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APPENDIX-A

DATA CHECKING KELANI GANGA

APPENDIX A: DATA CHECKING KELANI GANGA

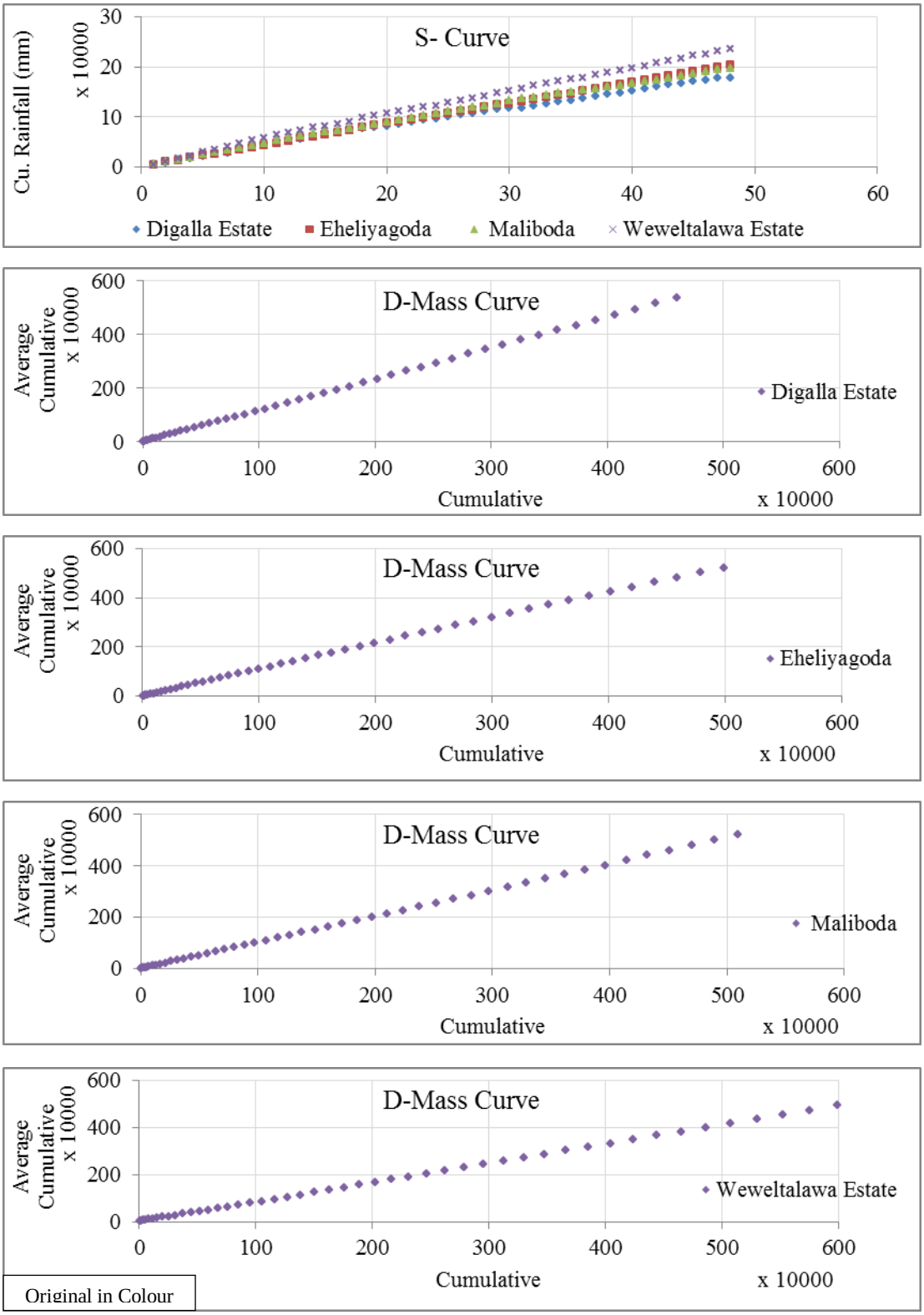


Figure A- 1: S-Curve & D-Mass Curve Analysis for Kelani Ganga (1966-2014)

