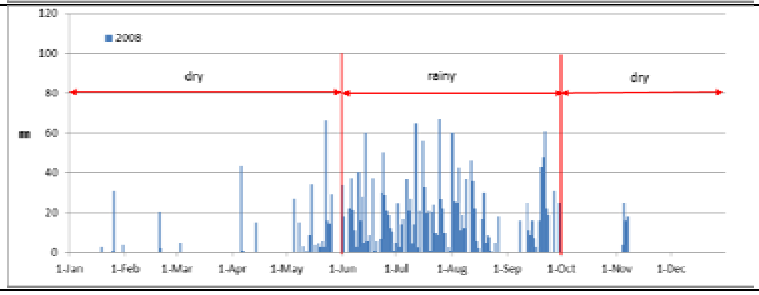
year	Daily rainfall
2003	
2004	
2005	
2006	
2007	
2008	

Figure 3.54　Bar graph of Daily Rainfall

【Musikot（Syarpudaha）】

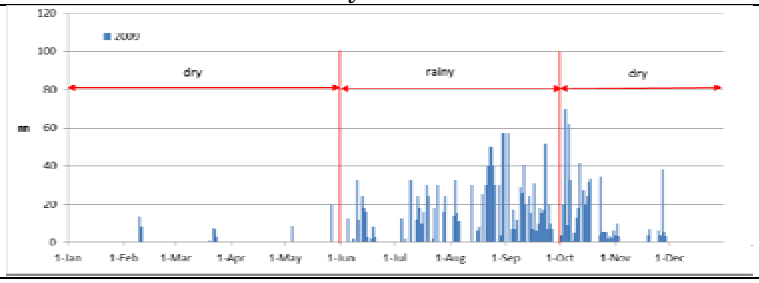
year	Daily rainfall
2009	

Figure 3.55　Bar graph of Daily Rainfall

【Musikot（Syarpudaha）】

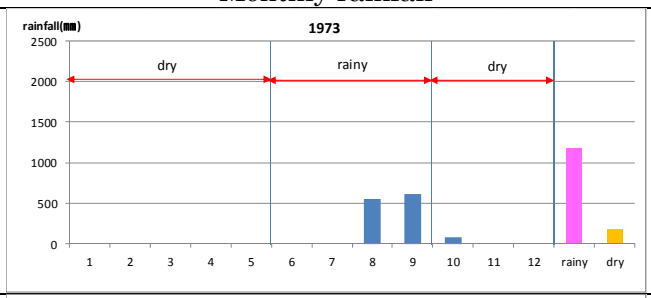
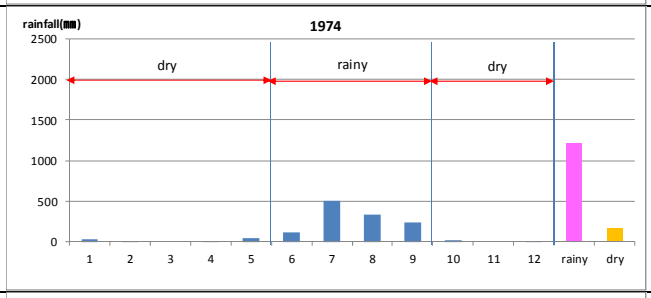
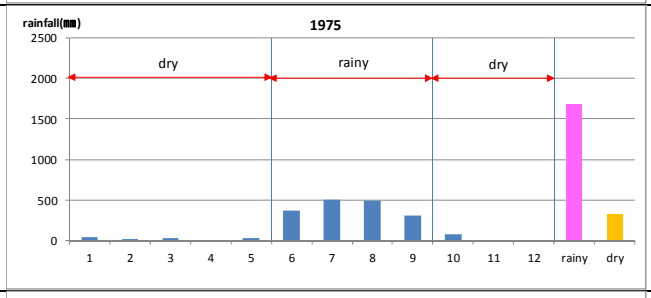
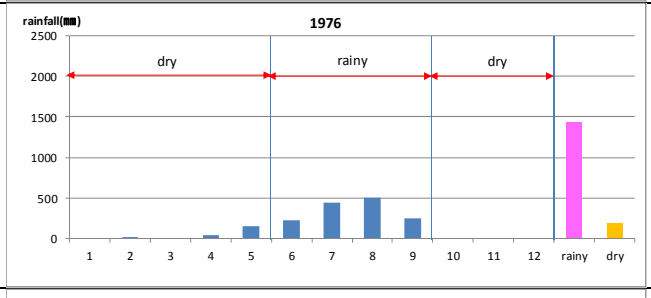
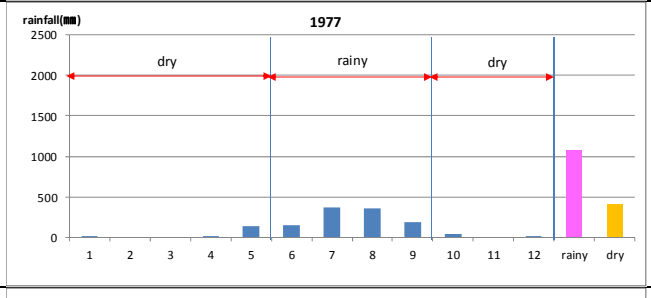
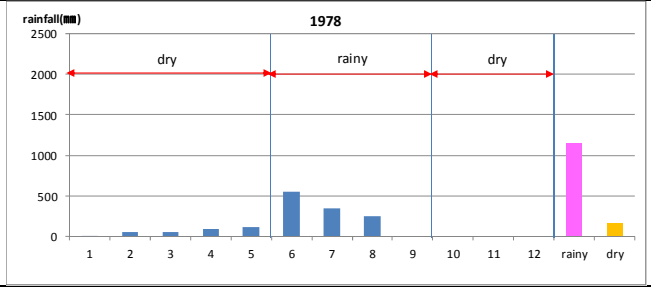
year	Monthly rainfall
1973	
1974	
1975	
1976	
1977	
1978	

Figure 3.56　Bar graph of Monthly Rainfall

【Musikot（Syarpudaha）】

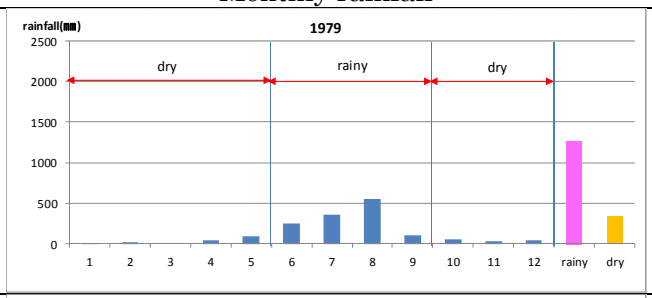
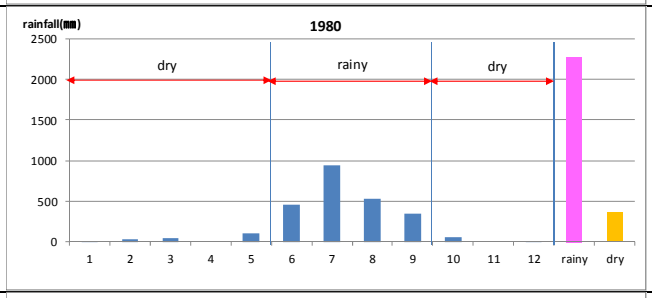
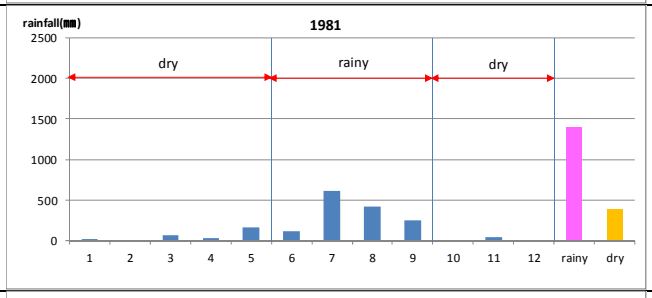
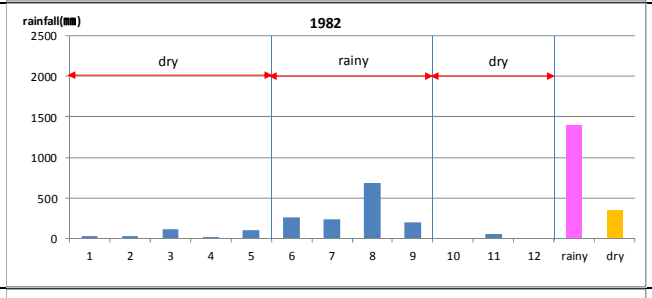
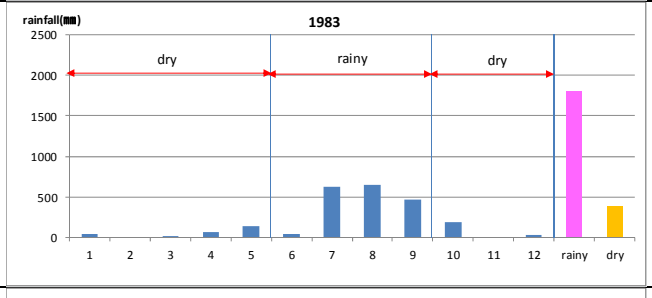
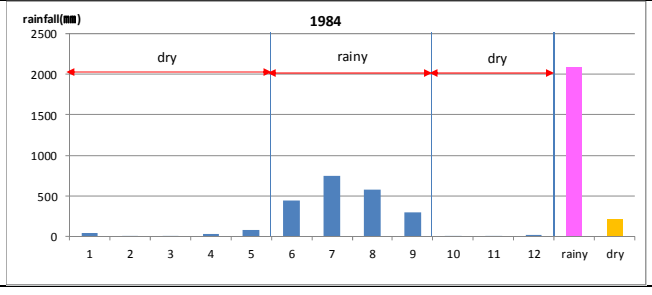
year	Monthly rainfall
1979	
1980	
1981	
1982	
1983	
1984	

Figure 3.57　Bar graph of Monthly Rainfall

【Musikot（Syarpudaha）】

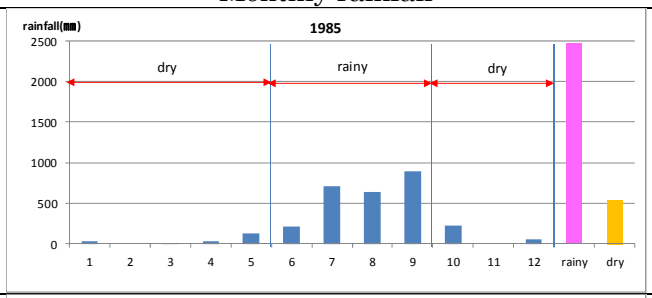
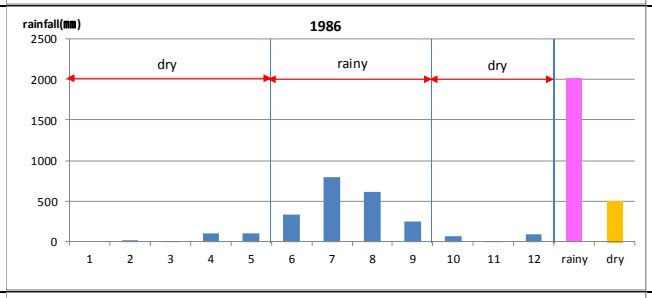
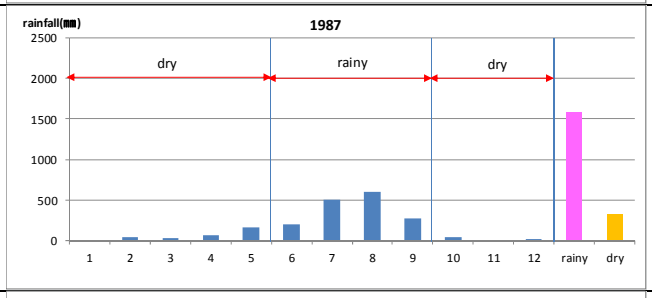
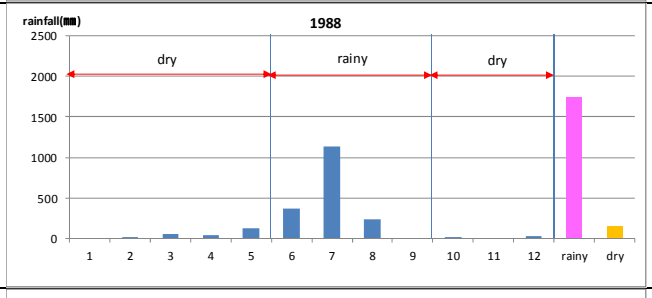
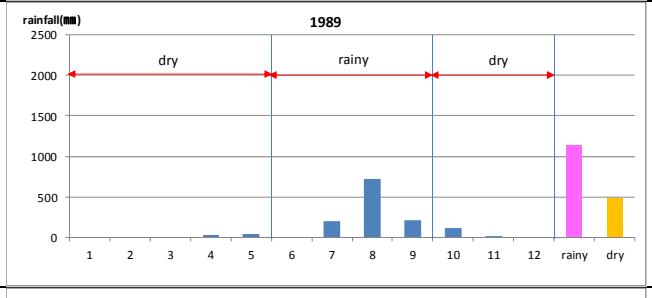
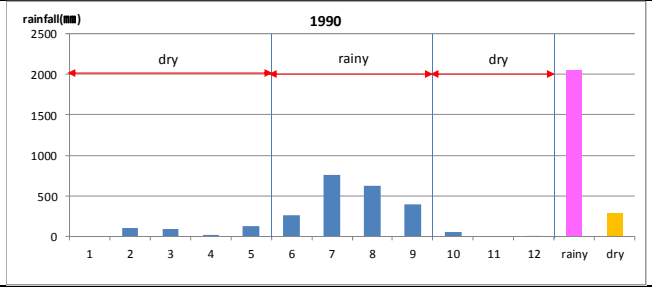
year	Monthly rainfall
1985	
1986	
1987	
1988	
1989	
1990	

Figure 3.58　Bar graph of Monthly Rainfall

【Musikot（Syarpudaha）】

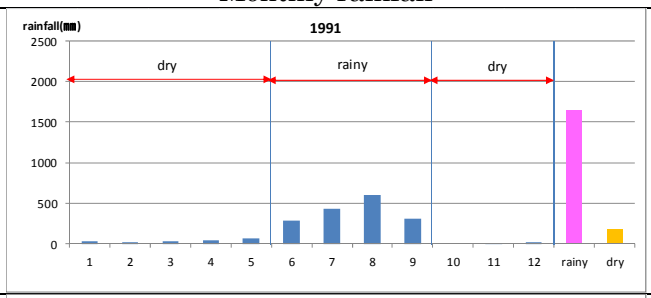
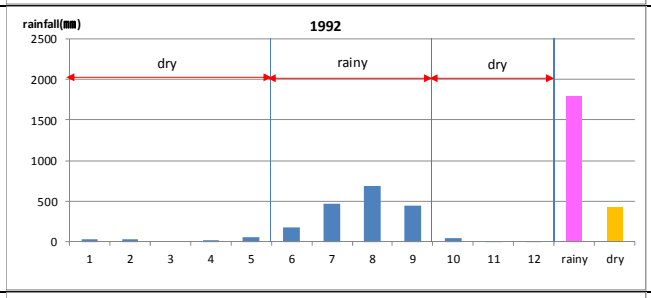
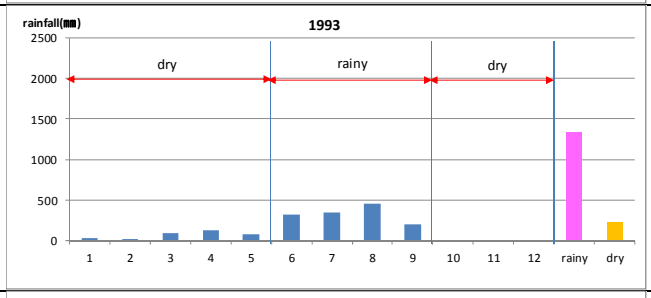
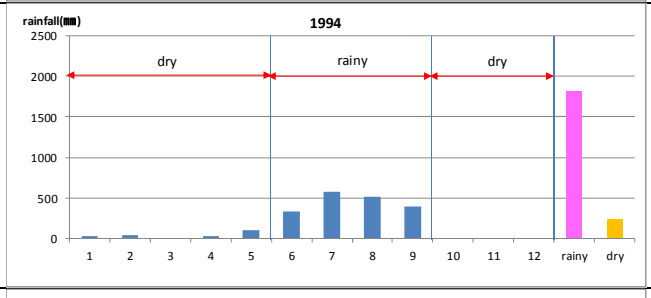
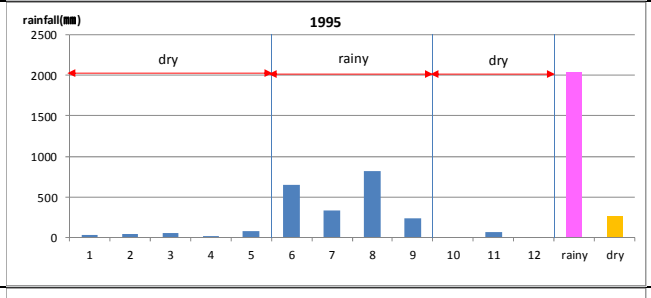
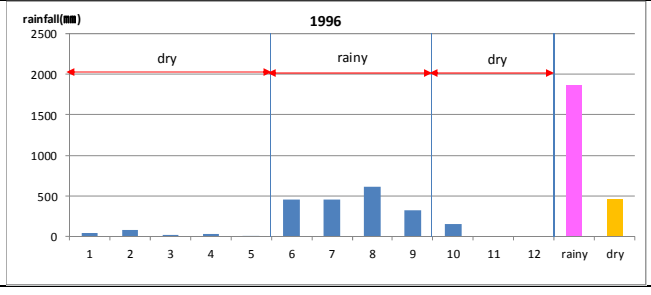
year	Monthly rainfall
1991	
1992	
1993	
1994	
1995	
1996	

Figure 3.59　Bar graph of Monthly Rainfall

【Musikot（Syarpudaha）】

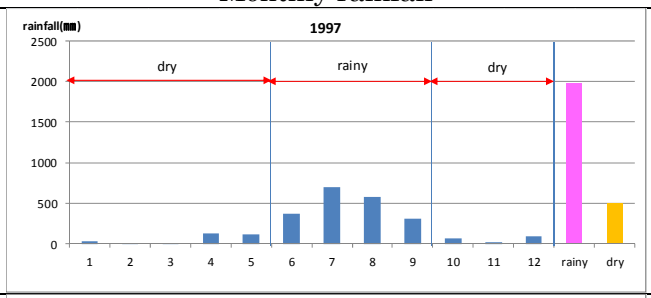
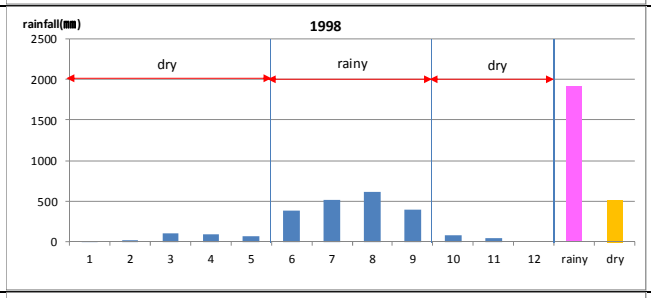
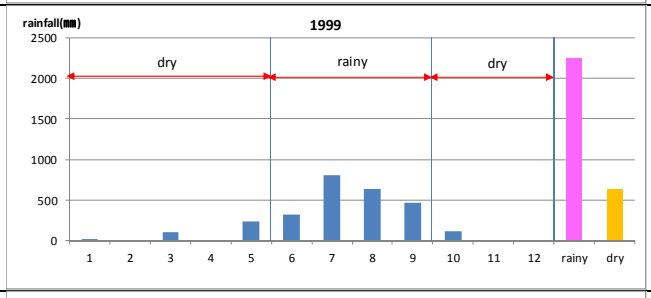
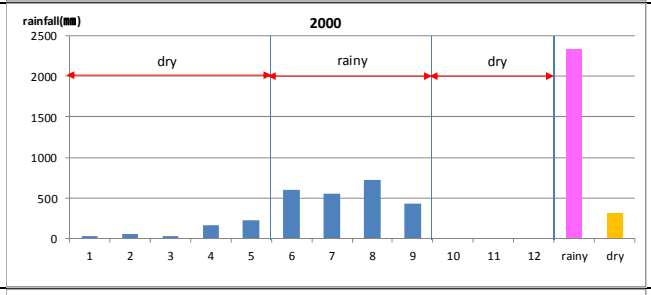
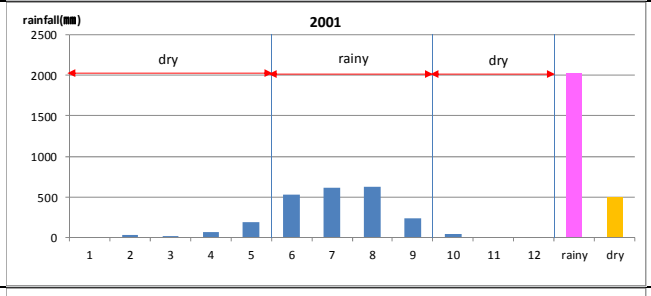
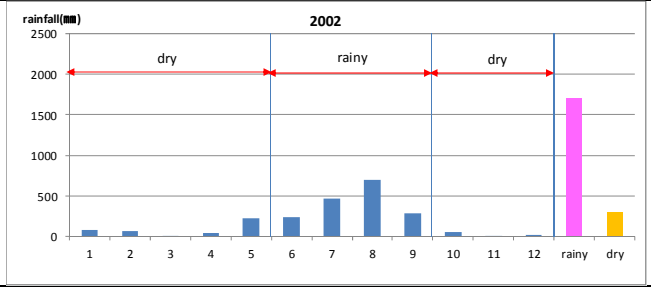
year	Monthly rainfall
1997	
1998	
1999	
2000	
2001	
2002	

Figure 3.60　Bar graph of Monthly Rainfall

【Musikot（Syarpudaha）】

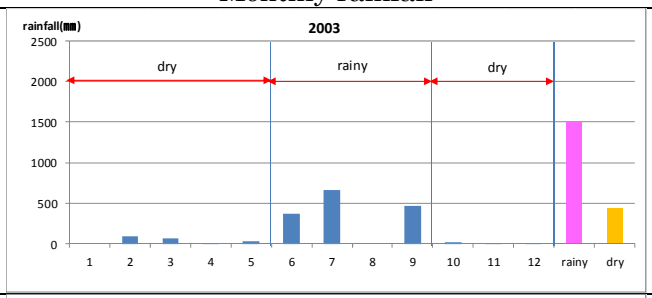
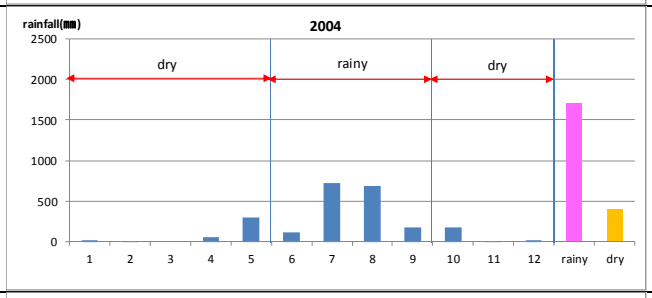
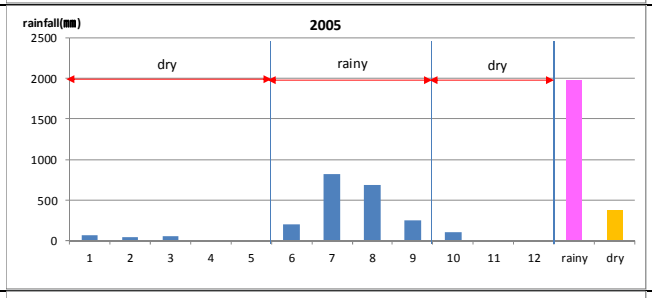
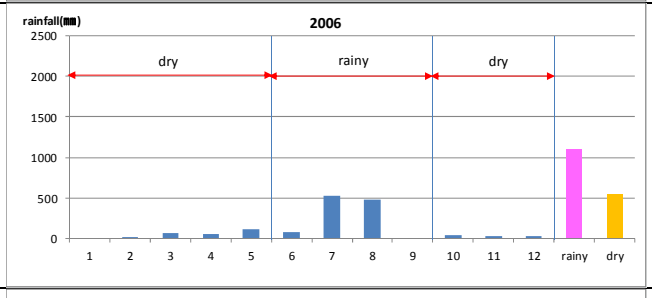
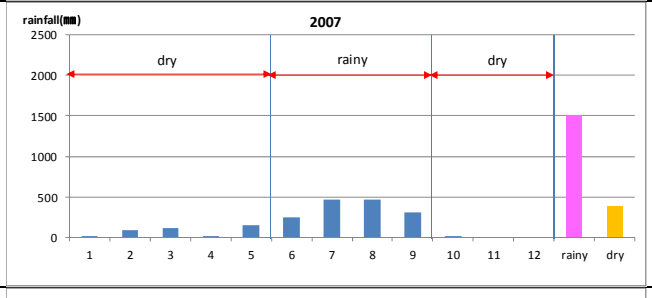
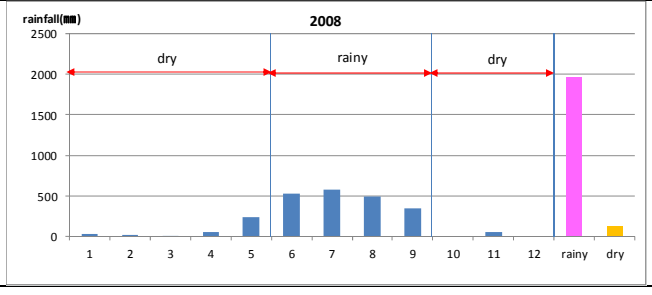
year	Monthly rainfall
2003	
2004	
2005	
2006	
2007	
2008	

Figure 3.61　Bar graph of Monthly Rainfall

【Musikot（Syarpudaha）】

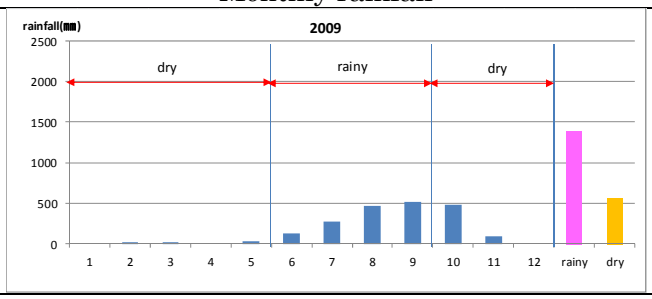
year	Monthly rainfall
2009	

Figure 3.62　Bar graph of Monthly Rainfall

Appendix-6 Reference Data

PREPARATORY SURVEY
ON
MICRO-HYDROPOWER IMPROVEMENT PROJECT
IN WESTERN AREA
IN
FEDERAL DEMOCRATIC REPUBLIC OF NEPAL

REFERENCE DATA FOR
EXPANSION POSSIBILITY OF
INSTALLED CAPACITY
IN THE EXISTING PLANT

NIPPON KOEI CO., LTD.

REFERENCE DATA FOR EXPANSION POSSIBILITY OF INSTALLED CAPACITY IN THE EXISTING PLANT

Table of Contents

Examination on Possibility of Capacity Expansion

Possibility of future capacity expansion at the three sites (Bajhan, Bajura, and Syarpudaha) was examined from the viewpoint of available hydropower potential. As no hydrological data which had been recorded in the past were available, the river flow conditions were determined on the basis of the discharge monitoring result in this study. Taking account of the situation of water use for irrigation purposes, the possibility of capacity expansion was verified. Details are described hereinafter.

1. Discharge Monitoring

Discharge monitoring was carried out for the purpose of determining the river flow conditions at the intake locations of the three sites (Bajhang, Bajura, and Syarpudaha). Methodology, location, period and result of the discharge monitoring are discussed below.

1.1 Method of Discharge Monitoring

Water levels in the rivers were continually monitored every hour by installing automatic water level gauges with pressure transducers and data loggers. As the velocities in the steep rivers were rapid, the water level gauges were fixed to the foundations of steel frames with sandbags as seen in Figure 1.1. Furthermore, discharge measurement was conducted periodically which included river cross section survey and river flow velocity measurement. Using the result of around ten discharge measurements, rating curves of discharge and water levels were established. With those rating curves, the water levels monitored with the water level gauges were converted to river discharges.

＜Specifications of Water Level Gauge＞
Detection method: Semiconductor pressure transducers
Accuracy of measurement: ±0.1% of full scale
Resolution of measurement: 1/3,000
Interval of measurement: 1~60 minutes as required
Capacity of recording: more than 300,000
Contents of recording: Time, ID, Voltage of battery, Water level
Power source: 9V cell batter, 1nos.
Battery life: about 50,000 data

Figure 1.1 Water Level Gauge with Foundation

1.2 Location of Discharge Monitoring

In order to determine the river flow conditions at the intake sites, the water level gauges were installed at locations immediately upstream of the intake weirs where the flows were stable. For Bajhang and Syarpudaha, discharge measurements were conducted at locations further upstream during the initial stage of observation when the river discharges were large due to the rainy season and thus river cross section survey and velocity measurement were difficult at the locations of the water level gauges. Locations of the water level gauges and discharge measurements are shown in Figure 1.2-1.7.

Table 1.1 Coordinates and Elevations of Water Level Gauges

Site	Latitude	Longitude	Elevation	Remarks
Bajhang	29°36'05"	81°08'45"	1,648m	
Bajura	29°27'10"	81°29'20"	1,630m	
Syarpudaha	28°41'14"	82°28'58"	1,226m	

Figure 1.2 Location of Discharge Monitoring (Bajhang)

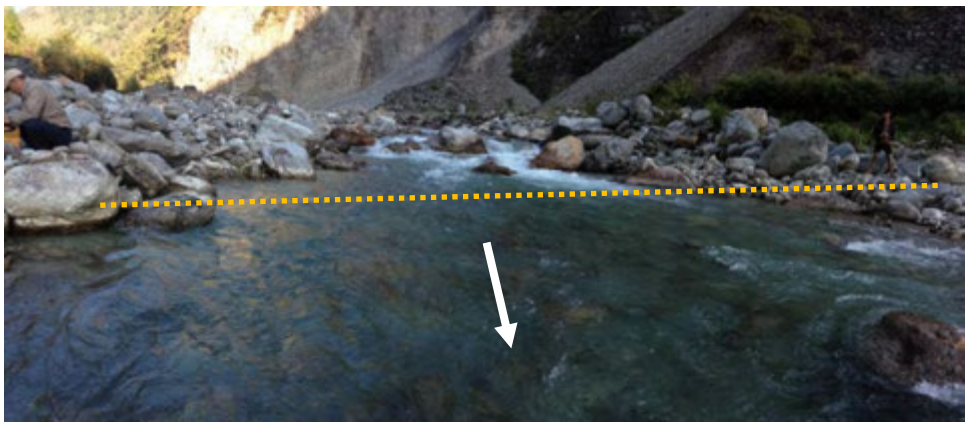


Figure 1.3 Location of Water Level Gauge (Bajhang)

Figure 1.4 Location of Discharge Monitoring (Bajura)

Figure 1.5 Location of Water Level Gauge (Bajura)

Figure 1.6 Location of Discharge Monitoring (Syarpudaha)

Figure 1.7 Location of Water Level Gauge (Syarpudaha)

1.3 Period of Discharge Monitoring

Periods of continual monitoring of the water levels with the water level gauges are as follows:

Bajhang : 22nd October 2013 ~ 10th February 2014
Bajura : 25th October 2013 ~12th February 2014
Syarpudaha : 30th October 2013 ~ 14th February 2014

1.4 Result of Discharge Monitoring

With the result of around ten discharge measurements, rating curves of discharge and water levels were established. With those rating curves, the water levels monitored with the water level gauges were converted to river discharges. Results of the monitoring are described hereinafter.

1.4.1 Establishment of Rating Curves of Discharge and Water Level

River cross sections at the locations of discharge measurement and water level monitoring are seen hereinafter. In order to establish the rating curves of discharge and water levels, the water levels obtained by the water level gauges were converted to water levels from the lowest river bed with the following equation:

Converted water level = Water level by water level gauge + 9 cm (height of water level gauge) + (height difference between the river bed at the water level gauge and the lowest river bed)

Table 1.2 Conversion Factors of Water Levels

Site	Height of Gauge	Height Difference of Riverbed
Bajhang	0.09m	0.145m
Bajura	0.09m	0.213m
Syarpudaha	0.09m	0.725m

H-Q relation is established based on the relationship between the discharge and water levels. Correlation coefficients are more than 0.8 for the three sites.

Table 1.3 H-Q Relation

Site	H-Q Relation	Correlation Coeffcicients
Bajhang	9.89(H-0.25)^2	0.9783
Bajura	8.70(H-0.34)^2	0.9717
Syarpudaha	6.04(H-0.76)^2	0.8743

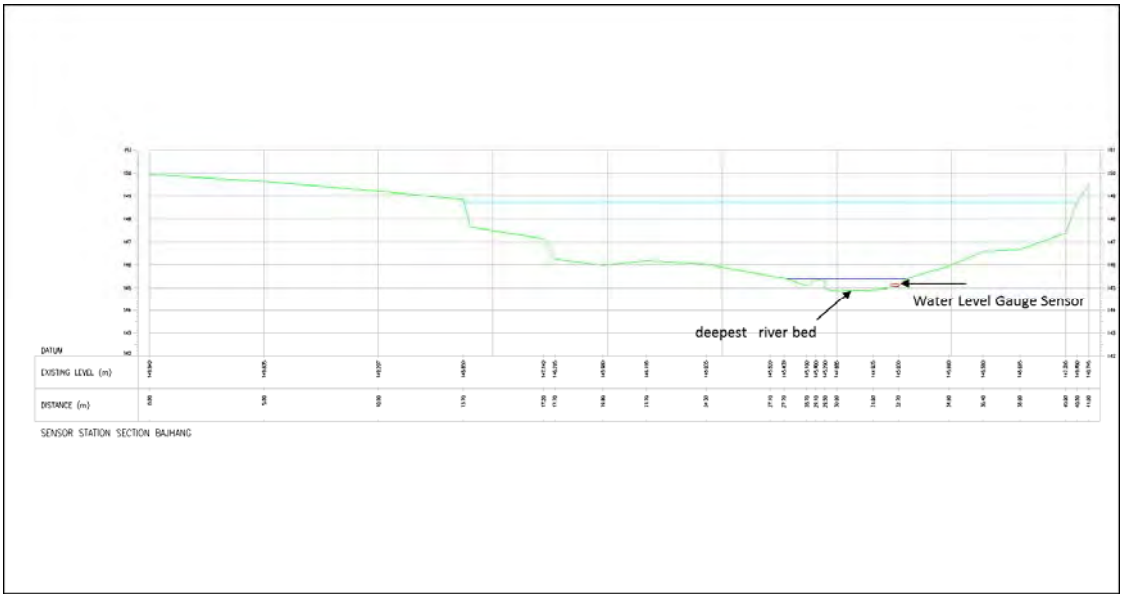


Figure 1.8 River Cross Section at Water Level Gauge (Bajhang)

Table 1.4 Data of River Cross Section at Water Level Gauge (Bajhang)

SWACHCHHA URJA VIKAS Pvt. Ltd

Sensor cross section and Discharge measurement cross section

Reduced level Calculation Form.

Chainage	Sight to	BS	IS	FS	HI	RL	Remarks
Cross Section at Sensor Location							
	BM 1	2.030			148.29	146.260	BM1
		2.190		0.400	150.08	147.890	
-			0.140			149.940	LB-0
5.00			0.445			149.635	
10.00			0.873			149.207	
13.70			1.230			148.850	
14.00			2.420			147.660	HFL-LB
17.20			2.940			147.140	HFL-LB
17.70			3.815			146.265	
19.80			4.100			145.980	
21.70			3.885			146.195	
24.30			4.045			146.035	
27.10			4.560			145.520	
27.70			4.641			145.439	WL LB
28.70			4.980			145.100	
		3.900		4.255	149.73	145.825	
29.10			4.325			145.400	
29.50			4.435			145.290	
29.50			4.775			144.950	
30.00			4.840			144.885	deepest river bed
31.60			4.800			144.925	
32.70			4.695			145.030	Bed level at sensor
32.70			4.655			145.070	Top of 4" pipe in which Sensor is kept
33.00			4.335			145.390	WL
34.90			3.765			145.960	
36.40			3.145			146.580	
38.00			3.060			146.665	
40.00			2.330			147.395	
40.50			0.235			149.490	HFL -RB
41.00			0.980			148.745	
		2.551		1.540	150.74	148.185	

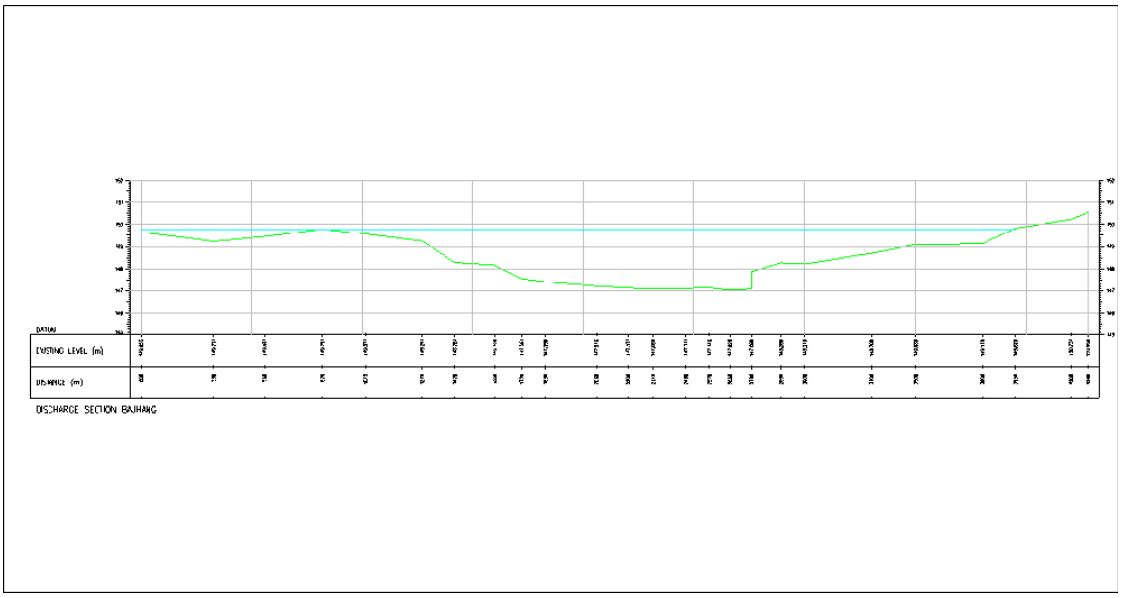


Figure 1.9 River Cross Section at Discharge Measurement (Bajhang)

Table 1.5 Data of River Cross Section at Discharge Measurement (Bajhang)

Cross Section at Discharge Measurement Location							
-			1.081			149.655	Discharge section
3.30			1.505			149.231	
5.60			1.285			149.451	
8.20			0.945			149.791	
10.15			1.165			149.571	
12.70			1.485			149.251	HFL
14.20			2.455			148.281	
16.00			2.570			148.166	
17.20			3.175			147.561	
18.30			3.338			147.398	WL-LB
20.60			3.520			147.216	
22.00			3.605			147.131	
23.15			3.650			147.086	
24.60			3.625			147.111	
25.70			3.590			147.146	
26.60			3.710			147.026	
27.60			3.650			147.086	
27.60			2.860			147.876	
28.90			2.470			148.266	
30.00			2.520			148.216	
33.00			2.030			148.706	
35.00			1.650			149.086	
38.00			1.620			149.116	
39.50			0.910			149.826	HFL
42.00			0.505			150.231	
42.80				0.170		150.566	

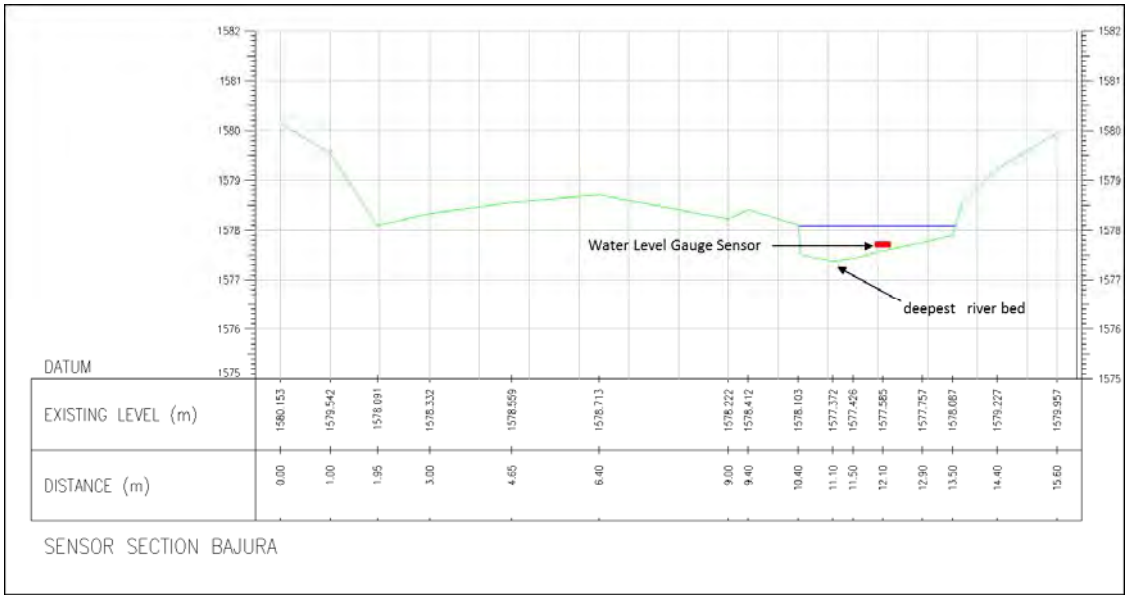


Figure 1.10 River Cross Section at Water Level Gauge (Bajura)

Table 1.6 Data of River Cross Section at Water Level Gauge (Bajura)

Cross Section at Sensor Location							
15.60			0.600			1,579.957	LB Gauge
14.40			1.330			1,579.227	
13.70			2.010			1,578.547	
13.50			2.470			1,578.087	WL LB Top
13.50			2.663			1,577.894	WL LB Bottom
12.90			2.800			1,577.757	
12.10			2.972			1,577.585	Bed level at sensor
12.10			2.621			1,577.936	Top of 4" pipe in which Sensor is kept
11.50			3.131			1,577.426	
11.10			3.185			1,577.372	deepest river bed
10.60			3.085			1,577.472	
10.45			3.038			1,577.519	
10.40			2.454			1,578.103	WL RB Bottom
10.40			2.350			1,578.207	WL RB Top
9.40			2.145			1,578.412	
9.00			2.335			1,578.222	
6.40			1.844			1,578.713	
4.65			1.998			1,578.559	
3.00			2.225			1,578.332	
1.95			2.466			1,578.091	
1.00			1.015			1,579.542	
-				0.404		1,580.153	RB

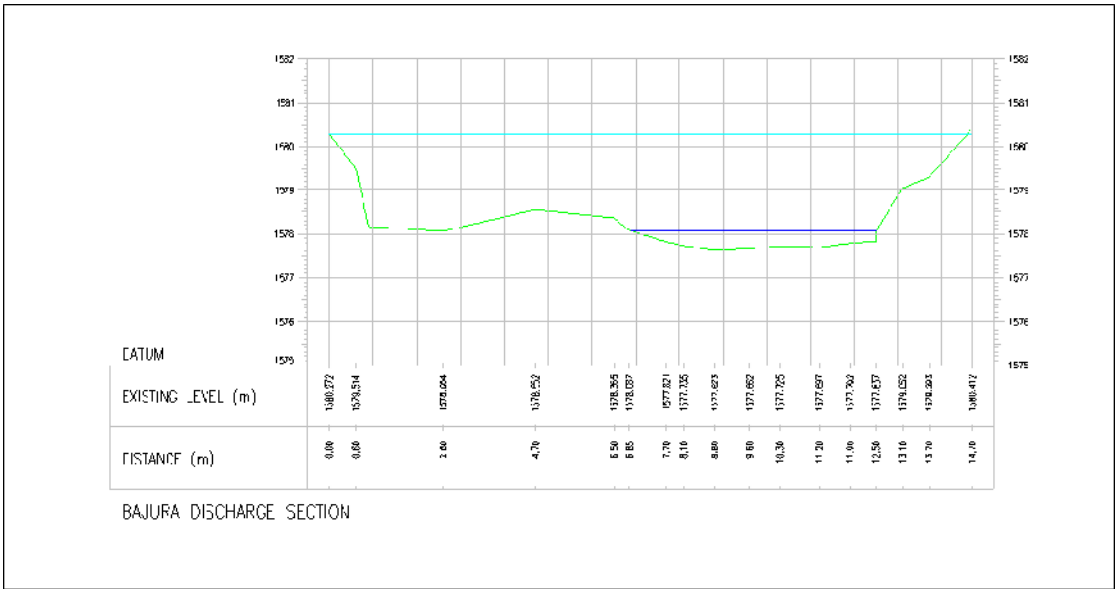


Figure 1.11 River Cross Section at Discharge Measurement (Bajura)

Table 1.7 Data of River Cross Section at Discharge Measurement (Bajura)

SWACHCHHA URJA VIKAS Pvt. Ltd

Sensor cross section and Discharge measurement cross section

Reduced level Calculation Form.

Chainage	Sight to	BS	IS	FS	HI	RL	Remarks
Cross Section at Discharge Measurement Location							
	BM 1	2.240			1578.14	1,575.900	BM 1
		2.824		0.407	1,580.56	1,577.733	
-			0.285			1,580.272	
0.60			1.043			1,579.514	
0.90			2.385			1,578.172	
2.60			2.493			1,578.064	
4.70			2.005			1,578.552	
6.50			2.192			1,578.365	
6.85			2.470			1,578.087	WL RB
7.70			2.736			1,577.821	
8.10			2.822			1,577.735	
8.80			2.934			1,577.623	
9.60			2.895			1,577.662	
10.30			2.832			1,577.725	
11.20			2.860			1,577.697	
11.90			2.765			1,577.792	
12.50			2.720			1,577.837	
12.50			2.480			1,578.077	WL LB
13.10			1.505			1,579.052	
13.70			1.264			1,579.293	
14.70			0.145			1,580.412	

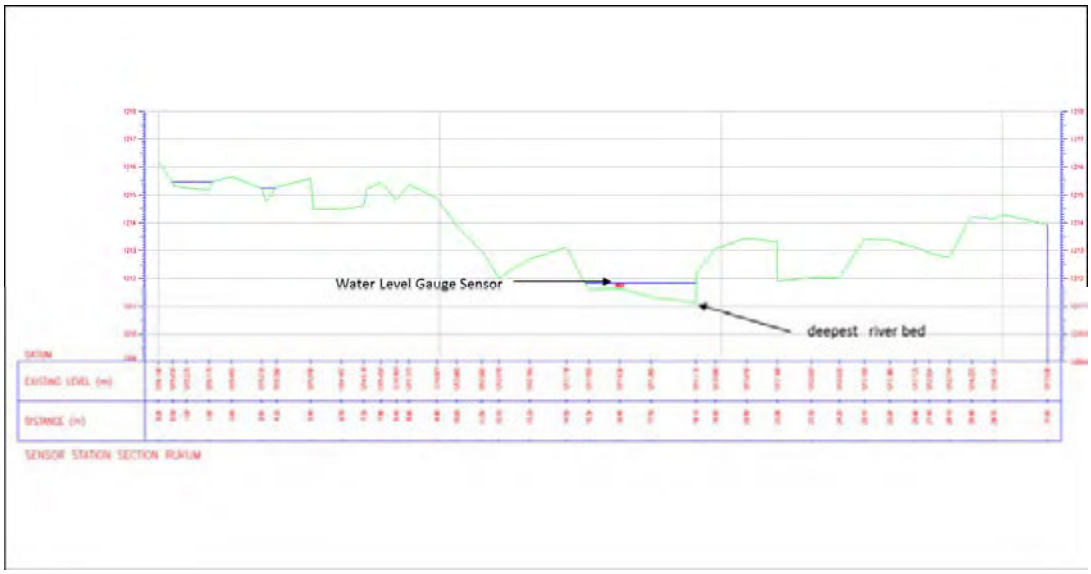


Figure 1.12 River Cross Section at Water Level Gauge (Syarpudaha)

Table 1.8 Data of River Cross Section at Water Level Gauge (Syarpudaha)

SWACHCHHA URJA VIKAS Pvt. Ltd
Sensor cross section and Discharge measurement cross section
Reduced level Calculation Form.

Chainage	Sight to	BS	IS	FS	HI	RL	Remarks
Cross Section at Sensor Location							
	BM 3	3.480			1216.26	1,212.780	BM 3
-			0.070			1,216.190	RB -0
0.50			0.805			1,215.455	WL Bottom
0.50			0.910			1,215.350	WL Top
1.00			1.025			1,215.235	
1.80			1.090			1,215.170	WL
1.90			0.795			1,215.465	
2.60			0.605			1,215.655	
3.65			1.025			1,215.235	WL
3.70			1.115			1,215.145	
3.80			1.495			1,214.765	
4.20			0.980			1,215.280	WL
5.40			0.670			1,215.590	
5.50			1.775			1,214.485	
6.50			1.793			1,214.467	
7.30			1.642			1,214.618	
7.40			1.055			1,215.205	
7.90			0.805			1,215.455	
8.45			1.459			1,214.801	
8.90			0.887			1,215.373	
9.90			1.389			1,214.871	
10.60			2.375			1,213.885	
11.50			3.275			1,212.985	
12.10			4.244			1,212.016	
13.20			3.555			1,212.705	
14.50			3.142			1,213.118	
15.30			4.705			1,211.555	WL RB Bottom
15.30			4.443			1,211.817	WL Top
16.40			4.630			1,211.630	Top of 4" pipe in which Sensor is kept
16.40			4.425			1,211.835	Bed level at sensor
17.50			4.955			1,211.305	
19.10			5.150			1,211.110	deepest river bed WL RB Bottom
19.10			4.110			1,212.150	WL RB top
19.80			3.180			1,213.080	Boulder
20.90			2.810			1,213.450	
22.00			2.960			1,213.300	
22.00			4.360			1,211.900	
23.20			4.235			1,212.025	End of boulder
24.20			4.225			1,212.035	
25.10			2.865			1,213.395	
26.00			2.880			1,213.380	
26.90			3.135			1,213.125	
27.40			3.336			1,212.924	
28.10			3.515			1,212.745	
28.90			2.035			1,214.225	
29.70			2.140			1,214.120	
30.00			1.955			1,214.305	
31.60			2.330			1,213.930	
		3.412		0.405	1,219.27	1,215.855	

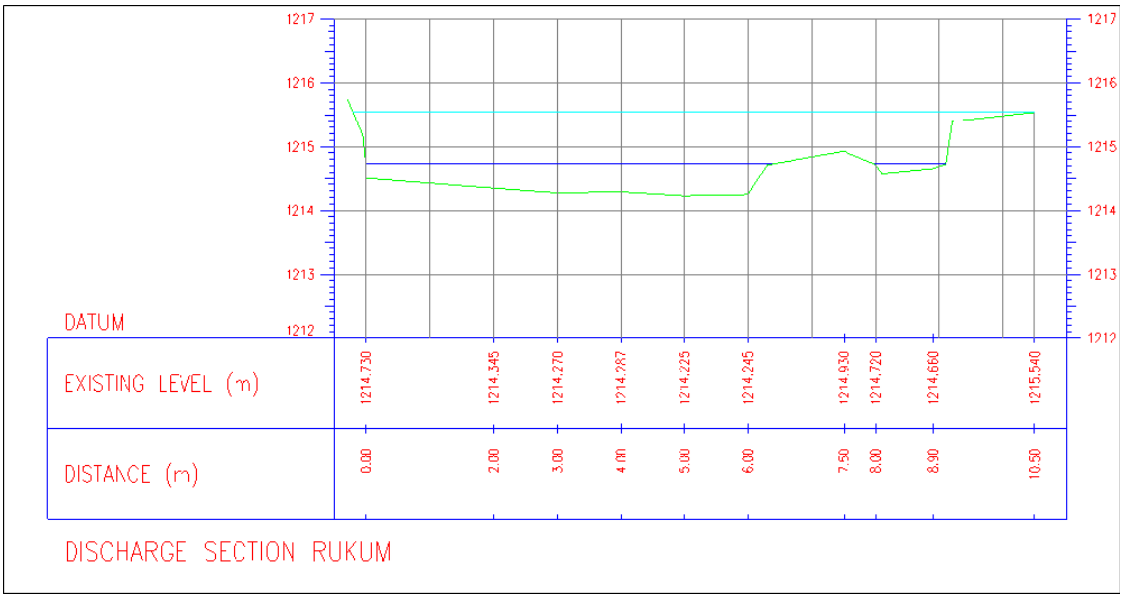


Figure 1.13 River Cross Section at Discharge Measurement (Syarpudaha)

Table 1.9 Data of River Cross Section at Discharge Measurement (Syarpudaha)