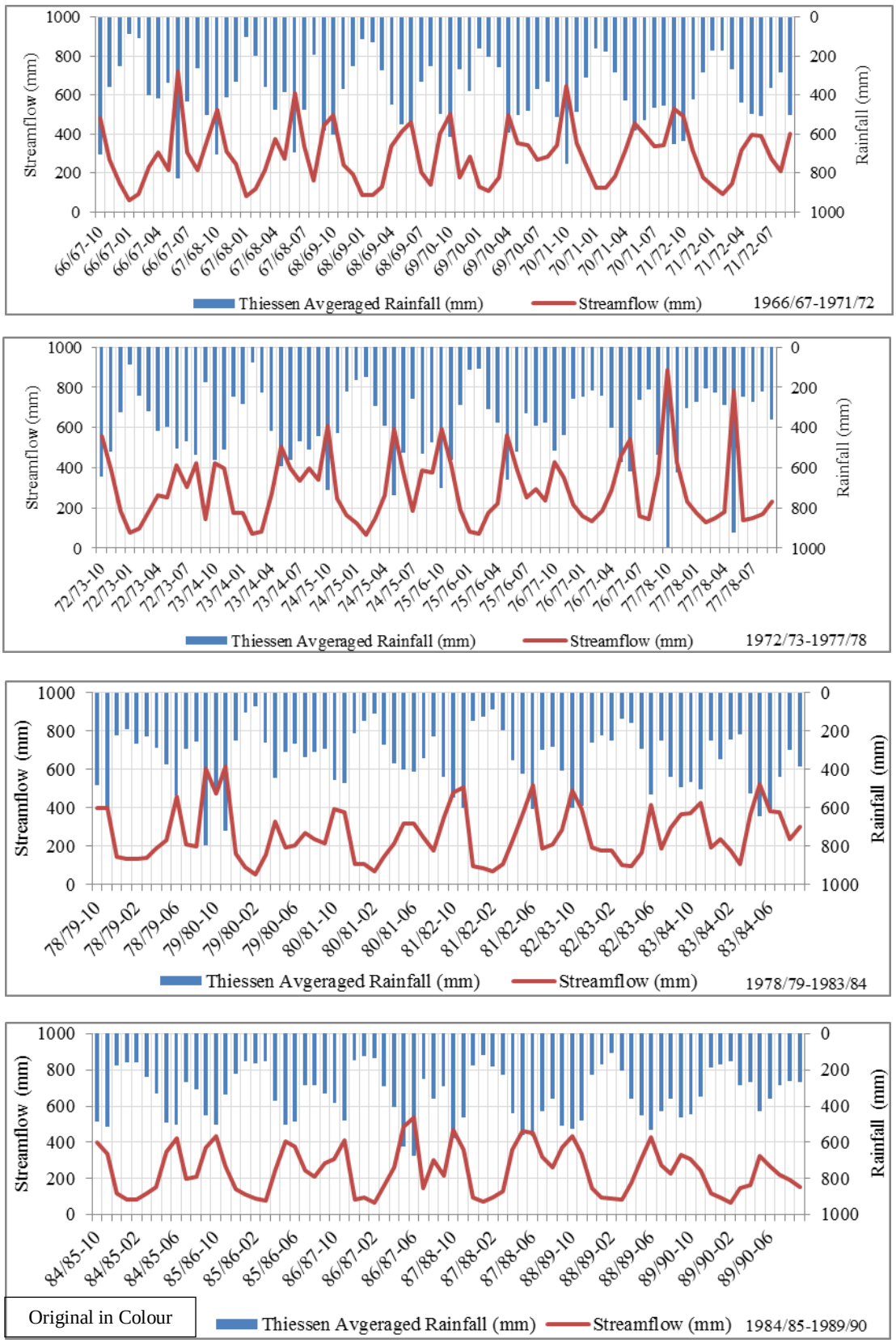


Figure A- 2: Streamflow Corresponding Monthly Rainfall for Kelani Ganga (1966-1990)

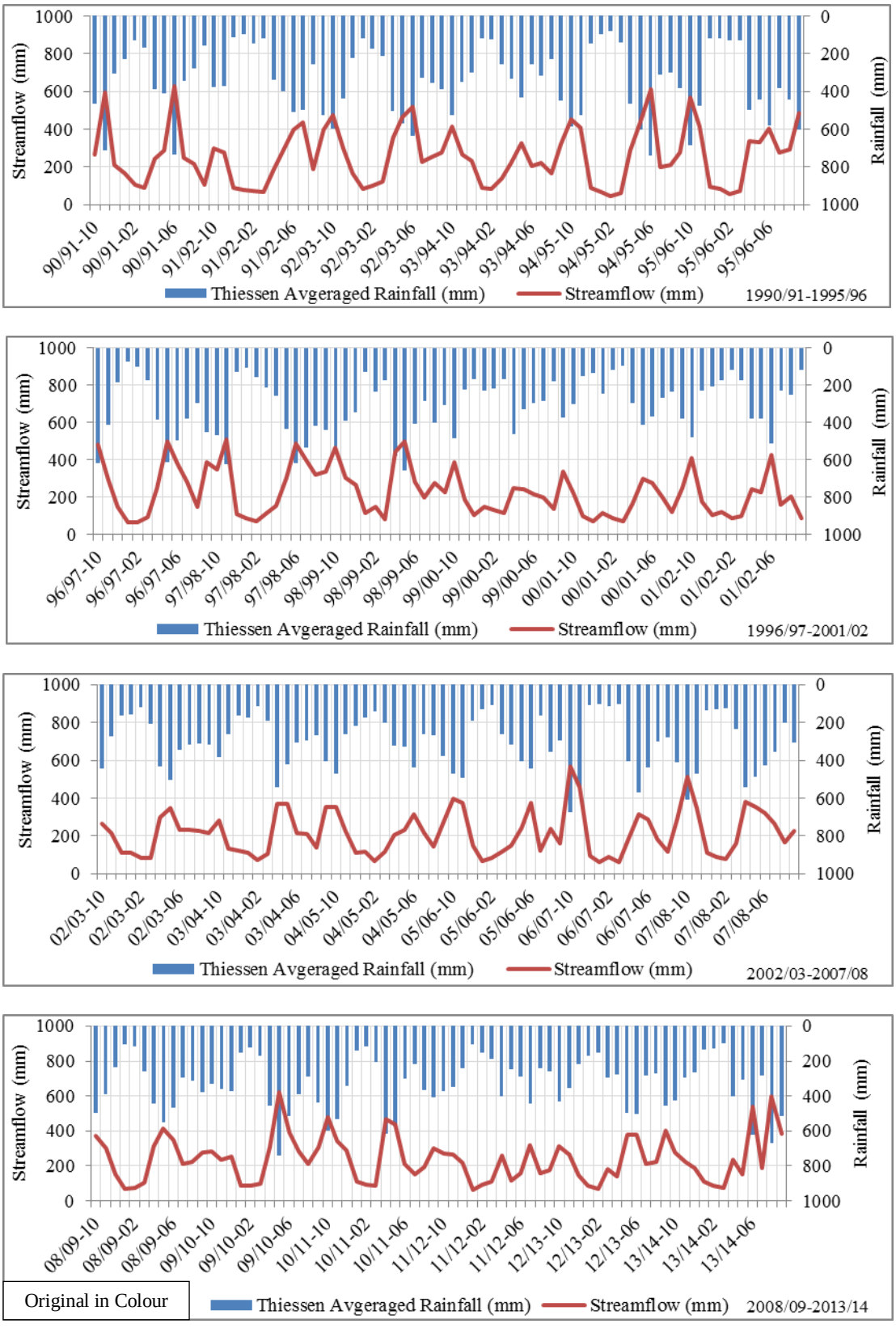


Figure A- 3: Streamflow Corresponding Monthly Rainfall for Kelani Ganga (1991-2014)