Cross Section at Discharge Measurement Location							
(0.70)			0.385			1,218.882	
(0.40)			0.410			1,215.850	
-			1.530			1,214.730	WL LB Top
-			1.760			1,214.500	WL Bottom
2.00			1.915			1,214.345	
3.00			1.990			1,214.270	
4.00			1.973			1,214.287	
5.00			2.035			1,214.225	
6.00			2.015			1,214.245	
6.30			1.545			1,214.715	
7.50			1.330			1,214.930	
8.00			1.540			1,214.720	WL Top RB
8.10			1.680			1,214.580	WL Bottom RB
8.90			1.600			1,214.660	WL
9.10			1.535			1,214.725	WL
9.20			0.863			1,215.397	
10.50				0.720		1,215.540	HFL

Table1.10 Result of Discharge Measurement（bajhang）

no	Date/time	Dischage recorded (㎥/s)	Conversion Water level (m)	Remarks
1	10/22/2013;15:30	3.69	0.849	
2	10/22/2013;16:10	3.60	0.849	
3	10/23/2013;7:30	3.65	0.848	
4	11/26/2013;15:30	1.40	0.653	
5	11/26/2013;15:45	1.50	0.652	
6	11/272013;8:35	1.48	0.652	
7	12/23/2013;16:45	0.90	0.569	
8	12/23/2013;16:55	0.79	0.569	
9	12/24/2013;8:15	0.91	0.569	
10	1/19/2014;15:30	0.90	0.521	
11	1/19/2014;15:45	0.89	0.521	
12	1/20/2014;8:30	0.88	0.524	
13	2/10/2014;15:30	0.66	0.510	
14	2/10/2014;16:30	0.67	0.508	
15	2/11/2014;7:15	0.65	0.513	

Table1.11 Result of Discharge Measurement（bajura）

no	Date/time	Dischage recorded (㎥/s)	Conversion Water level (m)	Remarks
1	10/25/2013;14:45	0.93	0.662	
2	10/25/2013;15:05	0.97	0.662	
3	10/26/2013;7:40	0.93	0.664	
4	11/29/2013;16:30	0.53	0.597	
5	11/29/2013;17:00	0.50	0.599	
6	11/30/2013;13:30	0.60	0.597	
7	12/26/2013;12:20	0.47	0.565	
8	12/26/2013;12:35	0.48	0.563	
9	12/27/2013;8:45	0.45	0.563	
10	1/15/2014;16:25	0.44	0.551	
11	1/15/2014;16:40	0.42	0.551	
12	1/16/2014;8:00	0.41	0.547	
13	2/12/2014;15:40	0.32	0.531	
14	2/12/2014;16:05	0.31	0.532	
15	2/13/2014;7:45	0.30	0.528	

Table1.12　Result of Discharge Measurement（syarpudaha）

no	Date/time	Dischage recorded (㎥/s)	Conversion Water level (m)	Remarks
1	10/29/2013;15:05	3.24	1.420	
2	10/29/2013;17:15	3.11	1.420	
3	10/30/2013;7:30	3.15	1.420	
4	11/5/2013;12:20	1.77	1.379	
5	11/5/2013;12:30	1.80	1.381	
6	11/6/2013;9:05	1.79	1.380	
7	12/30/2013;14:50	1.25	1.171	
8	12/30/2013;15:00	1.25	1.172	
9	12/31/2013;8:45	1.25	1.169	
10	1/24/2014;13:30	0.97	1.132	
11	1/24/2014;13:50	0.99	1.133	
12	1/25/2014;9:00	0.99	1.134	
13	2/14/2014;16:05	0.59	1.107	
14	2/14/2014;16:35	0.55	1.104	
15	2/15/2014;12:05	0.54	1.104	

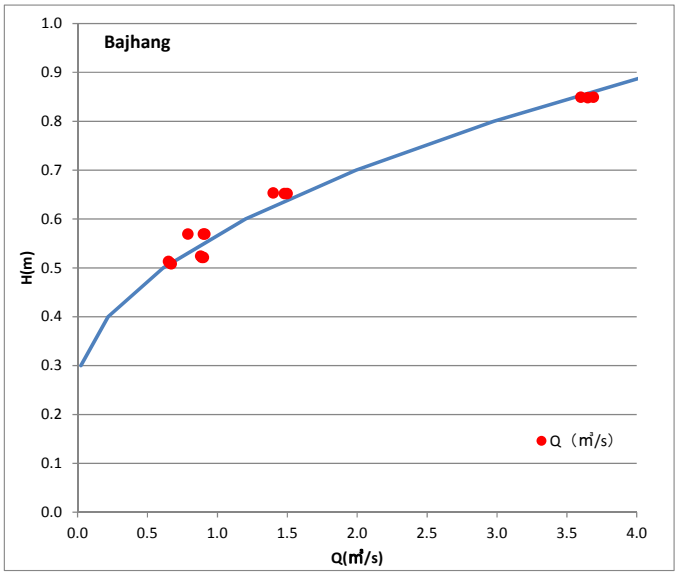


Figure 1.14 Rating Curve of Discharge and Water Level (Bajhang)

Table 1.13 Discharge and Water Level Relationship (Bajhang)

no	H(m)	Q(m³/s)	√Q	H^2	H√Q
1	0.849	3.69	1.921	0.721	1.631
2	0.849	3.60	1.897	0.721	1.611
3	0.848	3.65	1.910	0.719	1.620
4	0.653	1.40	1.183	0.426	0.773
5	0.652	1.50	1.225	0.425	0.799
6	0.652	1.48	1.217	0.425	0.793
7	0.569	0.90	0.949	0.324	0.540
8	0.569	0.79	0.889	0.324	0.506
9	0.569	0.91	0.954	0.324	0.543
10	0.521	0.90	0.949	0.271	0.494
11	0.521	0.89	0.943	0.271	0.492
12	0.524	0.88	0.938	0.275	0.492
13	0.510	0.66	0.812	0.260	0.414
14	0.508	0.67	0.819	0.258	0.416
15	0.513	0.65	0.806	0.263	0.414
total	9.307		17.412	6.007	11.536

Coefficient of correlation = 0.9783

$$\sqrt{a}b = \frac{[H][H\sqrt{Q}]-[H^2][\sqrt{Q}]}{[H][H]-n[H^2]} = -0.79$$

$$\sqrt{a} = \frac{[\sqrt{Q}][H]-n[H\sqrt{Q}]}{[H][H]-n[H^2]} = 3.15$$

a= 9.89 b= −0.25

$$Q = 9.89\ (H\ -0.25\ )^2$$

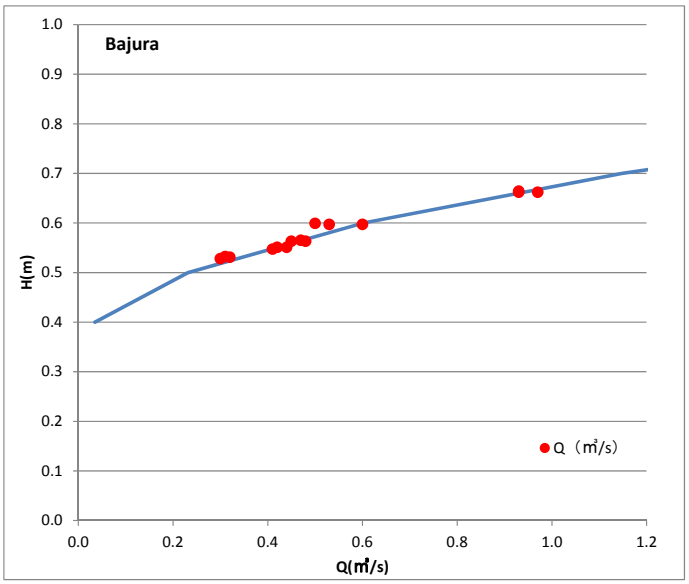


Figure 1.15　Rating Curve of Discharge and Water Level (Bajura)

Table 1.14　Discharge and Water Level Relationship (Bajura)

no	H(m)	Q(m³/s)	√Q	H^2	H√Q
1	0.662	0.93	0.964	0.438	0.638
2	0.662	0.97	0.985	0.438	0.652
3	0.664	0.93	0.964	0.441	0.640
4	0.597	0.53	0.728	0.356	0.435
5	0.599	0.50	0.707	0.359	0.424
6	0.597	0.60	0.775	0.356	0.462
7	0.565	0.47	0.686	0.319	0.387
8	0.563	0.48	0.693	0.317	0.390
9	0.563	0.45	0.671	0.317	0.378
10	0.551	0.44	0.663	0.304	0.365
11	0.551	0.42	0.648	0.304	0.357
12	0.547	0.41	0.640	0.299	0.350
13	0.531	0.32	0.566	0.282	0.300
14	0.532	0.31	0.557	0.283	0.296
15	0.528	0.30	0.548	0.279	0.289
total	8.712		10.794	5.092	6.365

Coefficient of correlation = 0.9717

$$\sqrt{}ab = \frac{[H][H\sqrt{}Q]-[H^2][\sqrt{}Q]}{[H][H]-n[H^2]} = -0.99$$

$$\sqrt{}a = \frac{[\sqrt{}Q][H]-n[H\sqrt{}Q]}{[H][H]-n[H^2]} = 2.95$$

a= 8.70　　b= −0.34

Q= 8.70 (−0.34) ^{2}

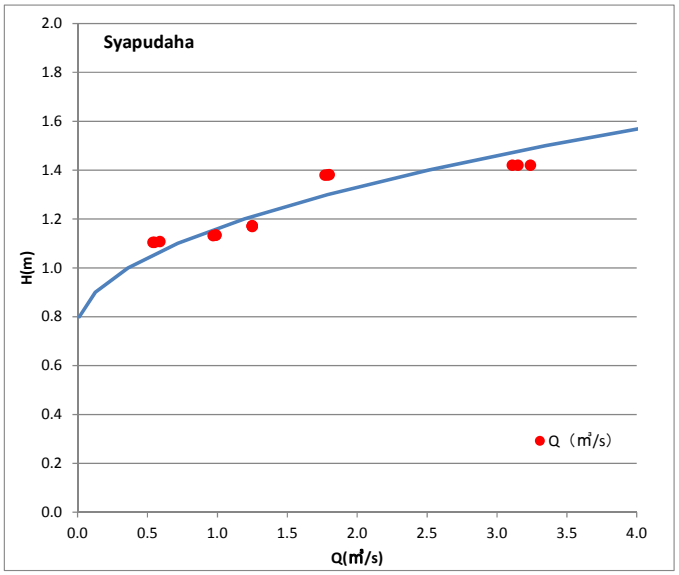


Figure 1.16　Rating Curve of Discharge and Water Level (Syapudaha)

Table 1.15　Discharge and Water Level Relationship (Syapudaha)

no	H(m)	Q(m³/s)	√Q	H^2	H√Q
1	1.420	3.24	1.800	2.016	2.556
2	1.420	3.11	1.764	2.016	2.504
3	1.420	3.15	1.775	2.016	2.520
4	1.379	1.77	1.330	1.902	1.835
5	1.381	1.80	1.342	1.907	1.853
6	1.380	1.79	1.338	1.904	1.846
7	1.171	1.25	1.118	1.371	1.309
8	1.172	1.25	1.118	1.374	1.310
9	1.169	1.25	1.118	1.367	1.307
10	1.132	0.97	0.985	1.281	1.115
11	1.133	0.99	0.995	1.284	1.127
12	1.134	0.99	0.995	1.286	1.128
13	1.107	0.59	0.768	1.225	0.850
14	1.104	0.55	0.742	1.219	0.819
15	1.104	0.54	0.735	1.219	0.811
total	18.626		17.922	23.388	22.892

Coefficient of correlation = 0.8743

$$\sqrt{}ab = \frac{[H][H\sqrt{}Q]-[H^2][\sqrt{}Q]}{[H][H]-n[H^2]} = -1.86$$

$$\sqrt{}a = \frac{[\sqrt{}Q][H]-n[H\sqrt{}Q]}{[H][H]-n[H^2]} = 2.46$$

a= 6.04　　b= −0.76

Q= 6.04 (−0.76) ^{2}

1.4.2 River Flow Condition

Based on the H-Q relation established above, the water level data (daily average) were converted to discharge so as to obtain the river flow conditions. Discharge duration curves and discharge transition graphs in time series are shown in Figure 1.17-1.22 In all the sites, the discharge observed at the beginning of monitoring are the largest, and they gradually decrease linearly. Table 1.16 shows the maximum and minimum discharge. As for the specific discharge for the minimum discharge, the one in the Syarpudaha was the largest at 1.798 $m^3/s/100\ km^2$, compared to Bajura at 1.231 $m^3/s/100\ km^2$ and Bajhang at 0.638 $m^3/s/100\ km^2$. The one in Syarpudaha is about four times larger than the one in Bajhang, which indicates that the flow conditions in Syarpudaha is favorable.

Table 1.16 River Flow Conditions

Site	Area (km²)	Discharge (m³/s)		Specific Discharge for the Minimum Discharge (m³/s /100 km²)	Remarks
		Max.	Min.		
Bajhang	105.75	3.560	0.675	0.638	
Bajura	26.89	0.935	0.331	1.231	
Syarpudaha	40.72	2.694	0.732	1.798	

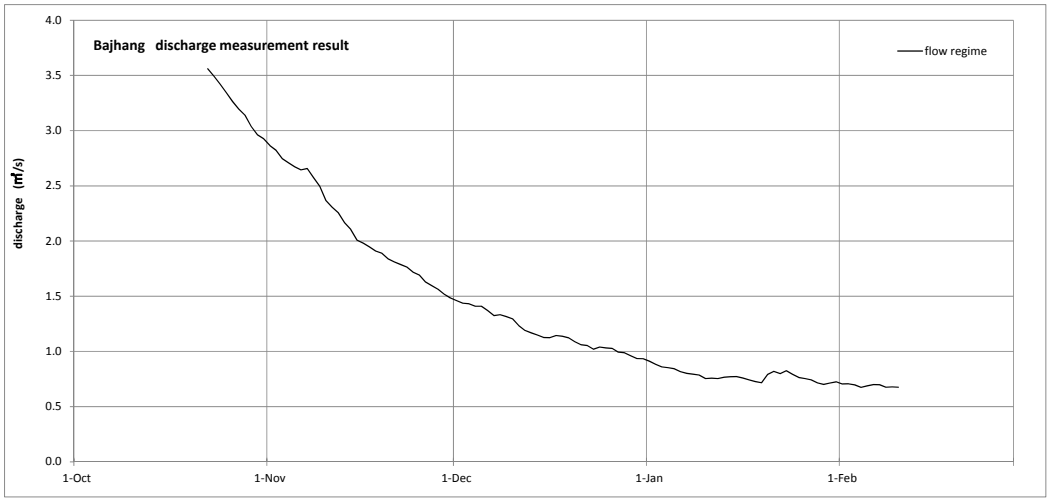


Figure 1.17 Transition Graph of Discharge in Time Series (Bajhang)

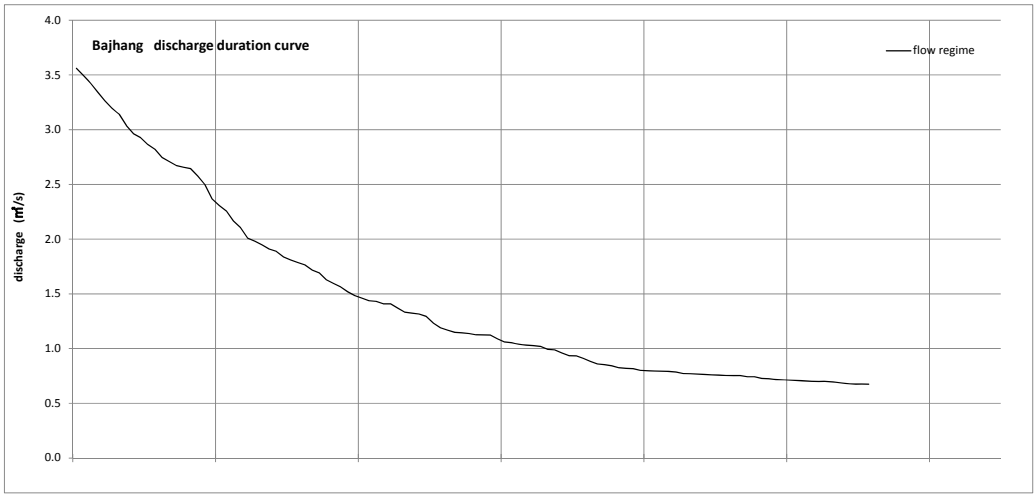


Figure 1.18 Discharge Duration Curve (Bajhang)

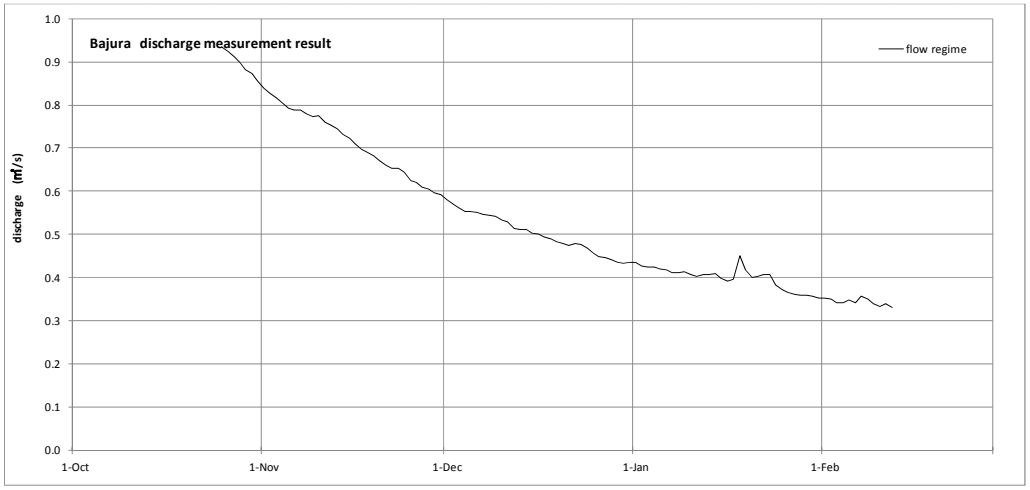


Figure 1.19 Transition Graph of Discharge in Time Series (Bajura)

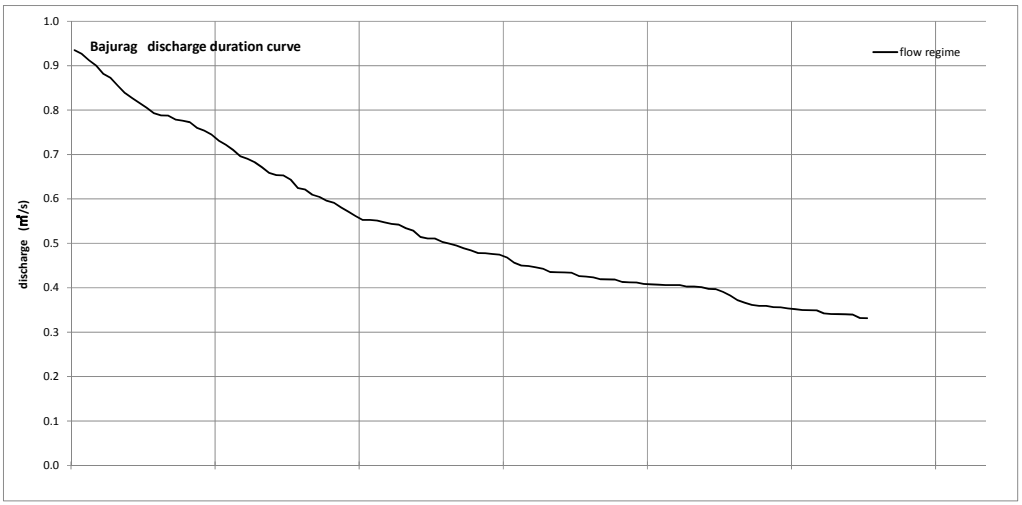


Figure 1.20 Discharge Duration Curve (Bajura)

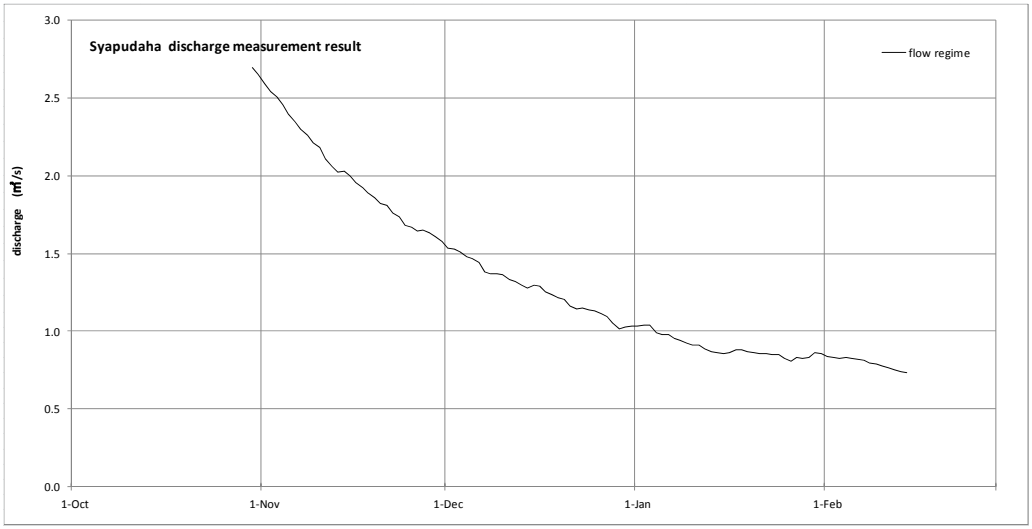


Figure 1.21 Transition Graph of Discharge in Time Series (Syapudaha)

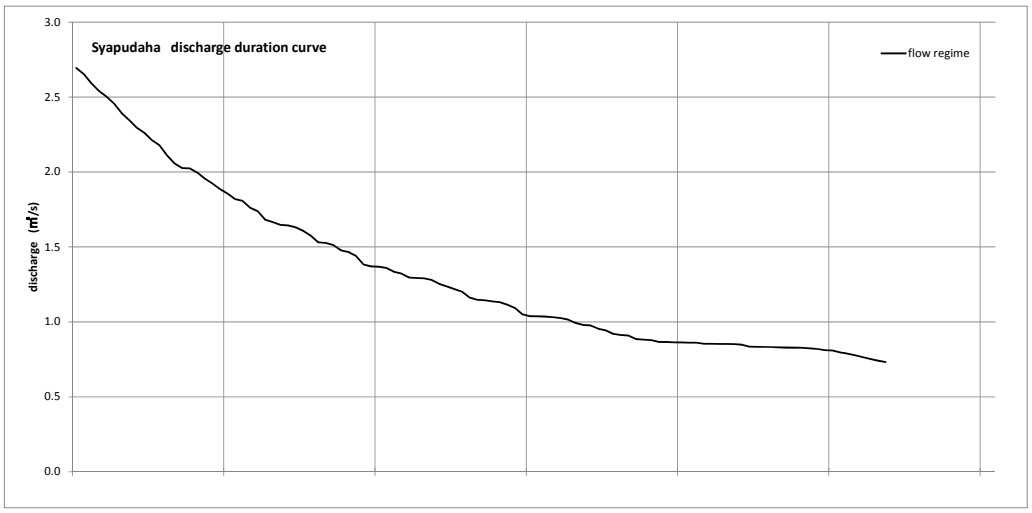


Figure 1.22 Discharge Duration Curve (Syapudaha)

1.4.3 Comparison of Rainfall

In order to assess the reliability of available discharge observed in this study, rainfall data in the past and during the observation period were compared.

Rainfall during the dry season (October-February) of each year for the last 30 years were ranked according to the amount from the smallest to the largest, and the rainfall during the observation period was assessed as to which rank it corresponds with among the 30-year data. As a result, it was assessed that Bajhang corresponds to 3/30, Bajura to 9/30 and Syarpudaha to 20/30. It can be said that the observation period of Bajhang site corresponds to a relatively low water year, Bajura and Syarpudaha site are high water year.