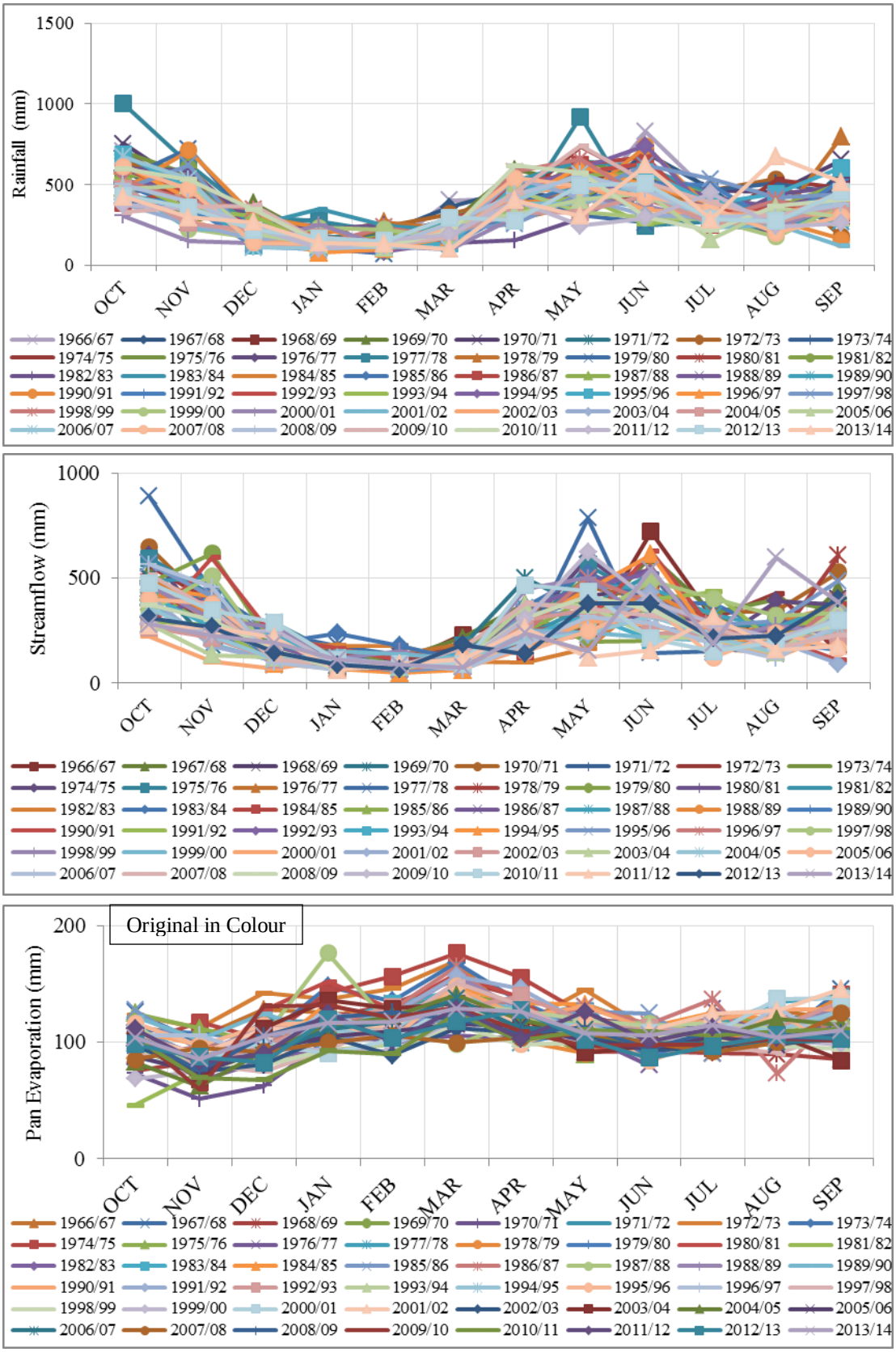
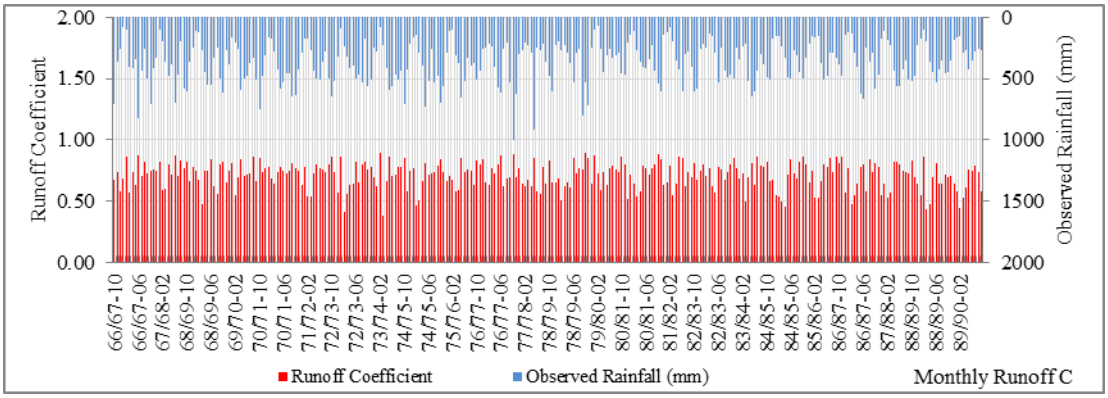
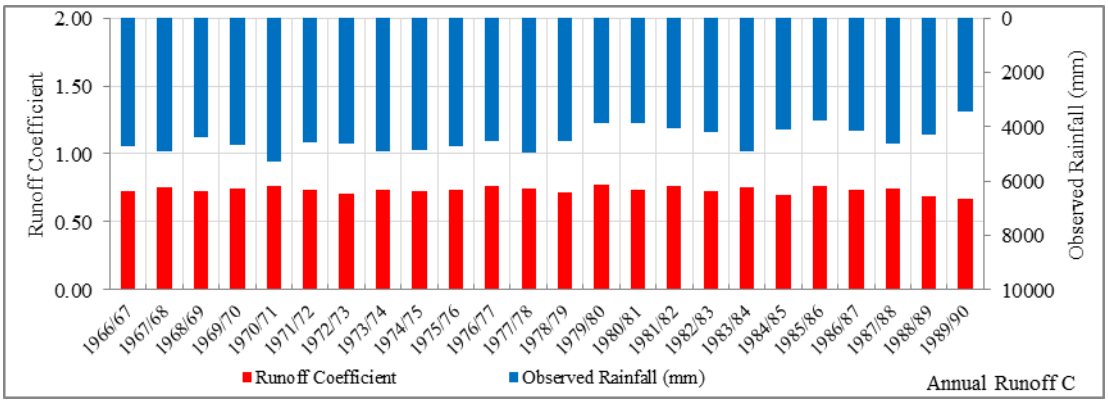
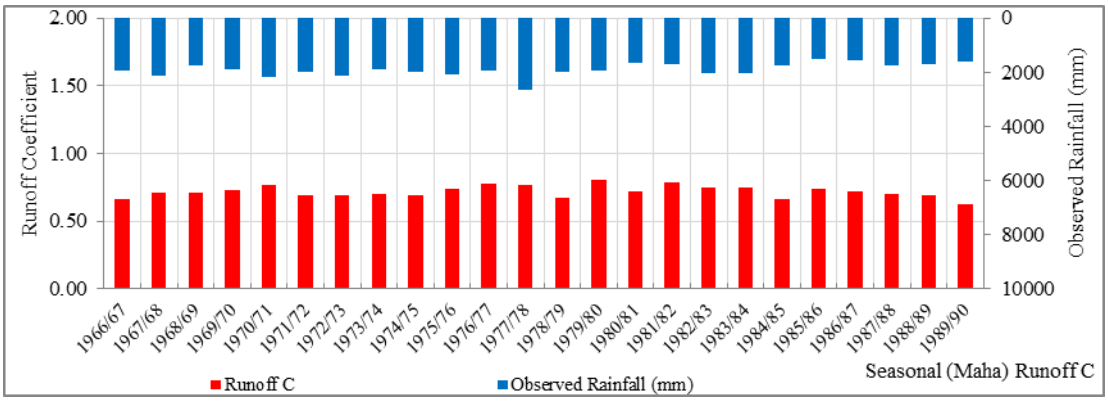
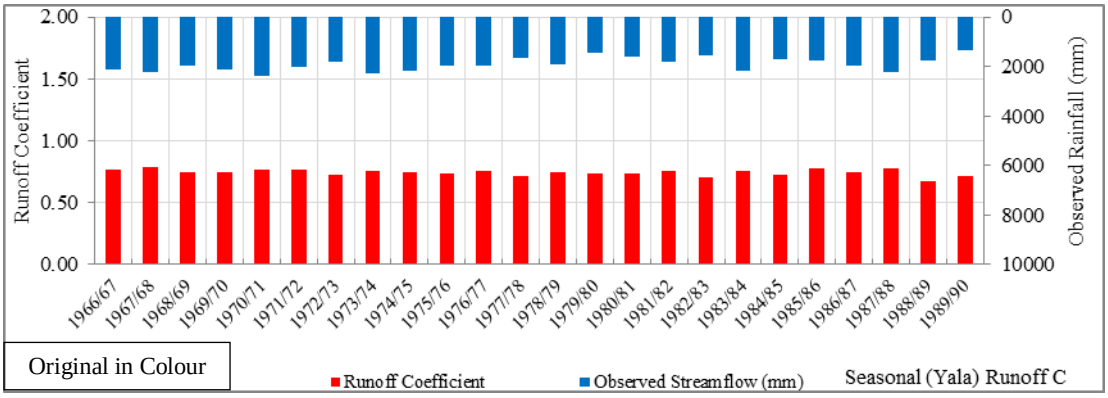