Table 1.17 Comparison of Rainfall (Dry season: October ~ February)

year	Bajhang		Bajura		Syarpudaha	
	rainfall (mm)	rank	rainfall (mm)	rank	rainfall (mm)	rank
1976	94	4	52	1	23	1
1977	208	20	163	11	134	16
1978	149	9	228	16	35	2
1979	143	8	247	18	170	19
1980	207	19	251	19	81	8
1981	242	23	312	24	139	17
1982	153	10	234	17	122	14
1983	306	28	335	26	271	28
1984	66	2	102	8	62	4
1985	380	30	261	21	315	29
1986	296	27	171	12	220	26
1987	163	11	212	14	92	11
1988	322	29	326	25	69	5
1989	missing					
1990	missing					
1991	177	13	228	15	93	12
1992	203	18	383	29	120	13
1993	181	15	186	13	82	9
1994	223	21	103	9	79	7
1995	228	22	99	6	213	24
1996	168	12	266	22	192	21
1997	283	25	366	28	218	25
1998	119	7	124	10	156	18
1999	202	17	366	27	209	23
2000	108	6	101	7	44	3
2001	253	24	305	23	205	22
2002	187	16	253	20	176	20
2003	89	3	71	3	69	6
2004	294	26	421	30	316	30
2005	42	1	73	4	126	15
2006	178	14	53	2	242	27
2007	101	5	89	5	85	10
2008	missing					
2009	missing					
2013	88	3/30	110	9/30	182	20/30

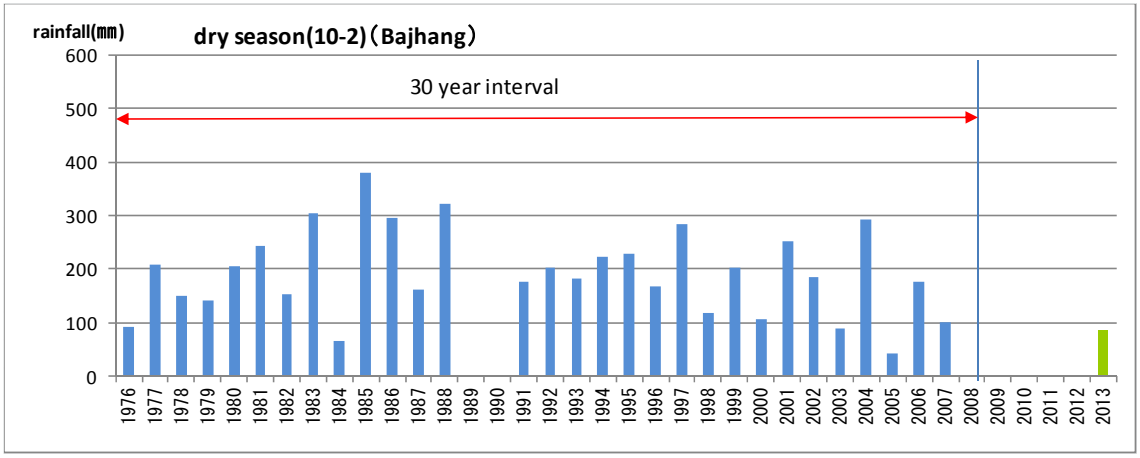


Figure 1.23 Comparison of Rainfall between the Last 30 years and Observation Period (Bajhang)

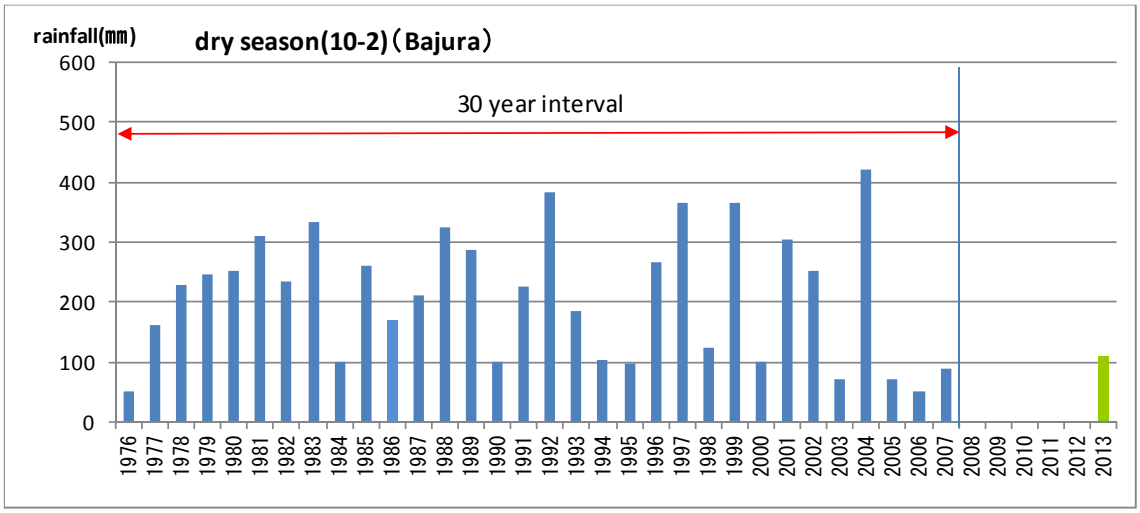


Figure 1.24 Comparison of Rainfall between the Last 30 years and Observation Period (Bajura)

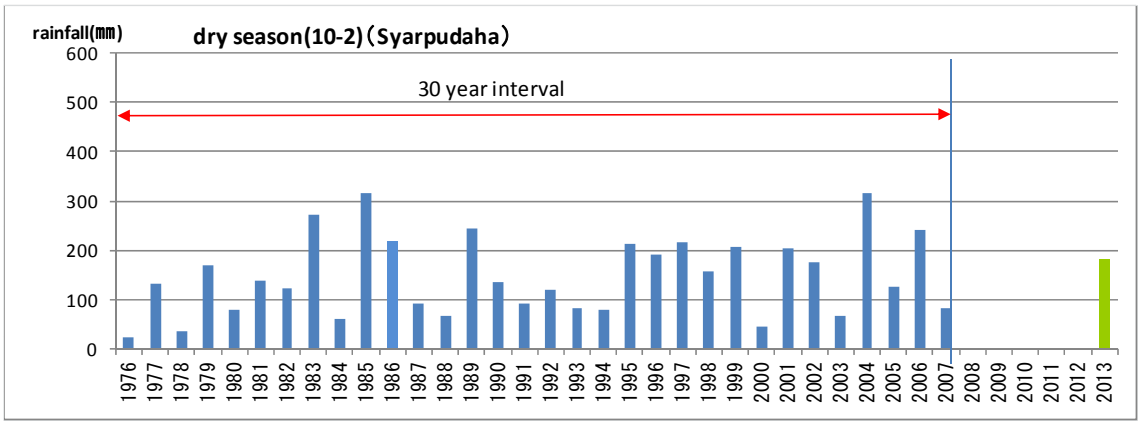


Figure 1.25 Comparison of Rainfall between the Last 30 years and Observation Period (Syapudaha)

2. Water Use at Discharge Reduction Section

Site survey was conducted at the three sites in Bajhan, Bajura, and Syarpudaha to confirm water use conditions in the river section between the intake and the tailrace, where reduction of natural river discharge occurred. Results of the survey are described hereinafter.

2.1 Water use at Bajhang Site

There exists no water intake for agricultural purposes coming directly from the Jeuli River section between the power intake and tailrace. However, water is taken from the power headrace channel to supply the cultivated land (4.65 ha) on the right bank of the Jeuli River near the powerhouse. Several notches are provided at about 500 m downstream of the intake weir as shown in Figure 2.1 for discharging water to the slopes above the cultivated land. Wheat, rice and vegetables are cultivated there by double-cropping (November-April and July-September). Required amount of water for cultivation is 0.004 m^3/s. With the plant discharge for power generation at 0.415 m^3/s, reduction of the natural discharge in the Jeuli River is 0.419 m^3/s at the discharge reduction section between the power intake and tailrace.

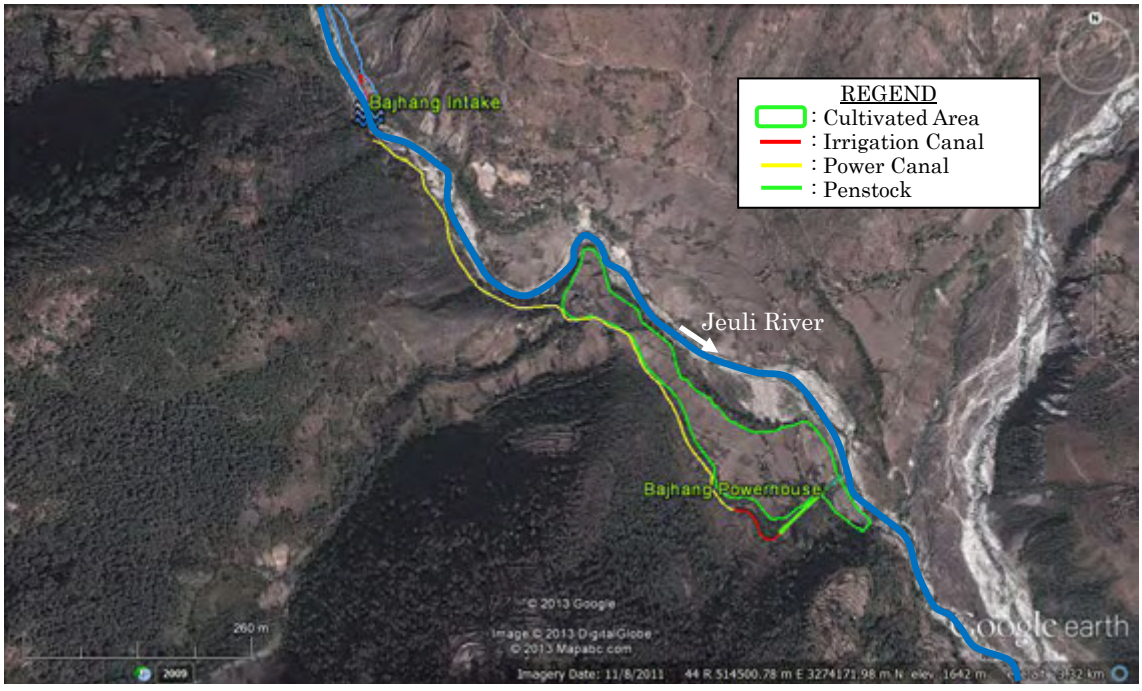


Figure 2.1 Location of Water Use at Discharge Reduction Section (Bajhang)

Table 2.1 Details of Water Use at Discharge Reduction Section (Bajhang)

Canal Intake No.	Intake Side	Distance from intake (m)	Cultivated Area (ha)	Peak Crop Water Requirement (lps)	Duration under cultivation	Crop Pattern	Remarks
Many	Right Bank	Starts from about 500m from intake	4.65	3.66	Nov-Apr and Jul-Sep	Wheat, Rice, Vegetables	Irrigated using the water from canal of the project

※Peak Crop Water Requirement are needed on September

2.2 Water use at Bajura Site

There exist three water intakes for agricultural purposes coming directly from the Bauli River section between the power intake and tailrace. The nearest intake from the intake weir (50 m distance downstream of the intake weir) supplies water to a cultivated land of 13.8 ha on the left bank through a water mill. The second intake (400 m downstream of the intake weir) supplies water to a downstream cultivated land of 15.2 ha on the left bank. The third intake (1,300 m downstream of the intake weir) is located downstream of a conjunction with a tributary on the right bank (900 m downstream of the intake), and supplies water to another cultivated land of 11.2 ha on the left bank. The said tributary has a catchment area, the scale of which is almost the same as the one in the Bauli River, and thus the effect of reduction of natural river discharge might be mitigated there. Wheat, rice and vegetables are cultivated by double-cropping (November-April and July-September). Required amount of water at the three intakes for cultivation is 0.032 m^3/s. With the plant discharge for power generation at 0.054 m^3/s, reduction of the natural discharge in the Bauli River is 0.086 m^3/s at the discharge reduction section.

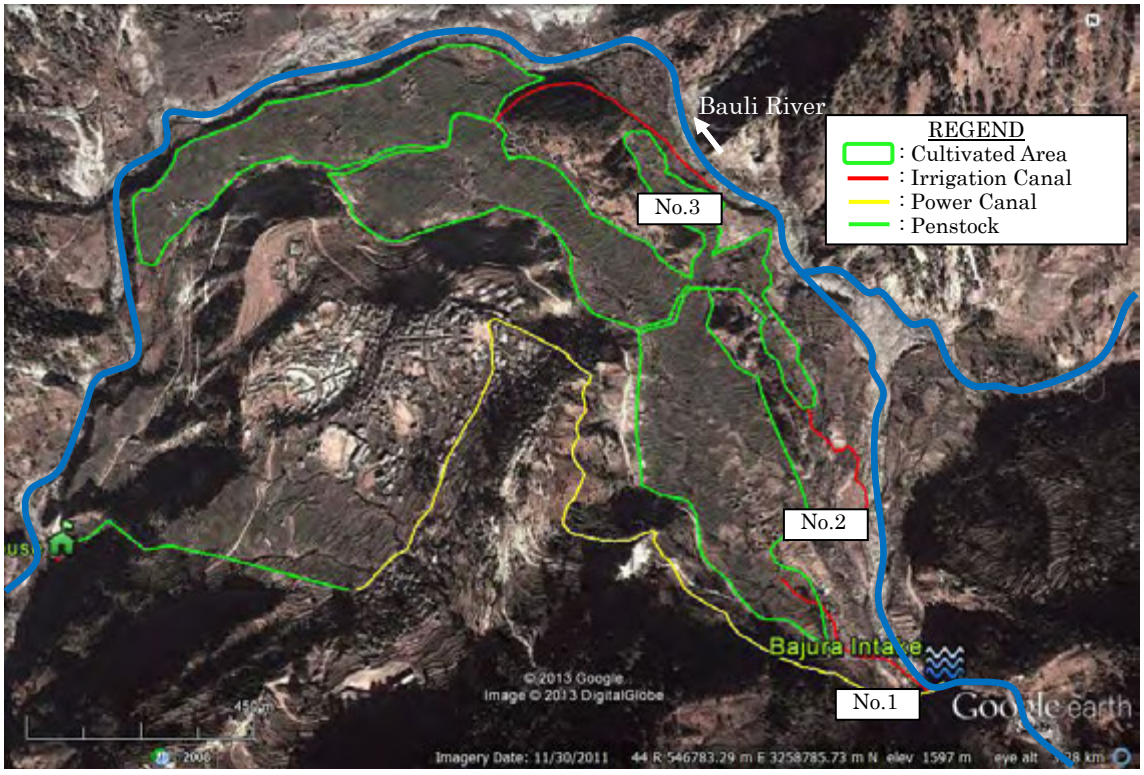


Figure 2.2 Location of Water Use at Discharge Reduction Section (Bajura)

Table 2.2 Details of Water Use at Discharge Reduction Section (Bajura)

Canal Intake No.	Intake Side	Distance from intake (m)	Cultivated Area (ha)	Peak Crop Water Requirement (lps)	Duration under cultivation	Crop Pattern	Remarks
1	Left Bank	50	13.78	10.84	Nov-Apr and Jul-Sep	Wheat, Rice, Vegetables	
2	Left Bank	400	15.21	12.00			
3	Left Bank	1,300	11.21	8.82			
Total	—	—	40.20	31.66	—	—	

※Peak Crop Water Requirement are needed on September

2.3 Water use at Syarpudaha Site

There exist seven water intakes for agricultural purposes coming directly from the Tilcha River section between the power intake and tailrace. Wheat, rice and vegetables were cultivated by double-cropping (November- April and July- September). Total area of the cultivated land is about 27 ha, and required amount of water is 0.027 m^3/s. With the plant discharge for power generation at 0.054 m^3/s, reduction of the natural discharge in the Tilcha River is 0.081 m^3/s at the discharge reduction section. The Tilcha River is blessed with ample discharge as underground water is supplied from an upstream lake. According to management association staff, the lake had not ever experienced drying up. Therefore, it may be assumed that the discharge of the Tilcha River would not be depleted even in the dry seasons. With the regulatory effect of water from the lake, negative influence of the water use at the discharge reduction section is considered to be less compared with the other sites.

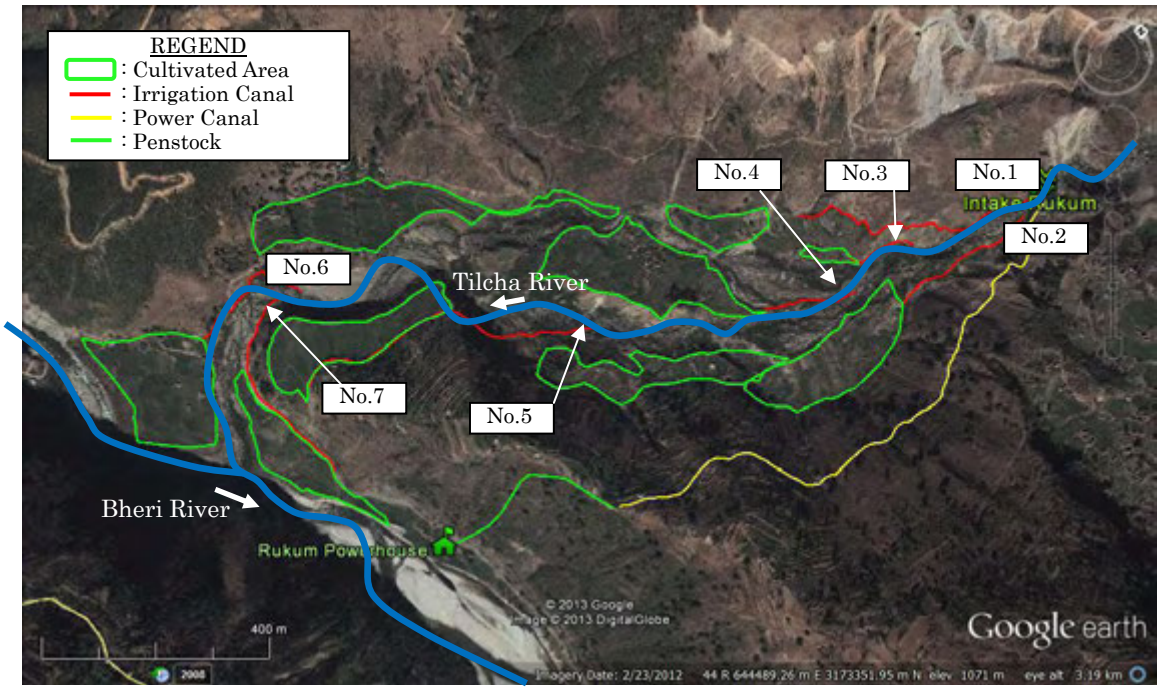


Figure 2.3 Location of Water Use at Discharge Reduction Section (Syarpudaha)

Table 2.3 Details of Water Use at Discharge Reduction Section (Syarpudaha)

Canal Intake No.	Intake Side	Distance from intake (m)	Cultivated Area (ha)	Peak Crop Water Requirement (lps)	Duration under cultivation	Crop Pattern	Remarks
1	Right Bank	10	5.70	5.77	Nov-Apr and Jul-Sep	Wheat, Rice, Vegetables	
2	Left Bank	65	6.58	6.66			
3	Right Bank	308	0.25	0.25			
4	Right Bank	464	4.60	4.66			
5	Left Bank	1,025	3.29	3.34			
6	Right Bank	1,687	4.36	4.41			
7	Left Bank	1,723	2.23	2.26			
Total	—	—	27.01	27.35	—	—	

※Peak Crop Water Requirement are needed on September

2.4 Water Use at Discharge Reduction Section

Water use at the discharge reduction sections of the three sites are summarized in Table 2.4. Wheat, rice and vegetables were cultivated, and water discharge of 0.004m^3/s-0.032 m^3/s are taken for that.

Table 2.4 Summary of Water Use at Discharge Reduction Section

Site	Agriculture					Power Generation	(3)Total Intake Water (m^3/s)	Remarks
	Cultivated Area (ha)	Number of Intake Point	(1)Peak Crop Water Requirement (m^3/s)	Duration under cultivation	Crop Pattern	(2)Intake Water (m^3/s)		
Bajhang	4.65	1	0.004	Nov-Apr and Jul-Sep	Wheat, Rice, Vegetables	0.415	0.419	
Bajura	40.20	3	0.032			0.054	0.086	
Sharpudaha	27.01	7	0.027			0.054	0.081	

※Peak Crop Water Requirement are needed on September

3. Examination on the Possibility of Capacity Expansion of Existing Hydro Plants

Possibility of capacity expansion of the existing hydropower plants were examined on the basis of the river flow conditions and water use in the discharge reduction sections. As seen in the following equation, available discharge for the expanded capacity was assumed as the minimum river discharge obtained during the observation period after deduction of the water use (for both the existing power plant and agriculture) and river maintenance flow. If such amount becomes less than zero, capacity expansion is judged to be not feasible.

Result of the examination is seen in Table 3.1. For Bajhang, available discharge for the expanded capacity ⑤turned out to be less than zero, and thus capacity expansion is judged not feasible. Meanwhile, ⑤ turned out to be more than zero for the other two sites, which may indicate possibility of capacity expansion. Particularly, Syarpudaha has a reserve for capacity expansion, as the available discharge for expansion is much larger than the existing water intake. It is noted, however, that the river flow conditions in the dry years could not be determined within the observation period of Bajura and Syarpudaha site of this study, and thus it is difficult to rigorously assess the feasibility of expansion with only the collected data to date. So as to improve accuracy of the assessment, it is recommended to further conduct continual discharge monitoring at the sites.

(Minimum river discharge obtained during the observation period) – (Water use for existing power plant and agriculture) – (River maintenance flow, $0.3m^3/s/100km^2$) > 0

Table 3.1 Available Discharge for Expanded Capacity

Site	Area (㎢)	①Minimum observed discharge (㎥/s)	②Water intake for agriculture (㎥/s)	③Water intake for existing hydro plant (㎥/s)	④River maintenance flow (㎥/s)	⑤Residual discharge ⑤=①-②-③-④ (㎥/s)	Available discharge for capacity expansion Positive number of ⑤ (㎥/s)
Bajhang	105.75	0.675	0.004	0.415	0.317	-0.061	0.000
Bajura	26.89	0.331	0.032	0.054	0.081	0.164	0.164
Syarpudaha	40.72	0.732	0.027	0.054	0.122	0.529	0.529

○According to the guidelines prepared by New Energy Foundation, Japan, the firm discharge for power generation of run-off river type is defined as the available discharge for 355 days a year. In this study, the minimum observed discharge during the observation period was adopted instead.

○As the observation period did not cover the latter part of dry season (three months between March and May), the adopted figure might be larger than the 355 days

available discharge.

○According to the guidelines prepared by MLIT (predecessor of the Ministry of Land, Infrastructure, Transport and Tourism, Japan) and METI (predecessor of the Ministry of Economy, Trade and Industry, Japan), the river maintenance flow of 0.1-0.3 m^3/s per catchment area of 100 km^2 is suggested in case of renewal of duration of water rights for power generation. Referring to this, the river maintenance flow of 0.3 $m^3/s/100$ km^2 is considered in this study.

Discharge measrued near the intake of various sites

Summary Sheet – Bajhang

	Date	Time	Discharge
Measurement 1.1	22-Oct-13	15:30	3.69
Measurement 1.2	22-Oct-13	16:10	3.60
Measurement 1.3	23-Oct-13	7:30	3.65
Measurement 2.1	26-Nov-13	15:30	1.40
Measurement 2.2	26-Nov-13	15:45	1.50
Measurement 2.3	27-Nov-13	8:35	1.48
Measurement 3.1	23-Dec-13	16:45	0.90
Measurement 3.2	23-Dec-13	16:55	0.79
Measurement 3.3	24-Dec-13	8:15	0.91
Measurement 4.1	19-Jan-14	15:30	0.90
Measurement 4.2	19-Jan-14	15:45	0.89
Measurement 4.3	20-Jan-14	8:30	0.88
Measurement 5.1	10-Feb-14	15:30	0.66
Measurement 5.2	10-Feb-14	16:30	0.67
Measurement 5.3	11-Feb-14	7:15	0.65

Summary Sheet – Bajura

	Date	Time	Discharge
Measurement 1.1	25-Oct-13	14:45	0.93
Measurement 1.2	25-Oct-13	15:05	0.97
Measurement 1.3	26-Oct-13	7:40	0.93
Measurement 2.1	29-Nov-13	16:30	0.53
Measurement 2.2	29-Nov-13	17:00	0.50
Measurement 2.3	30-Nov-13	13:30	0.60
Measurement 3.1	26-Dec-13	12:20	0.47
Measurement 3.2	26-Dec-13	12:35	0.48
Measurement 3.3	27-Dec-13	8:45	0.45
Measurement 4.1	15-Jan-14	16:25	0.44
Measurement 4.2	15-Jan-14	16:40	0.42
Measurement 4.3	16-Jan-14	8:00	0.41
Measurement 5.1	12-Feb-14	15:40	0.32
Measurement 5.2	12-Feb-14	16:05	0.31
Measurement 5.3	13-Feb-14	7:45	0.30

Summary Sheet – Syarpudaha

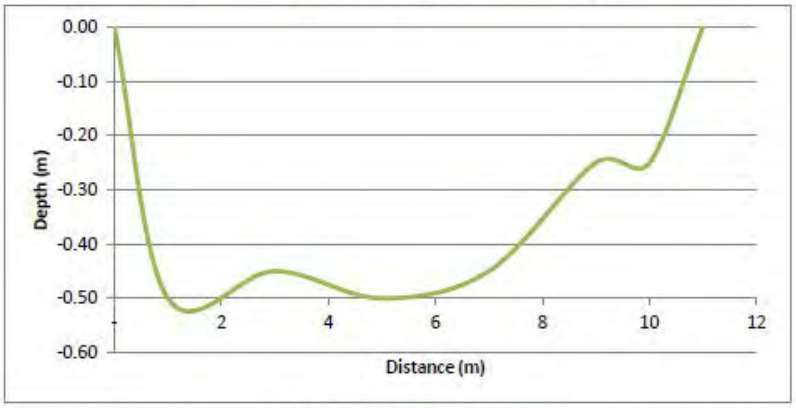
	Date	Time	Discharge
Measurement 1.1	29-Oct-13	15:05	3.24
Measurement 1.2	29-Oct-13	17:15	3.11
Measurement 1.3	30-Oct-13	7:30	3.15
Measurement 2.1	5-Dec-13	12:10	1.77
Measurement 2.2	5-Dec-13	12:30	1.80
Measurement 2.3	6-Dec-13	9:05	1.79
Measurement 3.1	30-Dec-13	14:50	1.25
Measurement 3.2	30-Dec-13	15:00	1.25
Measurement 3.3	31-Dec-13	8:45	1.25
Measurement 4.1	24-Jan-14	13:30	0.97
Measurement 4.2	24-Jan-14	13:50	0.99
Measurement 4.3	25-Jan-14	9:00	0.99
Measurement 5.1	14-Feb-14	16:05	0.59
Measurement 5.2	14-Feb-14	16:35	0.55
Measurement 5.3	15-Feb-14	12:05	0.54

Observation Record Sheet of Water Flow

Site	BAJHANG	River	JAULI GAD
Date	22-Oct-13	Time	15:30
		Weather Condition	Sunny

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

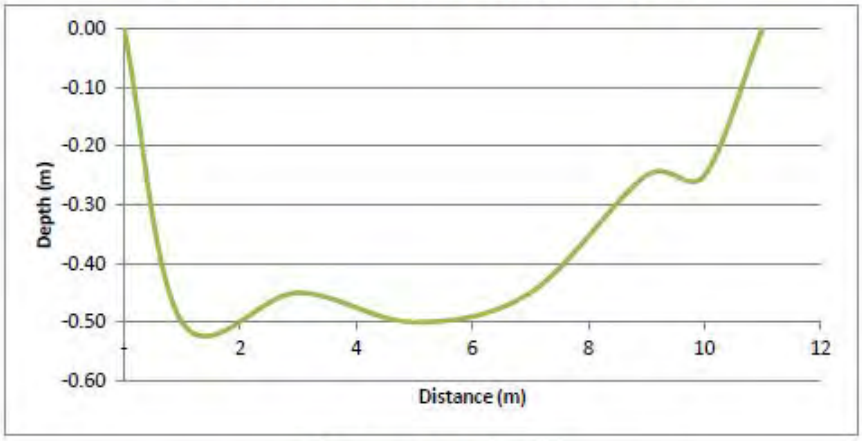
Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0	0.00	0	0.00	0.00	0.00
1	-0.50	25	0.54	0.75	0.40
3	-0.45	13	1.05	0.90	0.95
5	-0.50	23	0.89	1.00	0.89
7	-0.45	20	1.02	0.90	0.92
9	-0.25	21	0.97	0.38	0.37
10	-0.25	31	0.66	0.25	0.16
11	0.00	0	0.00	0.00	0.00
TOTAL DISCHARGE (m^3/s)					3.69

Observation Record Sheet of Water Flow

Site	BAJHANG	River	JAULI GAD
Date	22-Oct-13	Time	16:10
		Weather Condition	Sunny

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

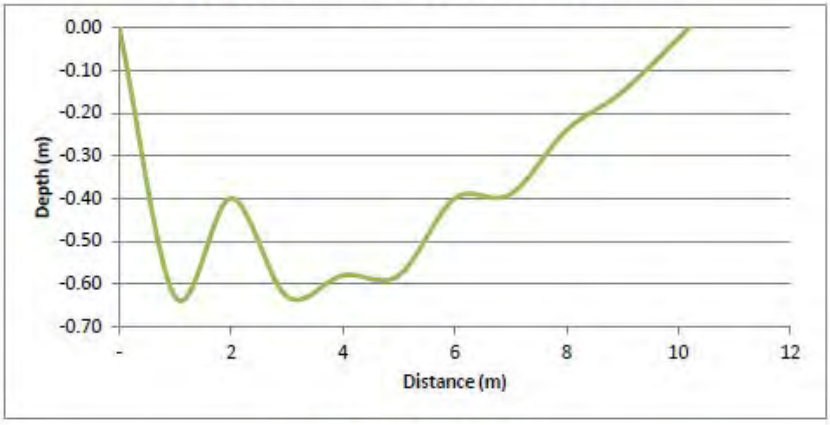
Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0	0.00	0	0.00	0.00	0.00
1	-0.50	45	0.45	0.75	0.34
3	-0.45	20	1.02	0.90	0.92
5	-0.50	23	0.89	1.00	0.89
7	-0.45	19	1.08	0.90	0.97
9	-0.25	23	0.89	0.38	0.33
10	-0.25	34	0.60	0.25	0.15
11	0.00	0	0.00	0.00	0.00
TOTAL DISCHARGE (m^3/s)					3.60

Observation Record Sheet of Water Flow

Site	BAJHANG	River	JAULI GAD
Date	23-Oct-13	Time	7:30
		Weather Condition	Sunny

Discharge Measurement Site

Cross section of river at measurement point



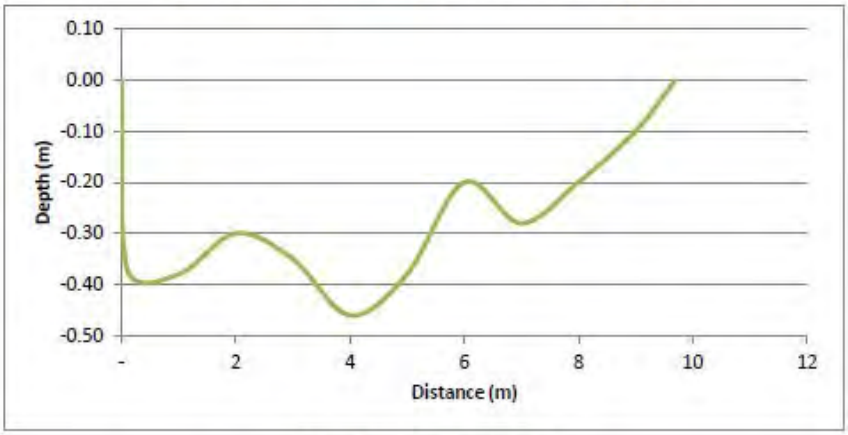
Discharge Calculation

Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0	0.00	0	0.00	0.00	0.00
1	-0.63	26	0.78	0.63	0.49
2	-0.40	22	0.93	0.40	0.37
3	-0.63	18	1.14	0.63	0.72
4	-0.58	31	0.66	0.58	0.38
5	-0.58	28	0.73	0.58	0.42
6	-0.40	19	1.08	0.40	0.43
7	-0.39	17	1.21	0.39	0.47
8	-0.24	19	1.08	0.24	0.26
9	-0.15	32	0.63	0.17	0.10
10.2	0.00	0	0.00	0.00	0.00
TOTAL DISCHARGE (m^3/s)					3.65

Observation Record Sheet of Water Flow

Site	BAJHANG	River	JAULI GAD
Date	26-Nov-13	Time	15:30
		Weather Condition	Sunny

Cross section of river at measurement point



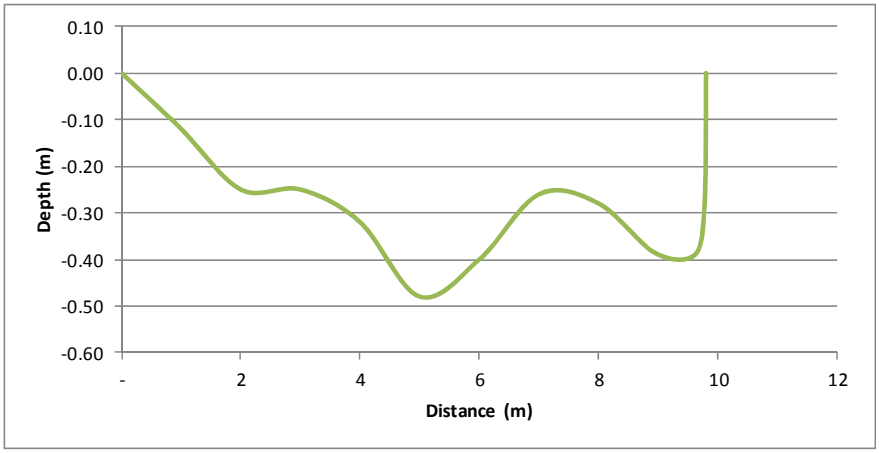
Discharge Calculation

Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0.0	0.00	0	0.00	0.00	0.00
0.1	-0.37	71	0.33	0.19	0.06
1.0	-0.38	58	0.40	0.36	0.15
2.0	-0.30	45	0.52	0.30	0.16
3.0	-0.35	38	0.62	0.35	0.22
4.0	-0.46	40	0.59	0.46	0.27
5.0	-0.38	46	0.51	0.38	0.19
6.0	-0.20	33	0.72	0.20	0.14
7.0	-0.28	70	0.33	0.28	0.09
8.0	-0.20	70	0.33	0.20	0.07
9.0	-0.10	40	0.59	0.09	0.05
9.7	0.00	0	0.00	0.00	0.00
TOTAL DISCHARGE (m^3/s)					1.40

Observation Record Sheet of Water Flow

Site	BAJHANG	River	JAULI GAD
Date	26-Nov-13	Time	15:45
		Weather Condition	Sunny

Cross section of river at measurement point



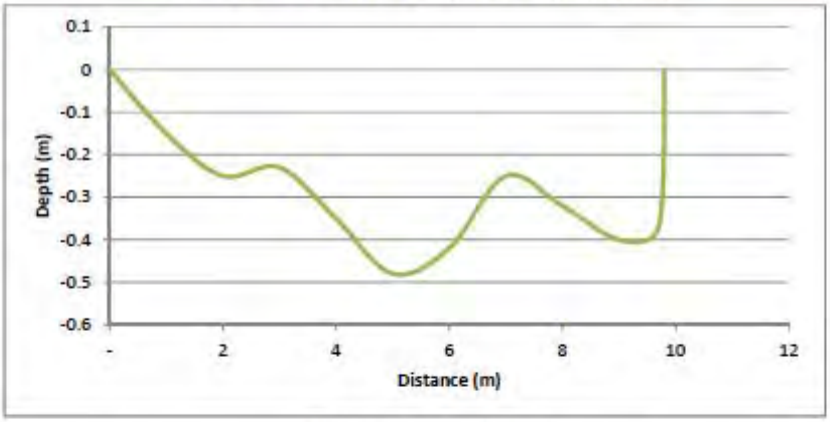
Discharge Calculation

Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0.0	0.00	0	0.00	0.00	0.00
1.0	−0.12	90	0.18	0.12	0.02
2.0	−0.25	42	0.40	0.25	0.10
3.0	−0.25	30	0.56	0.25	0.14
4.0	−0.32	23	0.74	0.32	0.24
5.0	−0.48	32	0.53	0.48	0.25
6.0	−0.40	28	0.60	0.40	0.24
7.0	−0.26	24	0.71	0.26	0.18
8.0	−0.28	31	0.54	0.28	0.15
9.0	−0.39	41	0.41	0.33	0.14
9.7	−0.37	58	0.28	0.15	0.04
9.8	0.00	0	0.00	0.00	0.00
TOTAL DISCHARGE (m^3/s)					1.50

Observation Record Sheet of Water Flow

Site	BAJHANG	River	JAULI GAD
Date	27-Nov-13	Time	8:35
		Weather Condition	Sunny

Cross section of river at measurement point



Discharge Calculation

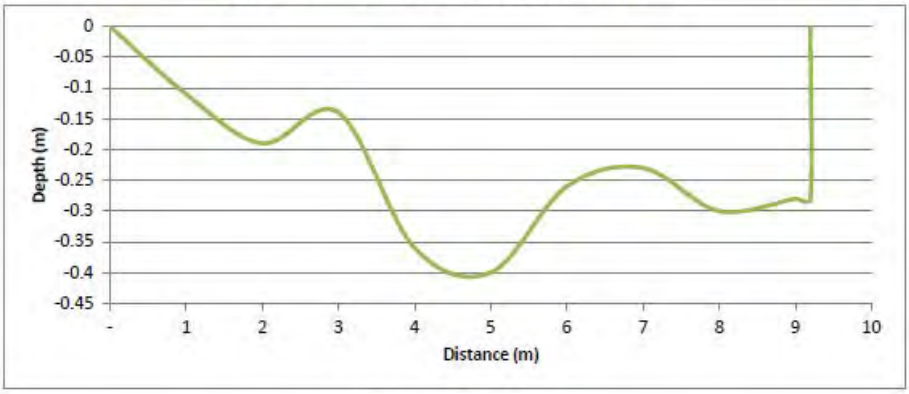
Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0	0	0	0.00	0.00	0.00
1	-0.15	108	0.18	0.15	0.03
2	-0.25	50	0.40	0.25	0.10
3	-0.23	37	0.55	0.23	0.13
4	-0.35	28	0.73	0.35	0.25
5	-0.48	39	0.52	0.48	0.25
6	-0.42	34	0.60	0.42	0.25
7	-0.25	30	0.68	0.25	0.17
8	-0.32	62	0.32	0.32	0.10
9	-0.40	42	0.48	0.34	0.16
9.7	-0.37	66	0.30	0.15	0.04
9.8	0.00	0	0.00	0.00	0.00
				TOTAL DISCHARGE (m^3/s)	1.48

Observation Record Sheet of Water Flow

Site	BAJHANG	River	JAULI GAD
Date	23-Dec-13	Time	16:45
		Weather Condition	Sunny

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

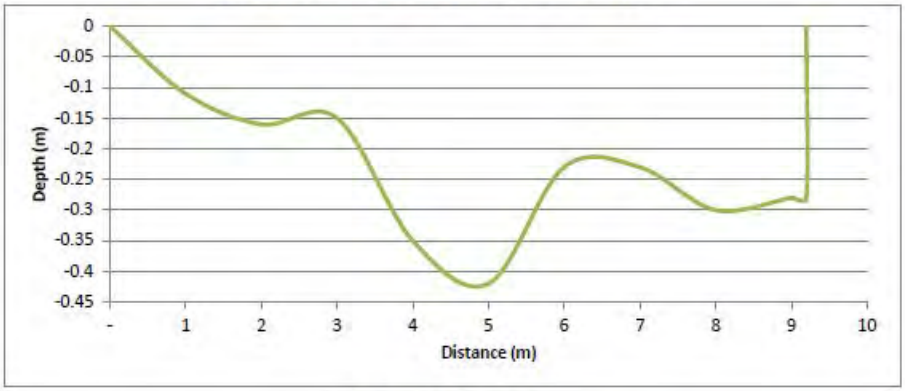
Distance	Revolutions	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0	10	0	0	0.00	0.00	0.00
1	10	-0.11	0	0.00	0.11	0.00
2	10	-0.19	29	0.22	0.19	0.04
3	10	-0.14	19	0.35	0.14	0.05
4	10	-0.36	12	0.56	0.36	0.20
5	10	-0.40	12	0.56	0.40	0.22
6	10	-0.26	15	0.45	0.26	0.12
7	10	-0.23	20	0.33	0.23	0.08
8	10	-0.30	16	0.42	0.30	0.13
9	10	-0.28	19	0.35	0.17	0.06
9.2	10	-0.28	23	0.29	0.03	0.01
TOTAL DISCHARGE (m^3/s)						0.90

Observation Record Sheet of Water Flow

Site	BAJHANG	River	JAULI GAD
Date	23-Dec-13	Time	16:55
		Weather Condition	Sunny

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

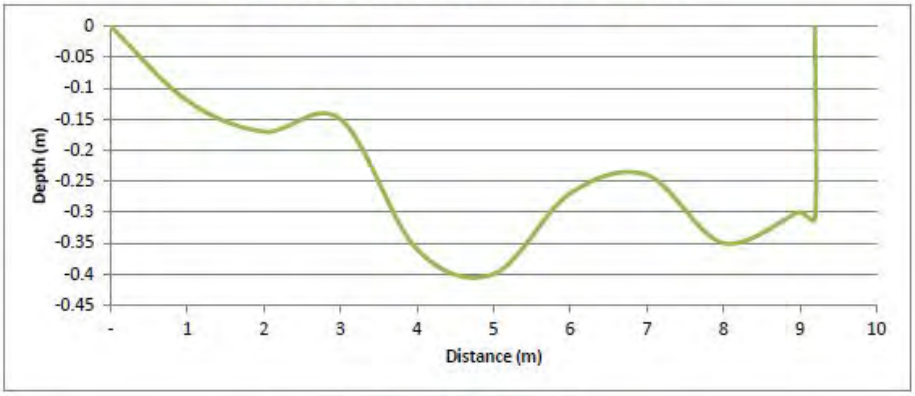
Distance	Revolutions	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0	10	0	0	0.00	0.00	0.00
1	10	-0.11	0	0.00	0.11	0.00
2	10	-0.16	34	0.19	0.16	0.03
3	10	-0.15	18	0.37	0.15	0.06
4	10	-0.35	16	0.42	0.35	0.15
5	10	-0.42	13	0.52	0.42	0.22
6	10	-0.23	15	0.45	0.23	0.10
7	10	-0.23	16	0.42	0.23	0.10
8	10	-0.30	25	0.26	0.30	0.08
9	10	-0.28	20	0.33	0.17	0.06
9.2	10	-0.28	23	0.29	0.03	0.01
TOTAL DISCHARGE (m^3/s)						0.79

Observation Record Sheet of Water Flow

Site	BAJHANG	River	JAULI GAD
Date	24-Dec-13	Time	8:15
		Weather Condition	Sunny

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

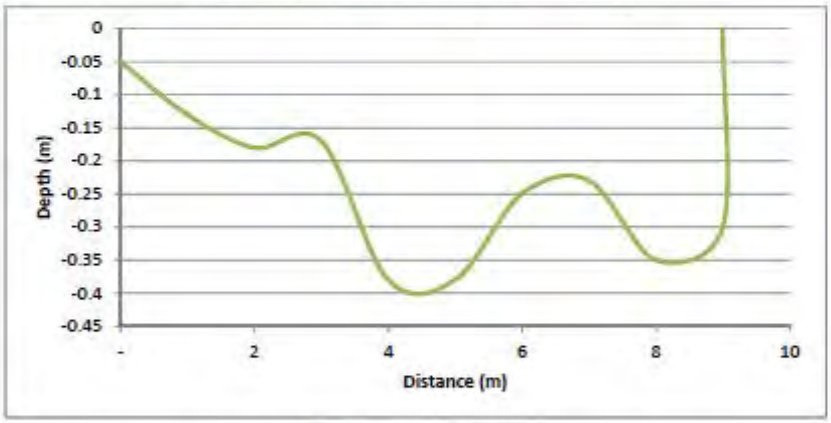
Distance	Revolutions	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0	10	0	0	0.00	0.00	0.00
1	10	-0.12	0	0.00	0.12	0.00
2	10	-0.17	24	0.27	0.17	0.05
3	10	-0.15	17	0.39	0.15	0.06
4	10	-0.36	16	0.42	0.36	0.15
5	10	-0.40	11	0.61	0.40	0.25
6	10	-0.27	14	0.48	0.27	0.13
7	10	-0.24	22	0.30	0.24	0.07
8	10	-0.35	16	0.42	0.35	0.15
9	10	-0.30	21	0.31	0.18	0.06
9.2	10	-0.31	25	0.26	0.03	0.01
TOTAL DISCHARGE (m^3/s)						0.91

Observation Record Sheet of Water Flow

Site	BAJHANG	River	JAULI GAD
Date	19-Jan-14	Time	15:30
		Weather Condition	Sunny (Rainf/snowfall before 24 hr.)

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

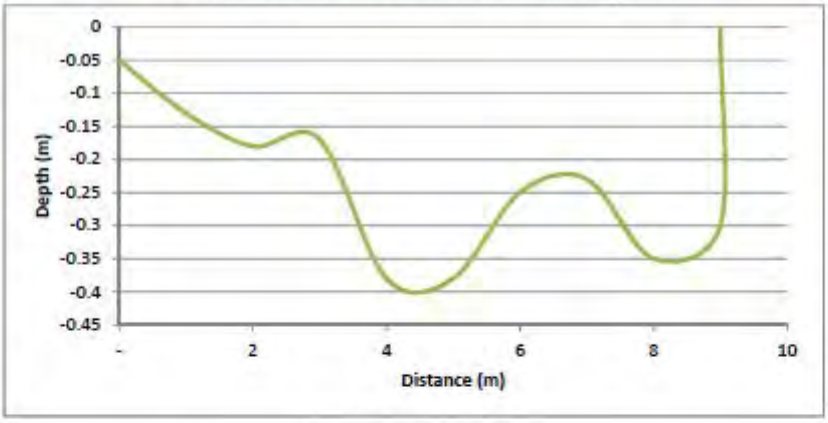
Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0	-0.05	0	0.00	0.03	0.00
1	-0.13	50	0.28	0.13	0.04
2	-0.18	50	0.15	0.18	0.03
3	-0.17	50	0.46	0.17	0.08
4	-0.38	50	0.39	0.38	0.15
5	-0.38	50	0.51	0.38	0.19
6	-0.25	50	0.44	0.25	0.11
7	-0.23	50	0.53	0.23	0.12
8	-0.35	50	0.43	0.35	0.15
9	-0.30	50	0.28	0.15	0.04
TOTAL DISCHARGE (m^3/s)					0.90

Observation Record Sheet of Water Flow

Site	BAJHANG	River	JAULI GAD
Date	19-Jan-14	Time	15:45
		Weather Condition	Sunny (Rain/snowfall before 24 hr.)

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

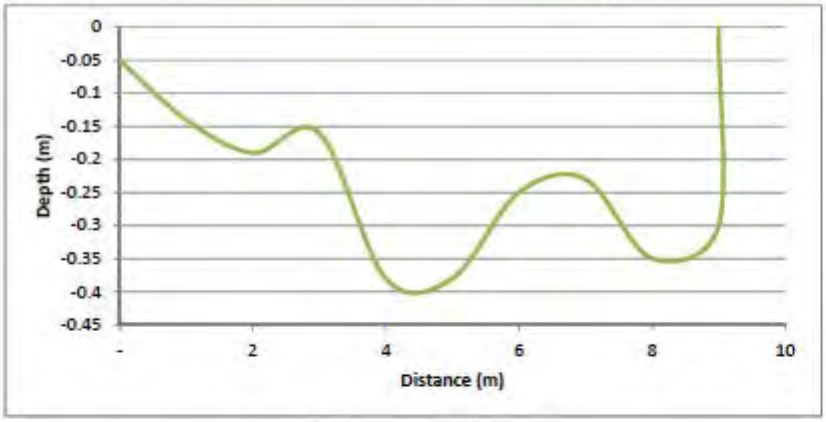
Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0	-0.05	0	0.00	0.03	0.00
1	-0.13	50	0.29	0.13	0.04
2	-0.18	50	0.17	0.18	0.03
3	-0.17	50	0.44	0.17	0.08
4	-0.38	50	0.36	0.38	0.14
5	-0.38	50	0.46	0.38	0.17
6	-0.25	50	0.47	0.25	0.12
7	-0.23	50	0.50	0.23	0.11
8	-0.35	50	0.47	0.35	0.16
9	-0.30	50	0.28	0.15	0.04
TOTAL DISCHARGE (m^3/s)					0.89

Observation Record Sheet of Water Flow

Site	BAJHANG	River	JAULI GAD
Date	20-Jan-14	Time	8:30
		Weather Condition	Sunny (Rain/snowfall before 36 hr.)

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

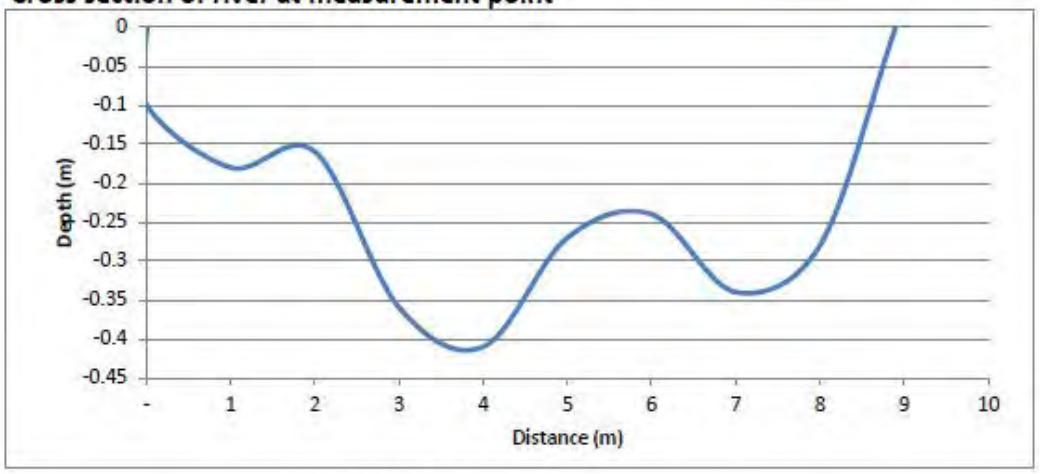
Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0	-0.05	0	0.00	0.03	0.00
1	-0.14	50	0.22	0.14	0.03
2	-0.19	50	0.15	0.19	0.03
3	-0.16	50	0.44	0.16	0.07
4	-0.38	50	0.37	0.38	0.14
5	-0.38	50	0.48	0.38	0.18
6	-0.25	50	0.47	0.25	0.12
7	-0.23	50	0.46	0.23	0.10
8	-0.35	50	0.47	0.35	0.16
9	-0.30	50	0.28	0.15	0.04
TOTAL DISCHARGE (m^3/s)					0.88

Observation Record Sheet of Water Flow

Site	BAJHANG	River	JAULI GAD
Date	10-Feb-14	Time	15:30
		eather Conditi	Cloudy

Discharge Measurement Site

Cross section of river at measurement point



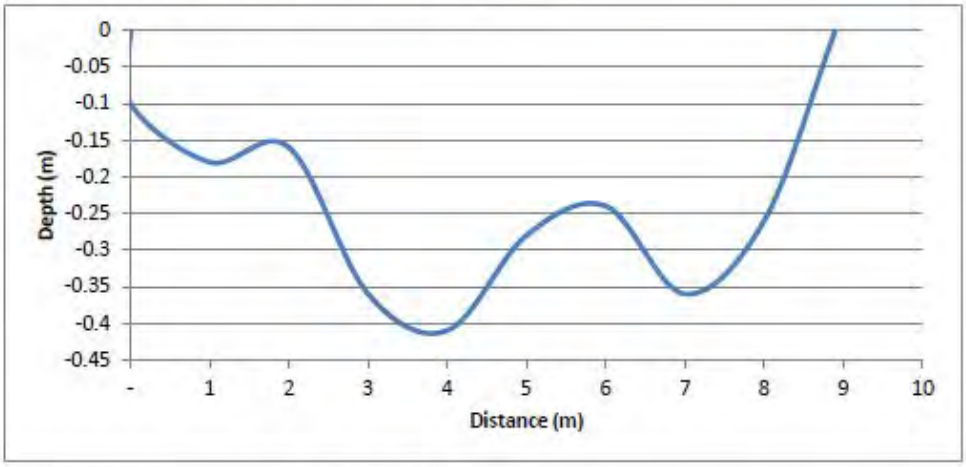
Discharge Calculation

Distance	Depth	Revolutions	Time (secs)	Velocity	Cross sectional area	Discharge
0	-0.1	20	0	0.00	0.05	0.00
1	-0.18	40	130	0.20	0.18	0.04
2	-0.16	40	92	0.29	0.16	0.05
3	-0.36	40	87	0.30	0.36	0.11
4	-0.41	40	59	0.45	0.41	0.19
5	-0.27	40	65	0.41	0.27	0.11
6	-0.24	40	103	0.25	0.24	0.06
7	-0.34	32	82	0.26	0.34	0.09
8	-0.28	20	132	0.09	0.27	0.02
8.9	0.00	0	0	0.00	0.00	0.00
TOTAL DISCHARGE (m^3/s)						0.66

Observation Record Sheet of Water Flow

Site	BAJHANG	River	JAULI GAD
Date	10-Feb-14	Time	16:30
		eather Conditi	Cloudy

Cross section of river at measurement point



Discharge Calculation

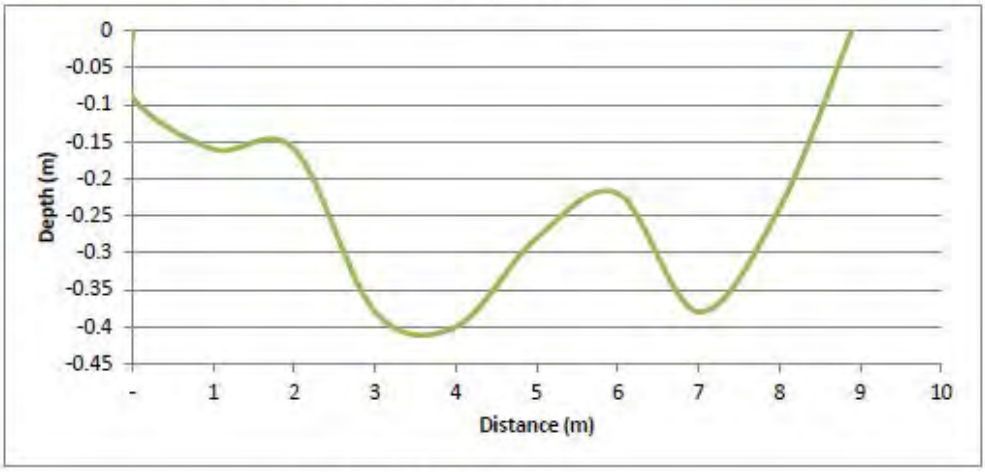
Distance	Depth	Revolutions	Time (secs)	Velocity	Cross sectional area	Discharge
0	-0.1	20	0	0.00	0.05	0.00
1	-0.18	20	82	0.15	0.18	0.03
2	-0.16	30	88	0.22	0.16	0.04
3	-0.36	30	62	0.32	0.36	0.12
4	-0.41	30	42	0.48	0.41	0.20
5	-0.28	30	48	0.42	0.28	0.12
6	-0.24	30	77	0.25	0.24	0.06
7	-0.36	30	89	0.22	0.36	0.08
8	-0.26	20	93	0.13	0.25	0.03
8.9	0.00	0	0	0.00	0.00	0.00
TOTAL DISCHARGE (m^3/s)						0.67