Figure A- 4: Monthly Rainfall, Streamflow and Evaporation for Kelani Ganga (1966-2014)









Original in Colour

Figure A- 5: Monthly, Annual & Seasonal Runoff Coefficient for Kelani Ganga (1966-1990)

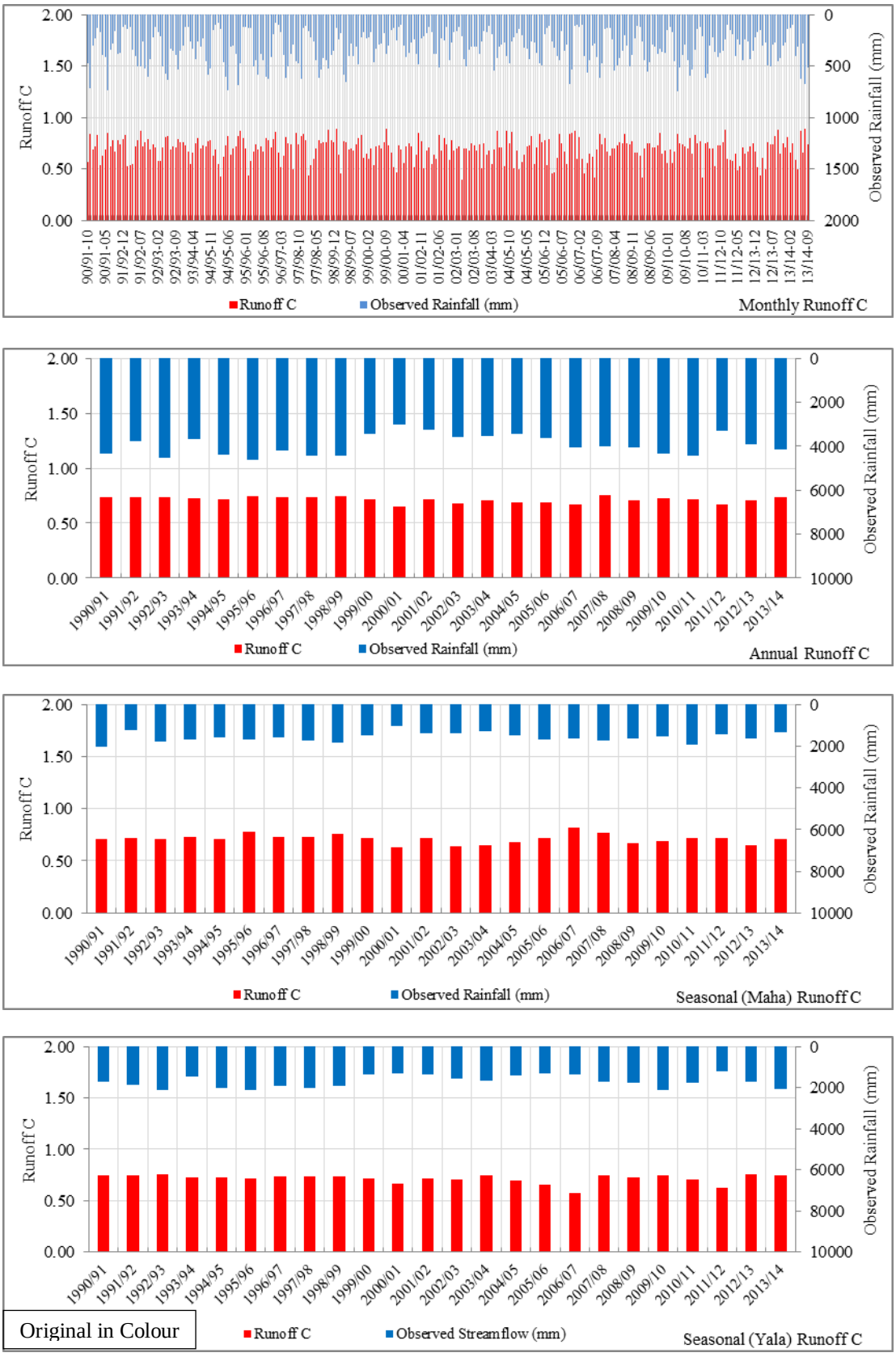


Figure A- 6: Monthly, Annual & Seasonal Runoff Coefficient for Kelani Ganga1990-2014