Observation Record Sheet of Water Flow

Site	BAJHANG	River	JAULI GAD
Date	11-Feb-14	Time	7:15
		eather Conditi	Cloudy

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

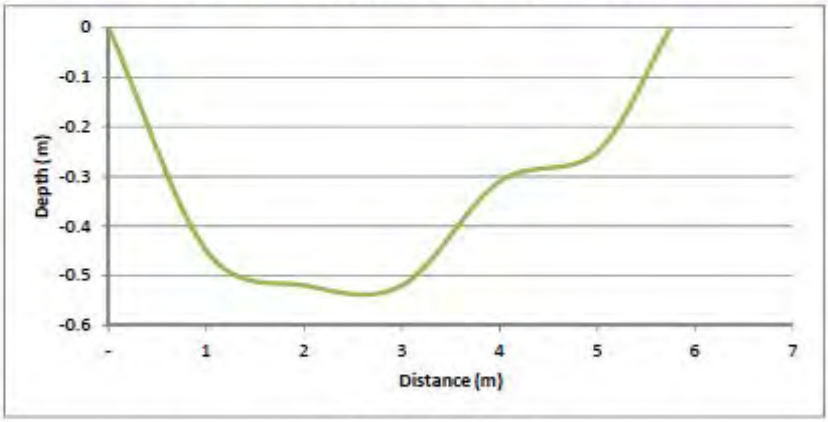
Distance	Revolutions	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0	20	-0.09	0	0.00	0.05	0.00
1	20	-0.16	95	0.13	0.16	0.02
2	30	-0.16	85	0.23	0.16	0.04
3	30	-0.38	66	0.30	0.38	0.11
4	30	-0.40	42	0.48	0.40	0.19
5	30	-0.28	47	0.43	0.28	0.12
6	30	-0.22	80	0.24	0.22	0.05
7	30	-0.38	95	0.20	0.38	0.08
8	20	-0.24	90	0.14	0.23	0.03
8.9	0	0.00	0	0.00	0.00	0.00
TOTAL DISCHARGE (m^3/s)						0.65

Observation Record Sheet of Water Flow

Site	BAJURA	River	BAULI GAD
Date	25-Oct-13	Time	14:45
		Weather Condition	Sunny

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

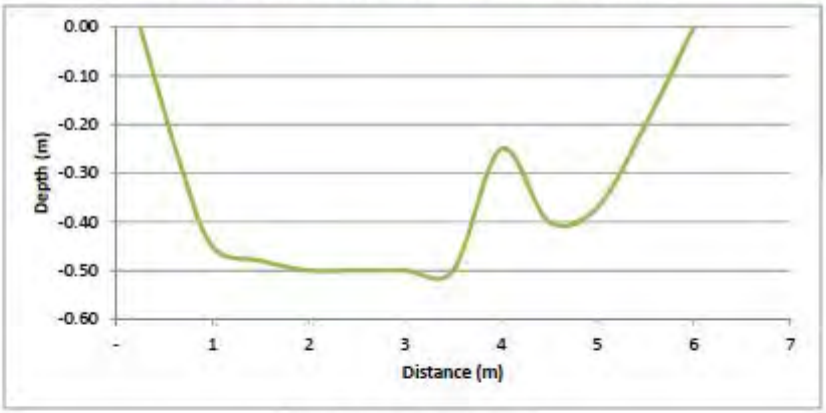
Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0.00	0	0	0.00	0.00	0.00
1.00	-0.45	33	0.61	0.45	0.28
2.00	-0.52	44	0.46	0.52	0.24
3.00	-0.52	55	0.36	0.52	0.19
4.00	-0.31	29	0.70	0.31	0.22
5.00	-0.25	102	0.05	0.22	0.01
5.75	0	0	0.00	0.00	0.00
TOTAL DISCHARGE (m^3/s)					0.93

Observation Record Sheet of Water Flow

Site	BAJURA	River	BAULI GAD
Date	25-Oct-13	Time	15:05
		Weather Condition	Sunny

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

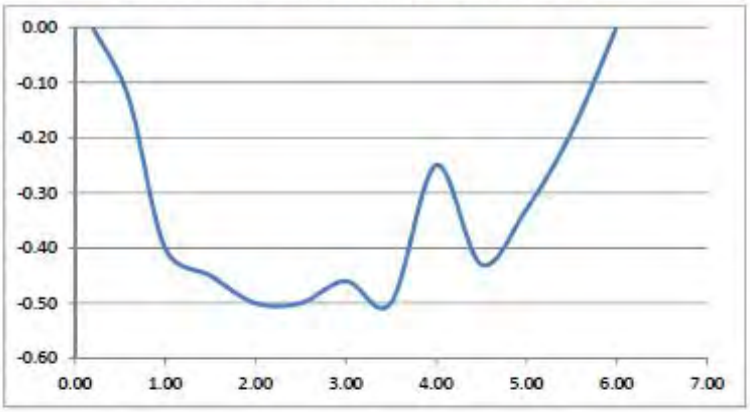
Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
6.00	0.00	0	0.00	0.00	0.00
5.50	-0.20	41	0.07	0.10	0.01
5.00	-0.37	71	0.28	0.19	0.05
4.50	-0.40	46	0.44	0.20	0.09
4.00	-0.25	23	0.89	0.13	0.11
3.50	-0.50	37	0.55	0.25	0.14
3.00	-0.50	86	0.23	0.25	0.06
2.50	-0.50	54	0.37	0.25	0.09
2.00	-0.50	52	0.38	0.25	0.10
1.50	-0.48	35	0.58	0.24	0.14
1.00	-0.45	24	0.85	0.19	0.16
0.65	-0.27	25	0.26	0.10	0.03
0.25	0.00	0	0.00	0.00	0.00
TOTAL DISCHARGE (m^3/s)					0.97

Observation Record Sheet of Water Flow

Site	BAJURA	River	BAULI GAD
Date	26-Oct-13	Time	7:40
		Weather Condition	Sunny

Discharge Measurement Site

Cross section of river at measurement point



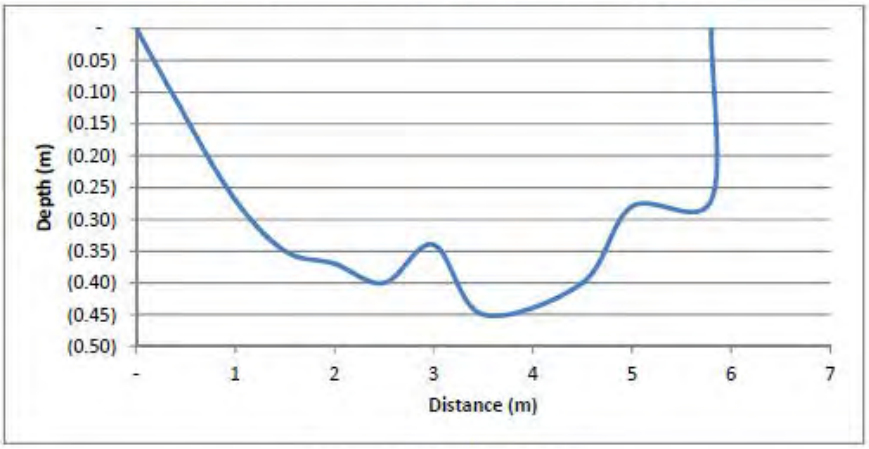
Discharge Calculation

Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
6.00	0.00	0	0.00	0.00	0.00
5.50	-0.19	66	0.04	0.10	0.00
5.00	-0.33	85	0.23	0.17	0.04
4.50	-0.43	39	0.52	0.22	0.11
4.00	-0.25	25	0.82	0.13	0.10
3.50	-0.50	36	0.56	0.25	0.14
3.00	-0.46	90	0.22	0.23	0.05
2.50	-0.50	47	0.43	0.25	0.11
2.00	-0.50	56	0.36	0.25	0.09
1.50	-0.45	41	0.49	0.23	0.11
1.00	-0.40	24	0.85	0.18	0.15
0.60	-0.13	15	0.45	0.05	0.02
0.20	0.00	0	0.00	0.00	0.00
TOTAL DISCHARGE (m^3/s)					0.93

Observation Record Sheet of Water Flow

Site	BAJURA	River	BAULI GAD
Date	29-Nov-13	Time	16:30
		Weather Condition	Sunny

Cross section of river at measurement point



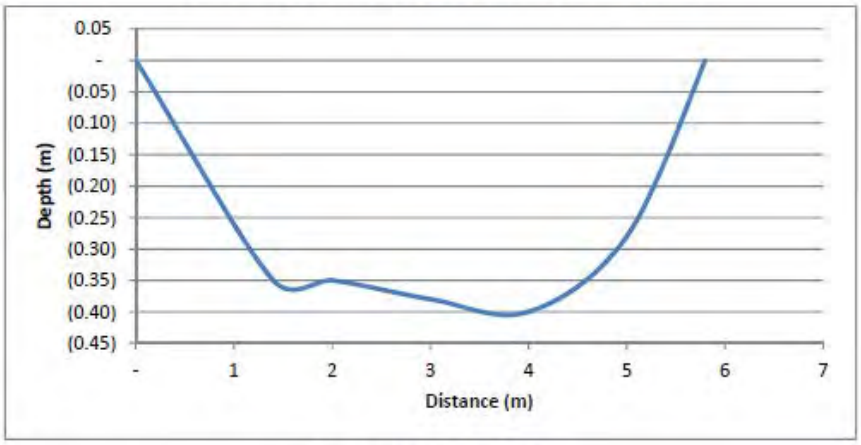
Discharge Calculation

Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
-	-	-	-	-	-
0.50	(0.14)	198.00	0.09	0.07	0.01
1.00	(0.27)	118.00	0.16	0.14	0.02
1.50	(0.35)	53.00	0.38	0.18	0.07
2.00	(0.37)	31.00	0.66	0.19	0.12
2.50	(0.40)	54.00	0.37	0.20	0.07
3.00	(0.34)	237.00	0.07	0.17	0.01
3.50	(0.45)	134.00	0.14	0.34	0.05
4.50	(0.40)	62.00	0.32	0.30	0.10
5.00	(0.28)	41.00	0.49	0.18	0.09
5.80	(0.27)	-	-	0.11	-
TOTAL DISCHARGE (m^3/s)					0.53

Observation Record Sheet of Water Flow

Site	BAJURA	River	BAULI GAD
Date	29-Nov-13	Time	17:00
		Weather Condition	Sunny

Cross section of river at measurement point



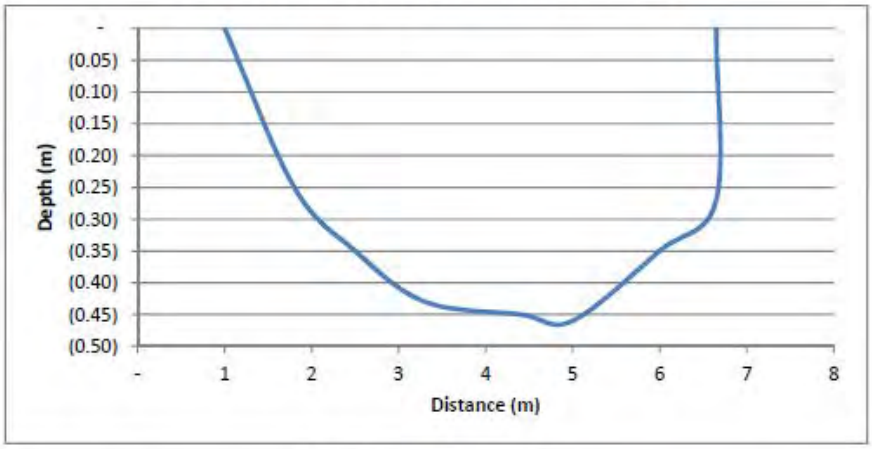
Discharge Calculation

Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
-	-	-	-	-	-
1.40	(0.35)	57.00	0.23	0.35	0.08
2.00	(0.35)	20.00	0.68	0.28	0.19
3.00	(0.38)	103.00	0.12	0.38	0.05
4.00	(0.40)	80.00	0.16	0.40	0.06
5.00	(0.28)	41.00	0.49	0.25	0.12
5.80	-	-	-	-	-
TOTAL DISCHARGE (m^3/s)					0.50

Observation Record Sheet of Water Flow

Site	BAJURA	River	BAULI GAD
Date	30-Nov-13	Time	13:30
		Weather Condition	Sunny

Cross section of river at measurement point



Discharge Calculation

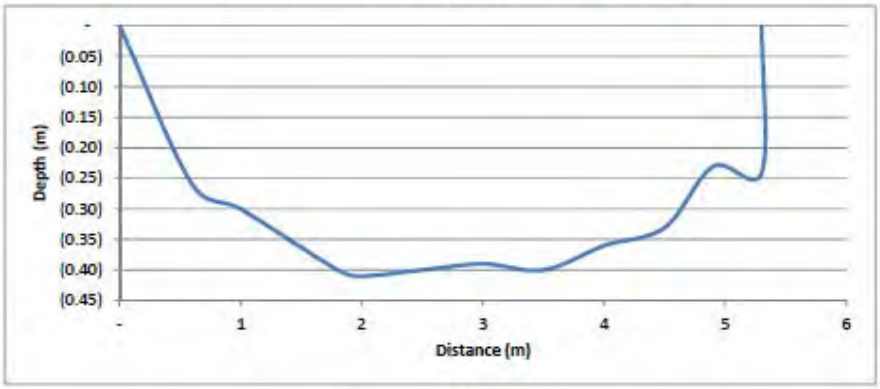
Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
1.00	-	-	-	-	-
1.80	(0.25)	44.00	0.14	0.19	0.03
2.50	(0.35)	18.00	0.37	0.26	0.10
3.30	(0.43)	11.00	0.61	0.41	0.25
4.40	(0.45)	64.00	0.09	0.38	0.04
5.00	(0.46)	41.00	0.15	0.37	0.06
6.00	(0.35)	15.00	0.45	0.29	0.13
6.65	(0.27)	-	-	0.09	-
TOTAL DISCHARGE (m^3/s)					0.60

Observation Record Sheet of Water Flow

Site	BAJURA	River	BAULI GAD
Date	26-Dec-13	Time	12:20
		Weather Condition	Sunny

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

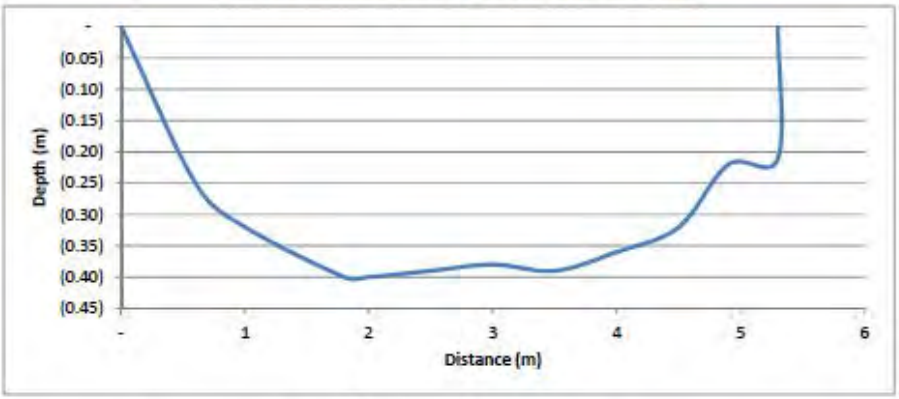
Distance	Revolutions	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0.60	9.00	(0.26)	50.00	0.11	0.13	0.01
1.00	20.00	(0.30)	50.00	0.26	0.18	0.05
1.80	46.00	(0.40)	50.00	0.62	0.20	0.12
2.00	34.00	(0.41)	50.00	0.46	0.14	0.07
2.50	13.00	(0.40)	50.00	0.17	0.20	0.03
3.00	4.00	(0.39)	50.00	0.04	0.20	0.01
3.50	15.00	(0.40)	50.00	0.19	0.20	0.04
4.00	20.00	(0.36)	50.00	0.26	0.18	0.05
4.50	29.00	(0.33)	50.00	0.39	0.15	0.06
4.90	29.00	(0.23)	50.00	0.39	0.09	0.04
5.30	-	(0.24)	50.00	-	0.05	-
TOTAL DISCHARGE (m^3/s)						0.47

Observation Record Sheet of Water Flow

Site	BAJURA	River	BAULI GAD
Date	26-Dec-13	Time	12:35
		Weather Condition	Sunny

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

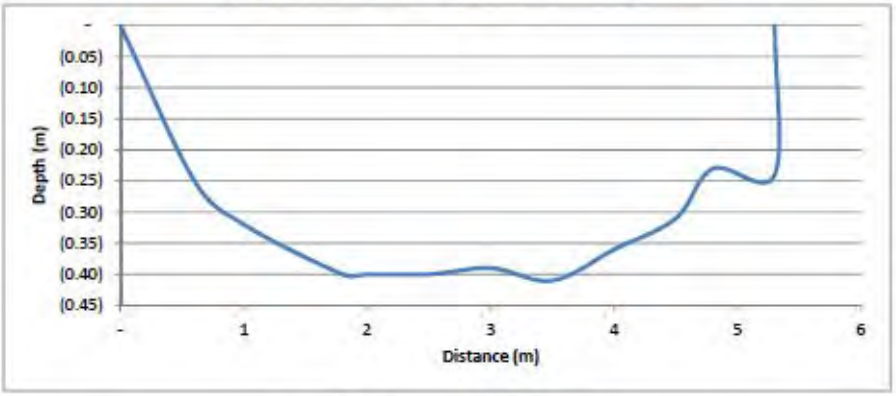
Distance	Revolutions	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0.60	10.00	(0.25)	50.00	0.12	0.13	0.02
1.00	27.00	(0.32)	50.00	0.36	0.19	0.07
1.80	47.00	(0.40)	50.00	0.64	0.20	0.13
2.00	37.00	(0.40)	50.00	0.50	0.14	0.07
2.50	8.00	(0.39)	50.00	0.10	0.20	0.02
3.00	3.00	(0.38)	50.00	0.03	0.19	0.01
3.50	15.00	(0.39)	50.00	0.19	0.20	0.04
4.00	19.00	(0.36)	50.00	0.25	0.18	0.04
4.50	29.00	(0.32)	50.00	0.39	0.14	0.06
4.90	34.00	(0.22)	50.00	0.46	0.09	0.04
5.30	-	(0.21)	50.00	-	0.04	-
TOTAL DISCHARGE (m^3/s)						0.48

Observation Record Sheet of Water Flow

Site	BAJURA	River	BAULI GAD
Date	27-Dec-13	Time	8:45
		Weather Condition	Sunny

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

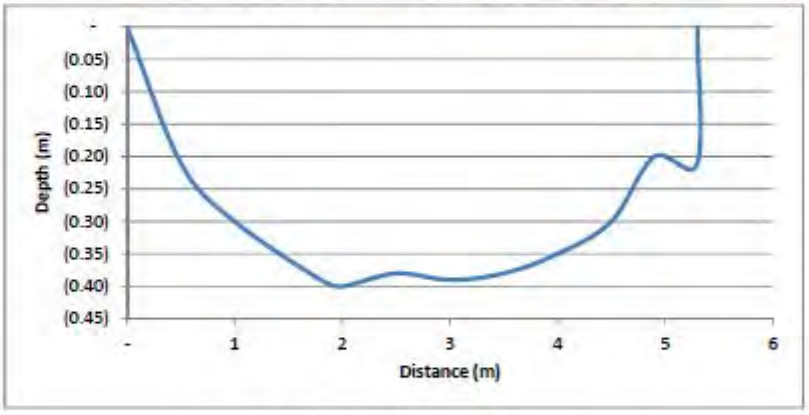
Distance	Revolutions	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0.60	9.00	(0.25)	50.00	0.11	0.13	0.01
1.00	23.00	(0.32)	50.00	0.30	0.19	0.06
1.80	47.00	(0.40)	50.00	0.64	0.20	0.13
2.00	30.00	(0.40)	50.00	0.40	0.14	0.06
2.50	7.00	(0.40)	50.00	0.08	0.20	0.02
3.00	4.00	(0.39)	50.00	0.04	0.20	0.01
3.50	16.00	(0.41)	50.00	0.21	0.21	0.04
4.00	21.00	(0.36)	50.00	0.28	0.18	0.05
4.50	27.00	(0.31)	50.00	0.36	0.12	0.04
4.80	25.00	(0.23)	50.00	0.33	0.09	0.03
5.30	-	(0.24)	50.00	-	0.06	-
TOTAL DISCHARGE (m^3/s)						0.45

Observation Record Sheet of Water Flow

Site	BAJURA	River	BAULI GAD
Date	15-Jan-14	Time	16:25
		Weather Condition	Cloudy

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

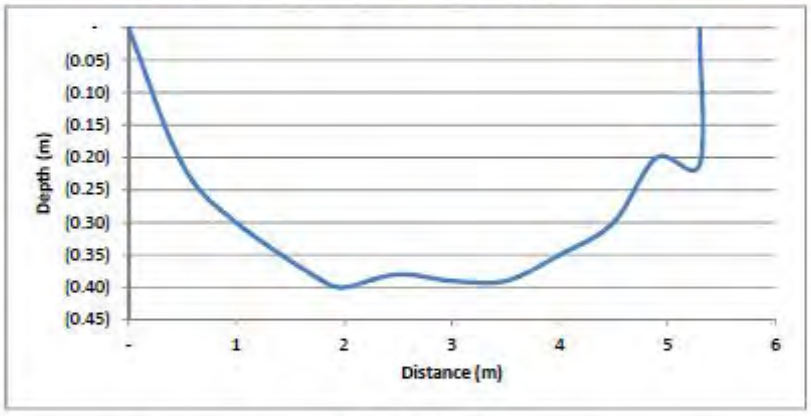
Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
-	-	50.00	-	-	-
0.50	(0.21)	50.00	0.12	0.11	0.01
1.00	(0.30)	50.00	0.39	0.20	0.08
1.80	(0.39)	50.00	0.57	0.20	0.11
2.00	(0.40)	50.00	0.39	0.14	0.05
2.50	(0.38)	50.00	0.11	0.19	0.02
3.00	(0.39)	120.00	0.01	0.20	0.00
3.50	(0.38)	50.00	0.15	0.19	0.03
4.00	(0.35)	50.00	0.28	0.18	0.05
4.50	(0.30)	50.00	0.36	0.14	0.05
4.90	(0.20)	50.00	0.48	0.08	0.04
5.30	(0.21)	50.00	-	0.04	-
TOTAL DISCHARGE (m^3/s)					0.44

Observation Record Sheet of Water Flow

Site	BAJURA	River	BAULI GAD
Date	15-Jan-14	Time	16:40
		Weather Condition	Cloudy

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

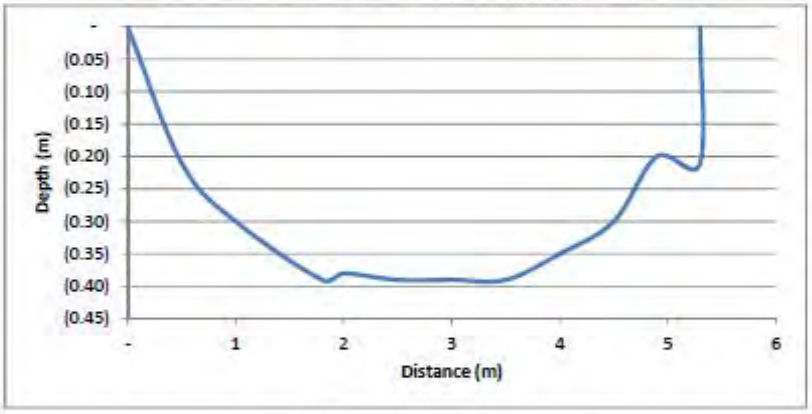
Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
-	-	50.00	-	-	-
0.50	(0.21)	50.00	0.14	0.11	0.01
1.00	(0.30)	50.00	0.30	0.20	0.06
1.80	(0.39)	50.00	0.53	0.20	0.10
2.00	(0.40)	50.00	0.47	0.14	0.07
2.50	(0.38)	50.00	0.11	0.19	0.02
3.00	(0.39)	120.00	0.01	0.20	0.00
3.50	(0.39)	50.00	0.14	0.20	0.03
4.00	(0.35)	50.00	0.25	0.18	0.04
4.50	(0.30)	50.00	0.36	0.14	0.05
4.90	(0.20)	50.00	0.48	0.08	0.04
5.30	(0.21)	50.00	-	0.04	-
TOTAL DISCHARGE (m^3/s)					0.42

Observation Record Sheet of Water Flow

Site	BAJURA	River	BAULI GAD
Date	16-Jan-14	Time	8:00
		Weather Condition	Sunny

Discharge Measurement Site

Cross section of river at measurement point



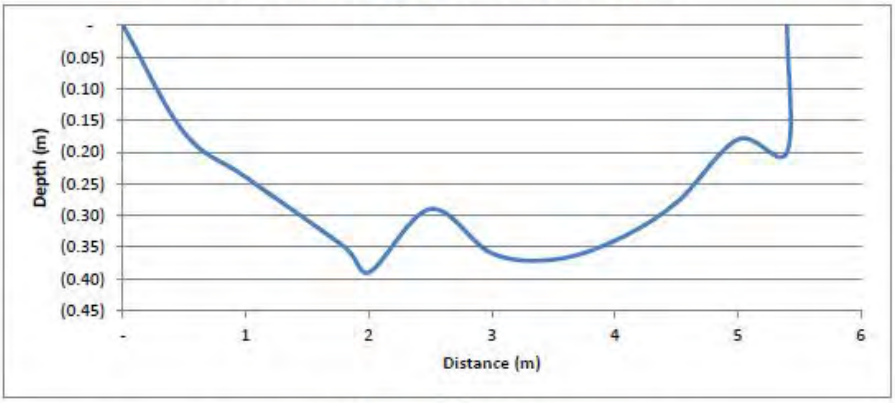
Discharge Calculation

Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
-	-	50.00	-	-	-
0.50	(0.21)	50.00	0.10	0.11	0.01
1.00	(0.30)	50.00	0.29	0.20	0.06
1.80	(0.39)	50.00	0.55	0.20	0.11
2.00	(0.38)	50.00	0.47	0.13	0.06
2.50	(0.39)	50.00	0.12	0.20	0.02
3.00	(0.39)	120.00	0.01	0.20	0.00
3.50	(0.39)	50.00	0.12	0.20	0.02
4.00	(0.35)	50.00	0.25	0.18	0.04
4.50	(0.30)	50.00	0.32	0.14	0.04
4.90	(0.20)	50.00	0.44	0.08	0.04
5.30	(0.21)	50.00	-	0.04	-
TOTAL DISCHARGE (m^3/s)					0.41

Observation Record Sheet of Water Flow

Site	BAJURA	River	BAULI GAD
Date	12-Feb-14	Time	15:40
		Weather Condition	Partly Cloudy (light rain sometime ago)

Cross section of river at measurement point



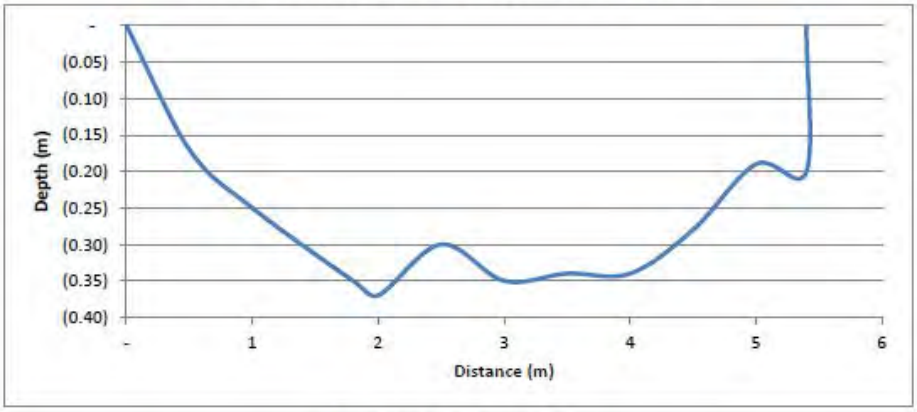
Discharge Calculation

Distance	Depth	Revolutions	Time (secs)	Velocity	Cross sectional area	Discharge
-	-	-	-	-	-	-
0.50	(0.17)	10	73	0.08	0.09	0.01
1.00	(0.24)	30	87	0.22	0.16	0.03
1.80	(0.35)	30	44	0.46	0.18	0.08
2.00	(0.39)	30	50	0.40	0.14	0.05
2.50	(0.29)	30	181	0.10	0.15	0.01
3.00	(0.36)	30	193	0.09	0.18	0.02
3.50	(0.37)	30	149	0.12	0.19	0.02
4.00	(0.34)	30	117	0.16	0.17	0.03
4.50	(0.28)	30	83	0.24	0.14	0.03
5.00	(0.18)	20	37	0.36	0.08	0.03
5.40	(0.20)	-	-	-	0.04	-
TOTAL DISCHARGE (m^3/s)						0.32

Observation Record Sheet of Water Flow

Site	BAJURA	River	BAULI GAD
Date	12-Feb-14	Time	16:05
		Weather Condition	Partly Cloudy (light rain sometime ago)

Cross section of river at measurement point



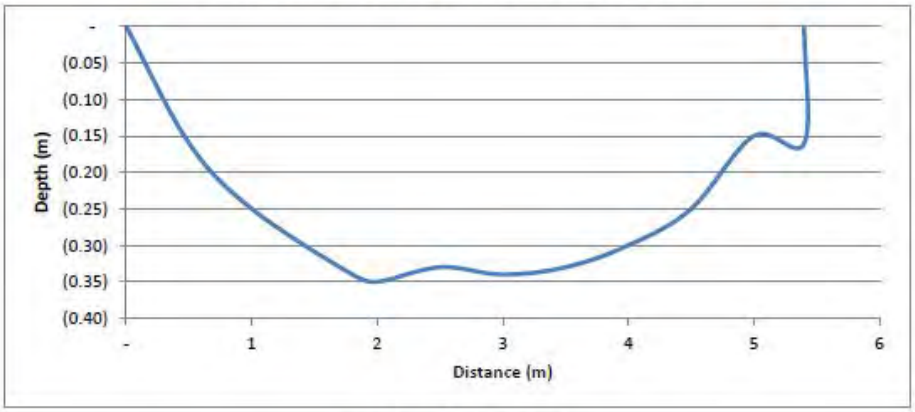
Discharge Calculation

Distance	Depth	Revolutions	Time (secs)	Velocity	Cross sectional area	Discharge
-	-	-	-	-	-	-
0.50	(0.17)	10	81	0.07	0.09	0.01
1.00	(0.25)	30	87	0.22	0.16	0.04
1.80	(0.35)	30	41	0.49	0.18	0.09
2.00	(0.37)	30	46	0.44	0.13	0.06
2.50	(0.30)	30	173	0.11	0.15	0.02
3.00	(0.35)	30	205	0.09	0.18	0.02
3.50	(0.34)	30	167	0.11	0.17	0.02
4.00	(0.34)	30	138	0.14	0.17	0.02
4.50	(0.28)	30	91	0.21	0.14	0.03
5.00	(0.19)	20	42	0.31	0.09	0.03
5.40	(0.20)	-	-	-	0.04	-
TOTAL DISCHARGE (m^3/s)						0.31

Observation Record Sheet of Water Flow

Site	BAJURA	River	BAULI GAD
Date	13-Feb-14	Time	7:45
		Weather Condition	Sunny

Cross section of river at measurement point



Discharge Calculation

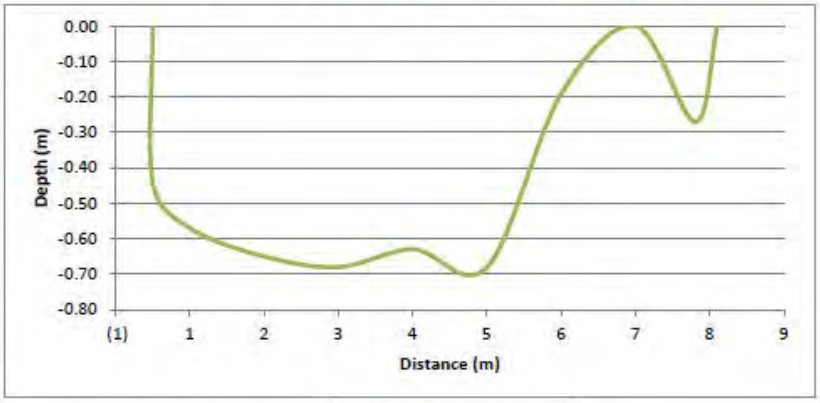
Distance	Depth	Revolutions	Time (secs)	Velocity	Cross sectional area	Discharge
-	-	-	-	-	-	-
0.50	(0.16)	10	81	0.07	0.08	0.01
1.00	(0.25)	30	87	0.22	0.16	0.04
1.80	(0.34)	30	41	0.49	0.17	0.08
2.00	(0.35)	30	46	0.44	0.12	0.05
2.50	(0.33)	30	173	0.11	0.17	0.02
3.00	(0.34)	30	205	0.09	0.17	0.01
3.50	(0.33)	30	167	0.11	0.17	0.02
4.00	(0.30)	30	138	0.14	0.15	0.02
4.50	(0.25)	30	91	0.21	0.13	0.03
5.00	(0.15)	20	42	0.31	0.07	0.02
5.40	(0.16)	-	-	-	0.03	-
TOTAL DISCHARGE (m^3/s)						0.30

Observation Record Sheet of Water Flow

Site	Syarpudaha	River	TILCHA KHOLA
Date	29-Oct-13	Time	15:05
		Weather Condition	Sunny

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

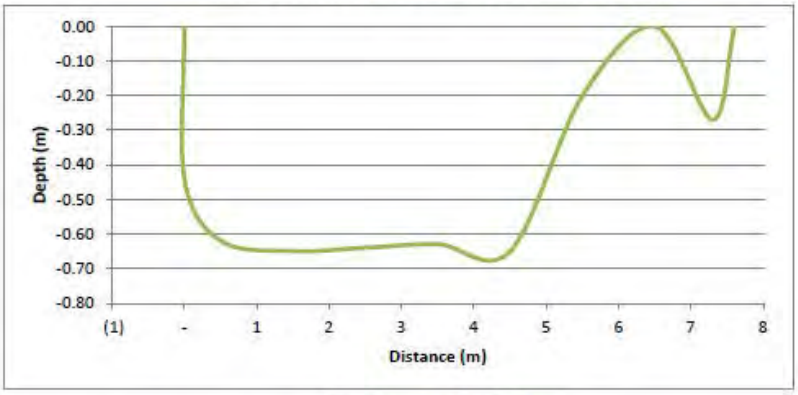
Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0	-0.44	0	0.00	0.11	0.00
0.5	-0.57	40	0.85	0.43	0.36
1.5	-0.65	37	0.92	0.65	0.60
2.5	-0.68	35	0.97	0.68	0.66
3.5	-0.63	38	0.90	0.63	0.56
4.5	-0.68	40	0.85	0.68	0.58
5.5	-0.19	36	0.95	0.19	0.18
6.5	0.00	0	0.00	0.00	0.00
7.3	-0.27	58	0.58	0.15	0.09
7.6	0.00	0	0.00	0.00	0.00
Additional Stream					
0	0	0	0.00	0.00	0.00
0.9	-0.45	40	0.50	0.41	0.20
1.8	0.00	37	0.00	0.00	0.00
			TOTAL DISCHARGE (m^3/s)		3.24

Observation Record Sheet of Water Flow

Site	Syarpudaha	River	TILCHA KHOLA
Date	29-Oct-13	Time	17:15
		Weather Condition	Sunny

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

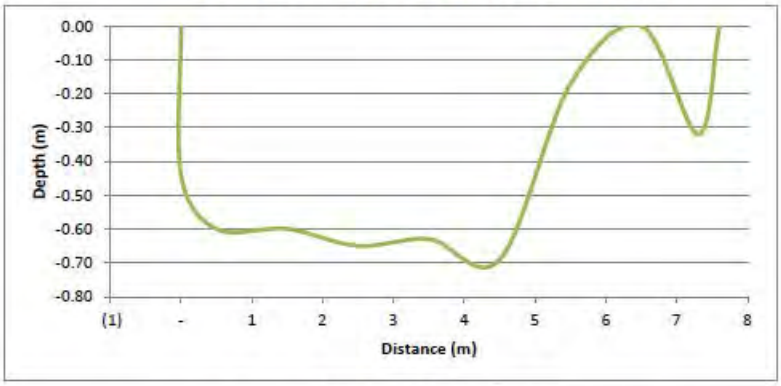
Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
7.6	0.00	0	0.00	0.00	0.00
7.3	-0.27	58	0.58	0.15	0.09
6.5	0.00	0	0.00	0.00	0.00
5.5	-0.20	43	0.79	0.20	0.16
4.5	-0.65	43	0.79	0.65	0.51
3.5	-0.63	36	0.95	0.63	0.60
2.5	-0.64	32	1.07	0.64	0.68
1.5	-0.65	36	0.95	0.65	0.62
0.5	-0.62	61	0.55	0.47	0.26
0.0	-0.44	0	0.00	0.11	0.00
Additional Stream					
0	0	0	0.00	0.00	0.00
0.9	-0.45	40	0.50	0.41	0.20
1.8	0.00	37	0.00	0.00	0.00
			TOTAL DISCHARGE (m^3/s)		3.11

Observation Record Sheet of Water Flow

Site	Syarpudaha	River	TILCHA KHOLA
Date	30-Oct-13	Time	7:30
		Weather Condition	Sunny

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

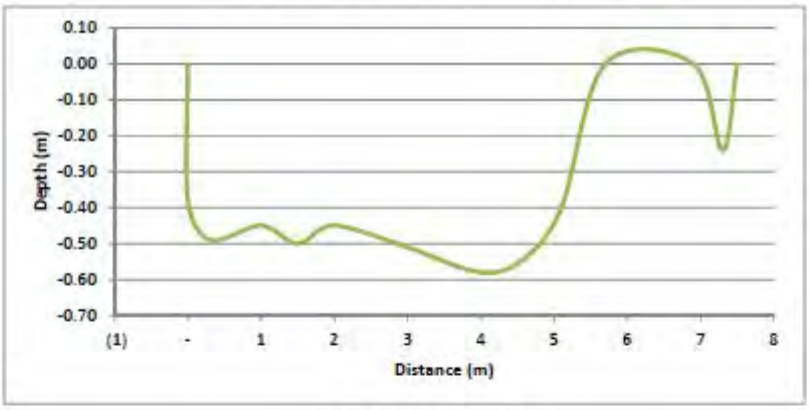
Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0	-0.44	0	0.00	0.11	0.00
0.5	-0.60	57	0.59	0.45	0.27
1.5	-0.60	36	0.95	0.60	0.57
2.5	-0.65	36	0.95	0.65	0.62
3.5	-0.63	35	0.97	0.63	0.61
4.5	-0.69	40	0.85	0.69	0.59
5.5	-0.17	40	0.85	0.17	0.14
6.5	0.00	0	0.00	0.00	0.00
7.3	-0.32	48	0.71	0.18	0.12
7.6	0.00	0	0.00	0.00	0.00
Additional Stream					
0	0	0	0.00	0.00	0.00
0.9	-0.50	40	0.50	0.45	0.23
1.8	0.00	37	0.00	0.00	0.00
TOTAL DISCHARGE (m^3/s)					3.15

Observation Record Sheet of Water Flow

Site	Syarpudaha	River	TILCHA KHOLA
Date	5-Dec-13	Time	12:10
		Weather Condition	Sunny

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

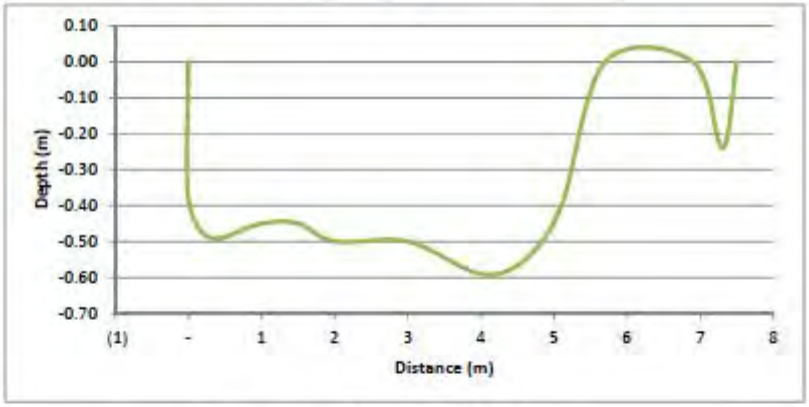
Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0	-0.38	0	0.00	0.06	0.00
0.3	-0.49	17	0.80	0.25	0.20
1	-0.45	26	0.52	0.27	0.14
1.5	-0.50	17	0.80	0.25	0.20
2	-0.45	20	0.68	0.34	0.23
3	-0.51	19	0.71	0.51	0.36
4	-0.58	20	0.68	0.46	0.31
4.6	-0.54	25	0.54	0.30	0.16
5.1	-0.40	21	0.64	0.22	0.14
5.7	0.00	0	0.00	0.00	0.00
6.9	0.00	0	0.00	0.00	0.00
7.3	-0.24	42	0.31	0.07	0.02
7.5	0.00	0	0.00	0.00	0.00
TOTAL DISCHARGE (m^3/s)					1.77

Observation Record Sheet of Water Flow

Site	Syarpudaha	River	TILCHA KHOLA
Date	5-Dec-13	Time	12:30
		Weather Condition	Sunny

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

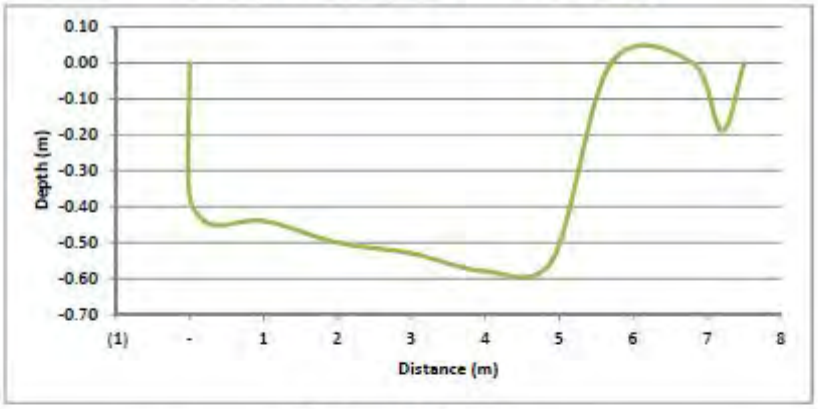
Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
7.5	0	0	0.00	0.00	0.00
7.3	-0.24	41	0.32	0.07	0.02
6.9	0.00	0	0.00	0.00	0.00
5.7	0.00	0	0.00	0.00	0.00
5.1	-0.40	20	0.68	0.22	0.15
4.6	-0.55	23	0.59	0.30	0.18
4	-0.59	22	0.61	0.47	0.29
3	-0.50	18	0.75	0.50	0.38
2	-0.50	19	0.71	0.38	0.27
1.5	-0.45	18	0.75	0.23	0.17
1	-0.45	23	0.59	0.27	0.16
0.3	-0.49	18	0.75	0.25	0.18
0	-0.38	0	0.00	0.06	0.00
TOTAL DISCHARGE (m^3/s)					1.80

Observation Record Sheet of Water Flow

Site	Syarpudaha	River	TILCHA KHOLA
Date	6-Dec-13	Time	9:05
		Weather Condition	Sunny

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

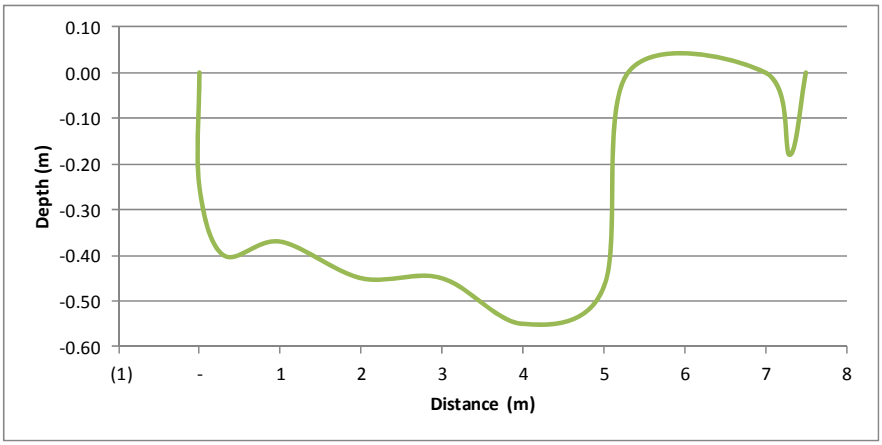
Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0.0	-0.37	0	0.00	0.06	0.00
0.3	-0.45	29	0.70	0.23	0.16
1.0	-0.44	41	0.49	0.37	0.18
2.0	-0.50	26	0.78	0.50	0.39
3.0	-0.53	27	0.75	0.53	0.40
4.0	-0.58	31	0.66	0.55	0.36
4.9	-0.55	35	0.58	0.47	0.27
5.7	0.00	0	0.00	0.00	0.00
6.8	0.00	0	0.00	0.00	0.00
7.2	-0.19	54	0.37	0.07	0.02
7.5	0.00	0	0.00	0.00	0.00
TOTAL DISCHARGE (m^3/s)					1.79

Observation Record Sheet of Water Flow

Site	Syarpudaha	River	TILCHA KHOLA
Date	30-Dec-13	Time	14:50
		Weather Condition	Sunny

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

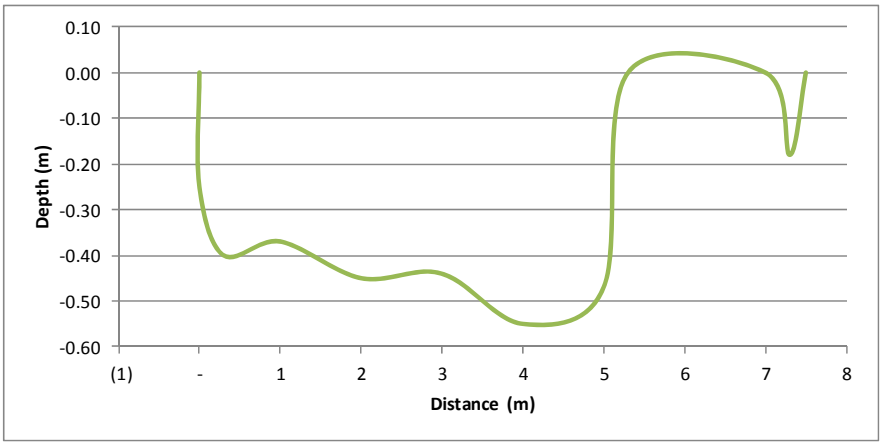
Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0.0	-0.25	0	0.00	0.04	0.00
0.3	-0.40	50	0.61	0.20	0.12
1.0	-0.37	50	0.41	0.31	0.13
2.0	-0.45	50	0.62	0.45	0.28
3.0	-0.45	50	0.64	0.45	0.29
4.0	-0.55	50	0.50	0.55	0.27
5.0	-0.47	50	0.47	0.31	0.14
5.3	0.00	0	0.00	0.00	0.00
7.0	0.00	0	0.00	0.00	0.00
7.3	-0.18	50	0.35	0.05	0.02
7.5	0.00	0	0.00	0.00	0.00
TOTAL DISCHARGE (m^3/s)					1.25

Observation Record Sheet of Water Flow

Site	Syarpudaha	River	TILCHA KHOLA
Date	30-Dec-13	Time	15:00
		Weather Condition	Sunny

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

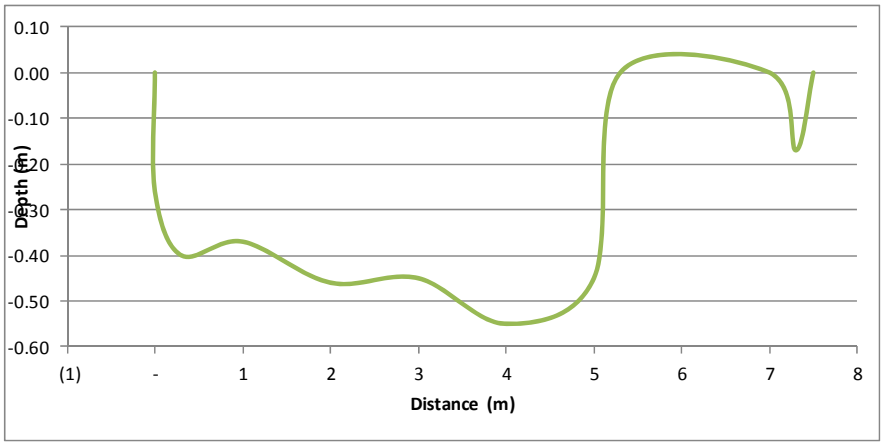
Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0.0	-0.25	0	0.00	0.04	0.00
0.3	-0.40	50	0.61	0.20	0.12
1.0	-0.37	50	0.46	0.31	0.14
2.0	-0.45	50	0.62	0.45	0.28
3.0	-0.44	50	0.64	0.44	0.28
4.0	-0.55	50	0.50	0.55	0.27
5.0	-0.47	50	0.44	0.31	0.14
5.3	0.00	0	0.00	0.00	0.00
7.0	0.00	0	0.00	0.00	0.00
7.3	-0.18	50	0.33	0.05	0.01
7.5	0.00	0	0.00	0.00	0.00
TOTAL DISCHARGE (m^3/s)					1.25

Observation Record Sheet of Water Flow

Site	Syarpudaha	River	TILCHA KHOLA
Date	31-Dec-13	Time	8:45
		Weather Condition	Cloudy

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

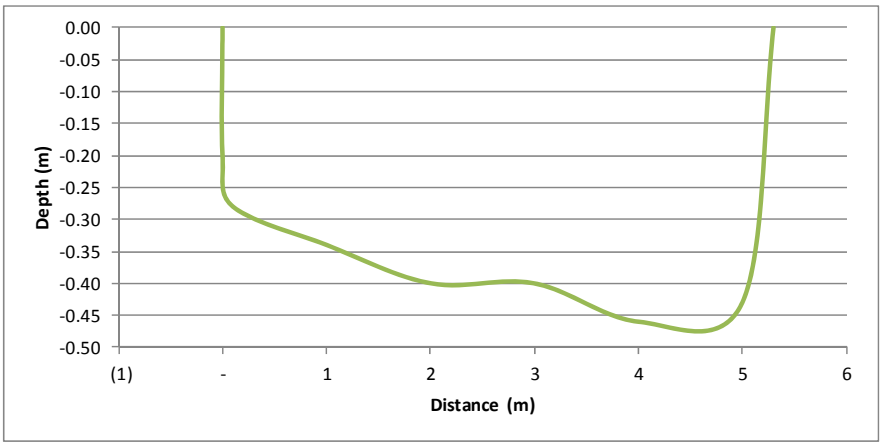
Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0.0	−0.26	0	0.00	0.04	0.00
0.3	−0.40	50	0.71	0.20	0.14
1.0	−0.37	50	0.43	0.31	0.13
2.0	−0.46	50	0.59	0.46	0.27
3.0	−0.45	50	0.64	0.45	0.29
4.0	−0.55	50	0.50	0.55	0.27
5.0	−0.45	50	0.44	0.29	0.13
5.3	0.00	0	0.00	0.00	0.00
7.0	0.00	0	0.00	0.00	0.00
7.3	−0.17	50	0.30	0.04	0.01
7.5	0.00	0	0.00	0.00	0.00
TOTAL DISCHARGE (m^3/s)					1.25

Observation Record Sheet of Water Flow

Site	Syarpudaha	River	TILCHA KHOLA
Date	24-Jan-14	Time	13:30
		Weather Condition	Sunny

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

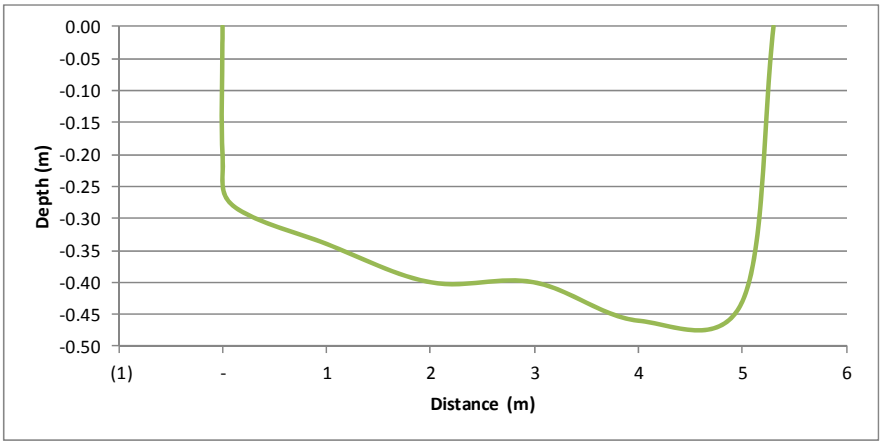
Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0.0	-0.20	0	0.00	0.01	0.00
0.1	-0.28	50	0.65	0.14	0.09
1.0	-0.34	50	0.46	0.32	0.15
2.0	-0.40	50	0.59	0.40	0.24
3.0	-0.40	50	0.48	0.40	0.19
4.0	-0.46	50	0.35	0.46	0.16
5.0	-0.43	50	0.53	0.28	0.15
5.3	0.00	0	0.00	0.00	0.00
TOTAL DISCHARGE (m^3/s)					0.97

Observation Record Sheet of Water Flow

Site	Syarpudaha	River	TILCHA KHOLA
Date	24-Jan-14	Time	13:50
		Weather Condition	Sunny