Table A- 1: Parameter Optimization using MRAE for Kelani Ganga

c/SC	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
255	0.307	0.227	0.170	0.146	0.154	0.192	0.251	0.322	0.391	0.457
538	0.304	0.216	0.147	0.113	0.118	0.163	0.230	0.300	0.369	0.434
705	0.319	0.224	0.144	0.096	0.099	0.142	0.210	0.281	0.350	0.415
818	0.332	0.236	0.149	0.093	0.090	0.131	0.196	0.268	0.337	0.402
990	0.353	0.256	0.166	0.099	0.088	0.119	0.179	0.248	0.317	0.383
1148	0.373	0.276	0.186	0.115	0.093	0.116	0.166	0.232	0.300	0.366
1389	0.403	0.306	0.215	0.146	0.113	0.122	0.158	0.213	0.278	0.343
1820	0.454	0.356	0.267	0.200	0.159	0.149	0.165	0.202	0.253	0.311
2384	0.511	0.413	0.327	0.261	0.215	0.192	0.190	0.209	0.244	0.291
3123	0.573	0.476	0.392	0.326	0.275	0.243	0.229	0.233	0.252	0.284

Table A- 2: Parameter Optimization using Nash-Sutcliffe efficiency for Kelani Ganga

c/SC	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
255	0.676	0.816	0.901	0.937	0.927	0.878	0.792	0.676	0.532	0.366
538	0.678	0.823	0.913	0.953	0.949	0.904	0.824	0.712	0.573	0.411
705	0.683	0.829	0.921	0.963	0.961	0.918	0.840	0.730	0.593	0.432
818	0.683	0.830	0.924	0.967	0.966	0.924	0.847	0.738	0.602	0.442
990	0.677	0.826	0.921	0.967	0.967	0.928	0.852	0.745	0.611	0.453
1148	0.665	0.817	0.914	0.961	0.964	0.926	0.853	0.747	0.615	0.458
1389	0.640	0.795	0.895	0.946	0.952	0.918	0.847	0.745	0.615	0.461
1820	0.581	0.743	0.850	0.908	0.920	0.891	0.827	0.730	0.605	0.456
2384	0.495	0.667	0.783	0.850	0.870	0.849	0.792	0.702	0.583	0.440
3123	0.387	0.571	0.698	0.775	0.805	0.794	0.745	0.663	0.552	0.415

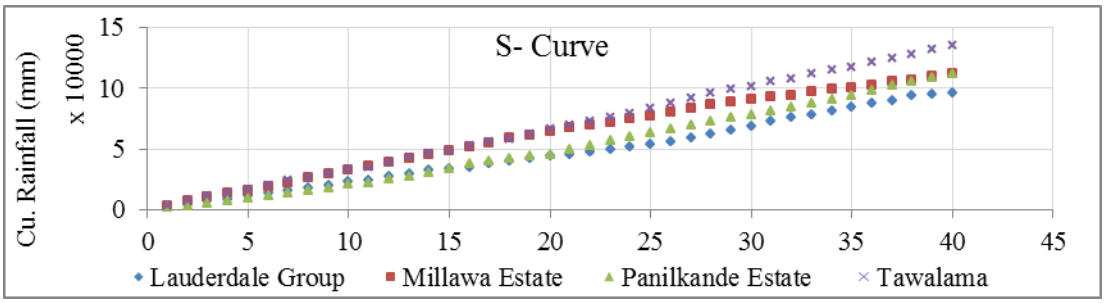
Table A- 3: Best Sets of Optimized Parameters for Kelani Ganga