Discharge Measurement Site

Cross section of river at measurement point



Discharge Calculation

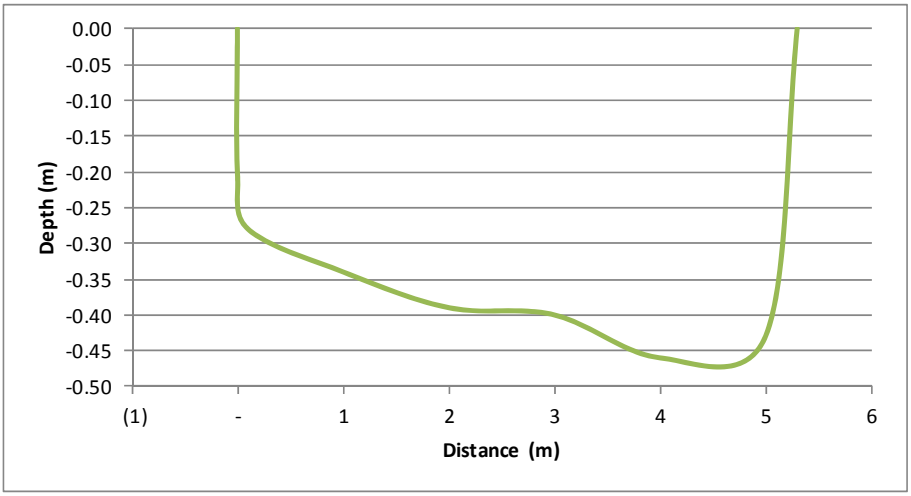
Distance	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0.0	−0.20	0	0.00	0.01	0.00
0.1	−0.28	50	0.69	0.14	0.10
1.0	−0.34	50	0.47	0.32	0.15
2.0	−0.40	50	0.59	0.40	0.24
3.0	−0.40	50	0.48	0.40	0.19
4.0	−0.46	50	0.35	0.46	0.16
5.0	−0.43	50	0.53	0.28	0.15
5.3	0.00	0	0.00	0.00	0.00
TOTAL DISCHARGE (m^3/s)					0.99

Observation Record Sheet of Water Flow

Site	Syarpudaha	River	TILCHA KHOLA
Date	25-Jan-14	Time	9:00
		Weather Conditio	Sunny

Discharge Measurement Site

Cross section of river at measurement point



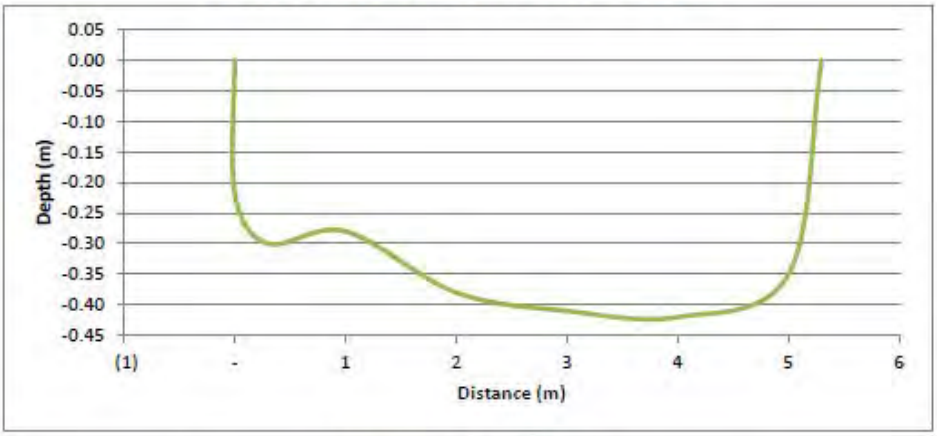
Discharge Calculation

Distance	Revolutions	Depth	Time (secs)	Velocity	Cross sectional area	Discharge
0.0	0	−0.20	0	0.00	0.01	0.00
0.1	50	−0.28	50	0.68	0.14	0.09
1.0	39	−0.34	50	0.53	0.32	0.17
2.0	45	−0.39	50	0.61	0.39	0.24
3.0	37	−0.40	50	0.50	0.40	0.20
4.0	26	−0.46	50	0.35	0.46	0.16
5.0	36	−0.43	50	0.48	0.28	0.14
5.3	0	0.00	0	0.00	0.00	0.00
TOTAL DISCHARGE (m^3/s)						0.99

Observation Record Sheet of Water Flow

Site	Syarpudaha	River	TILCHA KHOLA
Date	14-Feb-14	Time	16:05
		Weather Condition	Cloudy (light rain for last few days)

Cross section of river at measurement point



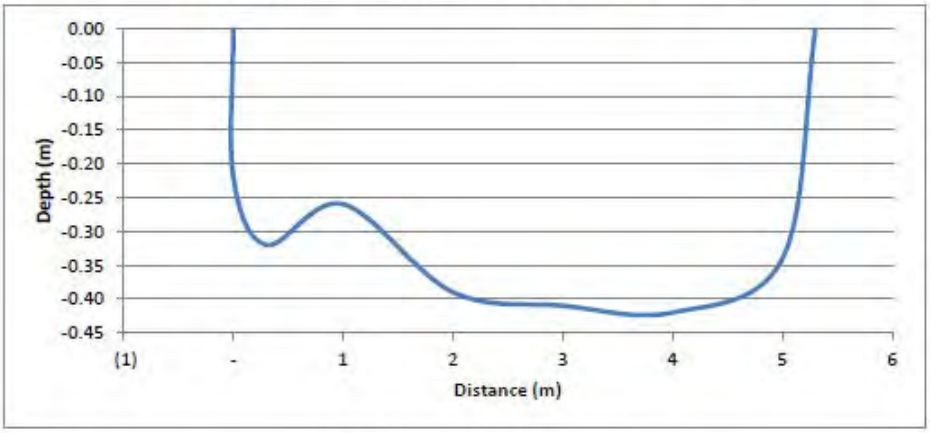
Discharge Calculation

Distance	Depth	Revolutions	Time (secs)	Velocity	Cross sectional area	Discharge
0.0	-	0	0	0.00	0.00	0.00
0.0	(0.22)	30	54	0.37	0.03	0.01
0.3	(0.30)	30	72	0.27	0.15	0.04
1.0	(0.28)	30	46	0.44	0.24	0.10
2.0	(0.38)	30	57	0.35	0.38	0.13
3.0	(0.41)	30	61	0.33	0.41	0.13
4.0	(0.42)	30	78	0.25	0.42	0.11
5.0	(0.35)	30	69	0.29	0.23	0.07
5.3	-	10	0	0.00	0.00	0.00
TOTAL DISCHARGE (m^3/s)						0.59

Observation Record Sheet of Water Flow

Site	Syarpudaha	River	TILCHA KHOLA
Date	14-Feb-14	Time	16:35
		Weather Condition	Cloudy (light rain for last few days)

Cross section of river at measurement point



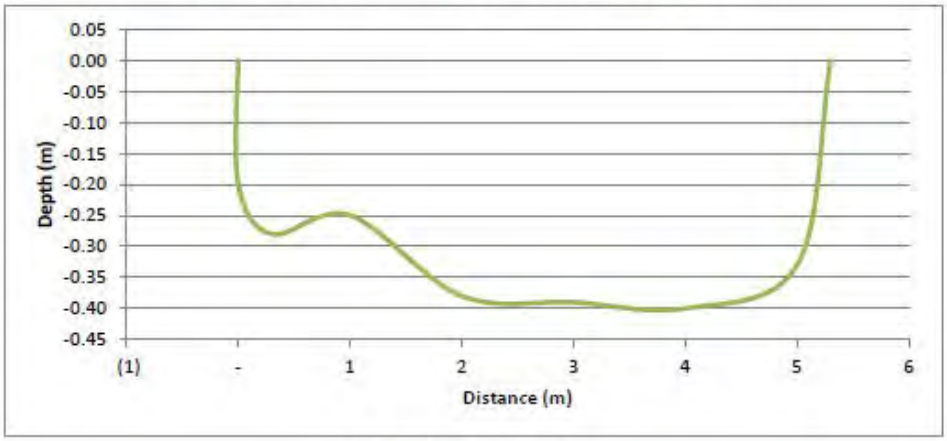
Discharge Calculation

Distance	Depth	Revolutions	Time (secs)	Velocity	Cross sectional area	Discharge
0.0	-	0	0	0.00	0.00	0.00
0.0	(0.22)	30	62	0.32	0.03	0.01
0.3	(0.32)	30	78	0.25	0.16	0.04
1.0	(0.26)	30	52	0.38	0.22	0.08
2.0	(0.39)	30	63	0.31	0.39	0.12
3.0	(0.41)	30	58	0.34	0.41	0.14
4.0	(0.42)	30	88	0.22	0.42	0.09
5.0	(0.34)	30	74	0.27	0.22	0.06
5.3	-	10	0	0.00	0.00	0.00
TOTAL DISCHARGE (m^3/s)						0.55

Observation Record Sheet of Water Flow

Site	Syarpudaha	River	TILCHA KHOLA
Date	15-Feb-14	Time	12:05
		Weather Condition	Light rain

Cross section of river at measurement point



Discharge Calculation

Distance	Depth	Revolutions	Time (secs)	Velocity	Cross sectional area	Discharge
0.0	-	0	0	0.00	0.00	0.00
0.0	(0.20)	30	50	0.40	0.03	0.01
0.3	(0.28)	30	76	0.26	0.14	0.04
1.0	(0.25)	30	46	0.44	0.21	0.09
2.0	(0.38)	30	64	0.31	0.38	0.12
3.0	(0.39)	30	58	0.34	0.39	0.13
4.0	(0.40)	30	83	0.24	0.40	0.09
5.0	(0.33)	30	74	0.27	0.21	0.06
5.3	-	10	0	0.00	0.00	0.00
TOTAL DISCHARGE (m^3/s)						0.54

Table 3.2　annual record of discharge（Bajhang）

【Bajhang】　Runoff: (m3/s) ※Daily Average　2013

day \ month	1	2	3	4	5	6	7	8	9	10	11	12
1											2.87	1.46
2											2.82	1.44
3											2.75	1.43
4											2.71	1.41
5											2.67	1.41
6											2.64	1.37
7											2.66	1.32
8											2.58	1.33
9											2.50	1.32
10											2.37	1.29
11											2.31	1.23
12											2.26	1.19
13											2.17	1.17
14											2.10	1.15
15											2.01	1.13
16											1.98	1.12
17											1.95	1.14
18											1.91	1.14
19											1.89	1.12
20											1.84	1.09
21											1.81	1.06
22										3.56	1.79	1.05
23										3.49	1.76	1.02
24										3.42	1.72	1.04
25										3.34	1.69	1.03
26										3.26	1.63	1.03
27										3.19	1.60	0.99
28										3.14	1.56	0.99
29										3.04	1.52	0.96
30										2.96	1.48	0.94
31										2.93		0.93
totall										32.34	63.53	36.31

【Bajhang】　Runoff: (m3/s) ※Daily Average　2014

day \ month	1	2	3	4	5	6	7	8	9	10	11	12
1	0.91	0.70										
2	0.88	0.71										
3	0.86	0.70										
4	0.85	0.67										
5	0.84	0.69										
6	0.82	0.70										
7	0.80	0.70										
8	0.79	0.68										
9	0.79	0.68										
10	0.75	0.68										
11	0.76											
12	0.75											
13	0.77											
14	0.77											
15	0.77											
16	0.76											
17	0.74											
18	0.73											
19	0.72											
20	0.79											
21	0.82											
22	0.80											
23	0.83											
24	0.79											
25	0.76											
26	0.75											
27	0.74											
28	0.71											
29	0.70											
30	0.71											
31	0.72											
totall	24.21	6.90										

Table 3.3　annual record of discharge（Bajura）

【Bajura】　Runoff: (m3/s) ※Daily Average　2013

day \ month	1	2	3	4	5	6	7	8	9	10	11	12
1											0.84	0.58
2											0.83	0.57
3											0.82	0.56
4											0.81	0.55
5											0.79	0.55
6											0.79	0.55
7											0.79	0.55
8											0.78	0.54
9											0.77	0.54
10											0.78	0.53
11											0.76	0.53
12											0.75	0.51
13											0.74	0.51
14											0.73	0.51
15											0.72	0.50
16											0.71	0.50
17											0.70	0.50
18											0.69	0.49
19											0.68	0.48
20											0.67	0.48
21											0.66	0.47
22											0.65	0.48
23											0.65	0.48
24											0.64	0.47
25										0.93	0.62	0.46
26										0.93	0.62	0.45
27										0.91	0.61	0.45
28										0.90	0.60	0.44
29										0.88	0.60	0.43
30										0.87	0.59	0.43
31										0.85		0.44
totall										6.28	21.40	15.54

【Bajura】　Runoff: (m3/s) ※Daily Average　2014

day \ month	1	2	3	4	5	6	7	8	9	10	11	12
1	0.43	0.35										
2	0.43	0.35										
3	0.43	0.34										
4	0.42	0.34										
5	0.42	0.35										
6	0.42	0.34										
7	0.41	0.36										
8	0.41	0.35										
9	0.41	0.34										
10	0.41	0.33										
11	0.40	0.34										
12	0.41	0.33										
13	0.41											
14	0.41											
15	0.40											
16	0.39											
17	0.40											
18	0.45											
19	0.42											
20	0.40											
21	0.40											
22	0.41											
23	0.41											
24	0.38											
25	0.37											
26	0.37											
27	0.36											
28	0.36											
29	0.36											
30	0.36											
31	0.35											
totall	12.40	4.13										

Table 3.4　annual record of discharge（Syapudaha）

【Syapudaha】　Runoff: (m3/s) ※Daily Average　2013

day \ month	1	2	3	4	5	6	7	8	9	10	11	12
1											2.59	1.53
2											2.54	1.53
3											2.50	1.51
4											2.46	1.48
5											2.39	1.47
6											2.35	1.44
7											2.30	1.38
8											2.26	1.37
9											2.21	1.37
10											2.18	1.36
11											2.11	1.33
12											2.06	1.32
13											2.02	1.29
14											2.03	1.28
15											2.00	1.30
16											1.96	1.29
17											1.92	1.25
18											1.89	1.24
19											1.86	1.22
20											1.82	1.20
21											1.81	1.16
22											1.76	1.14
23											1.74	1.15
24											1.68	1.14
25											1.67	1.13
26											1.64	1.11
27											1.65	1.09
28											1.63	1.05
29											1.61	1.02
30										2.69	1.58	1.03
31										2.65		1.04
totall										5.35	60.20	39.22

【Syapudaha】　Runoff: (m3/s) ※Daily Average　2014

day \ month	1	2	3	4	5	6	7	8	9	10	11	12
1	1.03	0.84										
2	1.04	0.83										
3	1.04	0.83										
4	0.99	0.83										
5	0.98	0.83										
6	0.98	0.82										
7	0.96	0.81										
8	0.94	0.80										
9	0.92	0.79										
10	0.91	0.78										
11	0.91	0.76										
12	0.89	0.75										
13	0.87	0.74										
14	0.86	0.73										
15	0.85											
16	0.86											
17	0.88											
18	0.88											
19	0.87											
20	0.86											
21	0.85											
22	0.85											
23	0.85											
24	0.85											
25	0.83											
26	0.81											
27	0.83											
28	0.82											
29	0.83											
30	0.86											
31	0.85											
totall	27.77	11.14										

Table 3.5　annual record of rainfall（Chainpur（Bajhang））

【Chainpur(Bajhang)】　Daily Rainfall: (mm/day)　2013

day \ month	1	2	3	4	5	6	7	8	9	10	11	12
1	0.0	0.0	0.0	0.0	0.0	–	0.0	0.0	9.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	–	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	–	36.0	0.0	0.0	0.0	0.0	0.0
4	0.0	2.0	0.0	5.0	0.0	–	7.0	5.5	0.0	17.2	0.0	0.0
5	0.0	9.4	0.0	0.0	0.0	–	0.0	10.5	0.0	0.0	0.0	0.0
6	0.0	46.0	0.0	0.0	0.0	–	21.0	6.5	4.0	0.0	0.0	0.0
7	0.0	0.0	1.0	0.0	0.0	–	0.0	0.0	3.0	2.6	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	–	5.0	23.7	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	–	19.0	16.2	1.2	0.0	3.5	0.0
10	0.0	0.0	0.0	0.0	0.0	–	0.0	5.5	7.5	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	–	15.0	20.0	0.0	3.6	0.0	0.0
12	0.0	0.0	0.0	0.0	11.4	–	13.0	2.0	12.5	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	7.6	–	14.5	27.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	–	0.0	10.0	0.0	0.0	0.0	0.0
15	0.0	0.0	3.0	0.0	1.2	0.0	0.0	33.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	17.6	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	68.6	0.0	1.7	0.0	6.8	34.5	30.0	0.0	0.0	0.0	0.0
18	44.5	0.0	0.2	0.0	0.0	51.0	4.0	0.0	0.0	0.0	0.0	0.0
19	72.2	0.0	0.0	0.0	0.0	46.0	26.0	31.8	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	16.2	40.0	3.0	1.6	6.0	0.0	0.0
21	0.0	0.0	0.0	4.0	4.0	1.0	47.5	0.0	6.6	0.0	0.0	0.0
22	0.0	0.0	18.4	2.0	0.0	0.0	11.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	4.3	5.0	0.0	1.8	0.0	0.0	0.0
24	0.0	13.0	0.0	0.0	0.0	27.2	0.0	0.0	0.0	0.0	0.0	0.0
25	0.0	0.0	0.0	0.0	0.0	10.0	10.5	3.4	0.0	0.0	0.0	0.0
26	0.0	0.0	0.0	0.0	0.0	15.1	0.0	19.0	1.2	0.0	0.0	0.0
27	0.0	0.0	0.0	0.0	0.0	27.0	26.0	0.0	0.0	0.0	0.0	0.0
28	0.0	0.0	0.0	0.0	0.0	27.0	0.0	2.0	18.0	0.0	0.0	0.0
29	0.0		0.0	0.0	17.0	10.5	0.0	3.0	6.0	0.0	0.0	0.0
30	0.0		0.0	0.0	0.0	2.0	41.0	2.8	5.4	0.0	0.0	0.0
31	0.0		0.0		0.0		0.0	0.0		0.0		0.0
totall	116.7	139.0	22.6	12.7	41.2	261.7	376.0	254.9	77.8	29.4	3.5	0.0

【Chainpur(Bajhang)】　Daily Rainfall: (mm/day)　2014

day \ month	1	2	3	4	5	6	7	8	9	10	11	12
1	0.0	0.0										
2	0.0	0.0										
3	0.0	0.0										
4	0.0	0.0										
5	0.0	0.0										
6	0.0	0.0										
7	0.0	0.0										
8	0.0	0.0										
9	0.0	0.0										
10	0.0	0.0										
11	0.0	0.0										
12	0.0	6.8										
13	0.0	–										
14	0.0	–										
15	0.0	–										
16	0.0	–										
17	0.0	–										
18	17.3	–										
19	25.7	–										
20	0.0	–										
21	0.0	–										
22	0.0	–										
23	5.2	–										
24	0.0	–										
25	0.0	–										
26	0.0	–										
27	0.0	–										
28	0.0	–										
29	0.0											
30	0.0											
31	0.0											
totall	48.2	6.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 3.6 annual record of rainfall （Bajura）

【Bajura】 Daily Rainfall: (mm/day) 2013

month / day	1	2	3	4	5	6	7	8	9	10	11	12
1	0.0	0.0	0.0	0.0	0.0	3.4	21.8	0.0	1.6	0.0	12.4	0.0
2	0.0	0.0	0.0	3.2	0.0	11.5	0.0	10.0	1.7	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.0	26.0	0.0	0.0	0.0
4	0.0	2.7	0.0	0.0	0.0	0.0	15.0	62.4	0.0	20.5	0.0	0.0
5	0.0	0.0	0.0	6.2	0.0	47.6	33.0	75.5	11.1	0.0	0.0	0.0
6	0.0	13.2	0.0	0.0	0.0	7.0	16.5	15.0	1.8	0.0	0.0	0.0
7	0.0	58.4	0.0	0.0	0.0	2.6	6.5	12.8	11.1	0.0	0.0	0.0
8	0.0	4.1	0.0	0.0	0.0	0.0	19.2	3.5	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	17.7	20.5	31.5	0.0	0.0	18.5	0.0
10	0.0	0.0	0.0	0.0	0.0	10.7	25.5	2.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	8.5	27.5	19.0	4.9	2.3	0.0	0.0
12	0.0	0.0	0.0	2.4	0.0	1.8	14.3	4.5	2.3	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	7.1	26.2	22.5	23.4	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	4.6	18.7	16.6	7.0	0.0	0.0	0.0
15	0.0	0.0	0.0	1.2	10.5	3.2	1.3	17.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	2.6	94.4	10.1	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	4.9	18.8	26.7	25.5	4.2	0.0	0.0	0.0	0.0
18	0.0	53.6	0.0	4.0	11.2	104.6	34.0	0.0	0.0	–	0.0	0.0
19	58.4	0.0	0.0	3.0	0.0	12.2	37.0	53.4	0.0	–	0.0	0.0
20	76.6	0.0	0.0	0.0	0.0	0.0	21.5	29.6	1.6	–	0.0	0.0
21	0.0	0.0	0.0	5.8	0.0	0.0	12.5	0.0	5.3	–	0.0	0.0
22	0.0	0.0	0.0	5.1	0.0	6.2	4.3	47.8	0.0	–	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	16.4	1.1	0.0	0.0	–	0.0	0.0
24	0.0	0.0	11.5	0.0	0.0	15.0	45.4	0.0	0.0	–	0.0	0.0
25	0.0	14.5	0.0	0.0	3.5	82.6	19.6	7.6	1.5	–	0.0	0.0
26	0.0	0.0	0.0	5.2	19.5	14.5	2.1	4.5	3.0	–	0.0	0.0
27	0.0	0.0	0.0	0.3	18.2	20.0	73.6	40.5	1.3	–	0.0	0.0
28	0.0	0.0	0.0	0.0	2.8	12.0	5.9	5.0	38.5	–	0.0	0.0
29	0.0		0.0	0.0	18.7	4.1	2.5	2.5	4.5	–	0.0	0.0
30	0.0		0.0	0.0	0.0	6.1	24.2	41.1	5.0	–	0.0	0.0
31	0.0		8.4		0.0		4.5	0.0		–		1.1
totall	135.0	146.5	19.9	41.3	110.3	467.8	650.4	570.5	128.2	22.8	30.9	1.1

【Bajura】 Daily Rainfall: (mm/day) 2014

month / day	1	2	3	4	5	6	7	8	9	10	11	12
1	2.1	0.0										
2	0.0	0.0										
3	0.0	0.0										
4	0.0	0.0										
5	0.0	0.0										
6	0.0	0.0										
7	0.0	0.0										
8	0.0	6.2										
9	0.0	0.0										
10	0.0	0.0										
11	0.0	0.0										
12	0.0	5.1										
13	0.0	–										
14	0.0	–										
15	0.0	–										
16	0.0	–										
17	0.0	–										
18	15.7	–										
19	17.7	–										
20	0.0	–										
21	0.0	–										
22	0.0	–										
23	8.7	–										
24	0.0	–										
25	0.0	–										
26	0.0	–										
27	0.0	–										
28	0.0	–										
29	0.0											
30	0.0											
31	0.0											
totall	44.2	11.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 3.7　annual record of rainfall（Musikot（Syarpudaha））

【Musikot（Syarpudaha）】 Daily Rainfall: (mm/day) 2013

month / day	1	2	3	4	5	6	7	8	9	10	11	12
1	0.0	0.0	0.0	20.0	0.0	15.0	7.0	90.0	10.5	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	16.0	22.0	–	4.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	15.0	7.0	14.0	8.5	5.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	2.0	29.0	30.0	0.0	17.0	0.0	0.0
5	0.0	14.5	0.0	0.0	0.0	0.0	34.0	23.0	0.0	0.0	0.0	0.0
6	0.0	17.0	31.0	0.0	0.0	3.0	33.0	44.0	0.0	14.0	0.0	0.0
7	0.0	2.0	0.0	0.0	0.0	1.0	2.0	28.0	18.0	5.5	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	3.0	10.0	23.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	20.0	4.0	73.0	5.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	45.0	4.0	40.5	22.0	0.0	0.0	0.0
11	0.0	0.0	0.0	4.5	0.0	25.0	11.5	30.0	11.0	4.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	9.5	46.0	35.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	2.0	35.0	7.0	34.0	19.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	18.0	30.5	44.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	8.5	66.5	33.0	0.0	8.5	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	5.0	68.5	11.0	1.0	23.5	0.0	0.0
17	18.9	12.5	0.0	6.0	15.0	33.0	9.0	39.0	0.0	39.0	0.0	0.0
18	29.0	7.0	0.0	0.0	17.0	61.5	20.5	22.5	0.0	2.0	0.0	0.0
19	0.0	0.0	0.0	5.5	0.0	23.0	73.5	18.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	2.0	41.0	21.0	2.5	15.0	0.0	0.0
21	0.0	0.0	0.0	8.0	9.5	0.0	23.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	2.0	82.0	7.0	17.5	0.0	0.0	0.0
23	0.0	0.0	0.0	24.0	19.0	5.0	0.0	0.0	58.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	3.5	42.5	6.5	23.0	0.0	0.0	0.0	0.0
25	0.0	0.0	0.0	5.5	0.0	5.5	22.0	25.0	4.5	0.0	0.0	0.0
26	0.0	0.0	0.0	0.0	19.0	20.0	10.0	5.0	41.0	0.0	0.0	0.0
27	0.0	0.0	0.0	0.0	0.0	5.9	14.0	25.0	26.5	0.0	0.0	0.0
28	0.0	0.0	0.0	0.0	4.0	42.0	10.0	10.0	34.8	0.0	0.0	0.0
29	0.0		0.0	0.0	0.0	25.0	7.0	10.5	3.0	0.0	0.0	0.0
30	0.0		0.0	0.0	0.0	7.0	17.0	16.0	12.0	0.0	0.0	0.0
31	0.0		0.0		0.0		34.1	5.5		0.0		0.0
totall	47.9	53.0	31.0	73.5	89.0	469.9	709.1	813.0	329.8	137.5	0.0	0.0

【Musikot（Syarpudaha）】 Daily Rainfall: (mm/day) 2014

month / day	1	2	3	4	5	6	7	8	9	10	11	12
1	0.0	0.0										
2	0.0	0.0										
3	0.0	0.0										
4	0.0	0.0										
5	0.0	0.0										
6	0.0	0.0										
7	0.0	0.0										
8	0.0	7.5										
9	0.0	0.0										
10	0.0	0.0										
11	0.0	0.0										
12	2.0	0.0										
13	0.0	0.0										
14	0.0	0.0										
15	0.0	0.0										
16	0.0	–										
17	0.0	–										
18	13.5	–										
19	21.0	–										
20	0.0	–										
21	0.0	–										
22	0.0	–										
23	0.0	–										
24	0.0	–										
25	0.0	–										
26	0.0	–										
27	0.0	–										
28	0.0	–										
29	0.0											
30	0.0											
31	0.0											
totall	36.5	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0