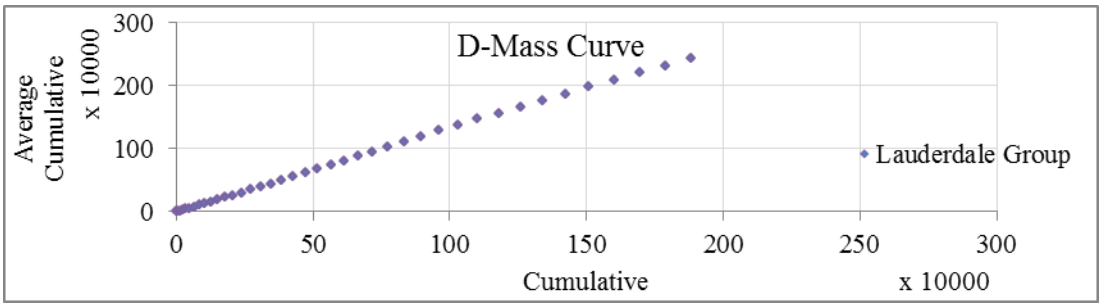
Parameter	c	SC
1	0.46	990.00
2	0.46	895.50
3	0.46	899.475

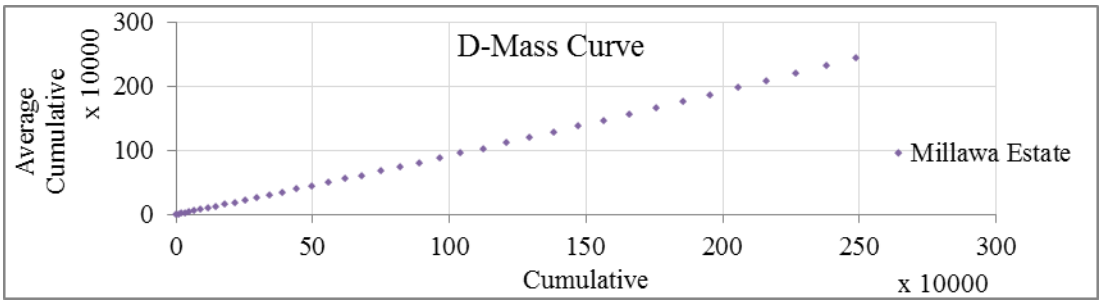
APPENDIX-B

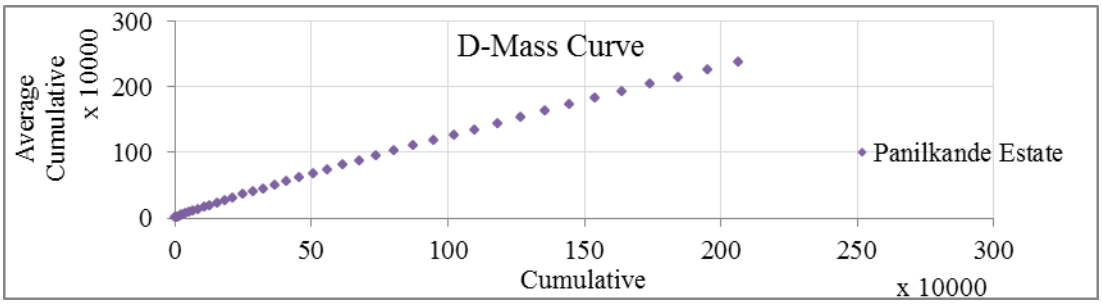
DATA CHECKING GIN GANGA

APPENDIX-B: DATA CHECKING GIN GANGA









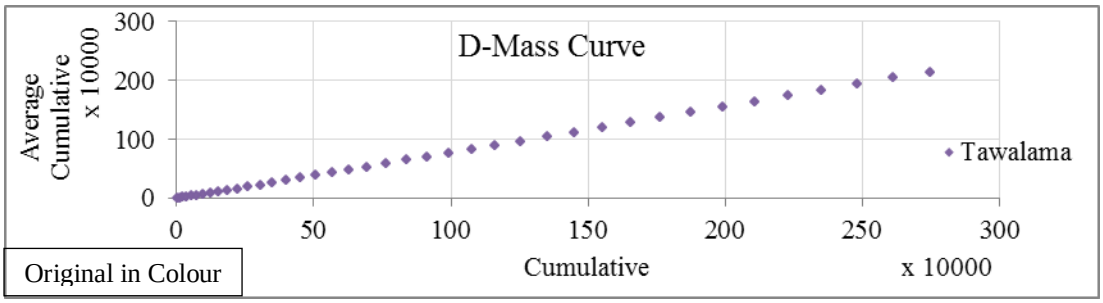


Figure B- 1: S-Curve & D-Mass Curve Analysis for Gin Ganga (1972-2012)

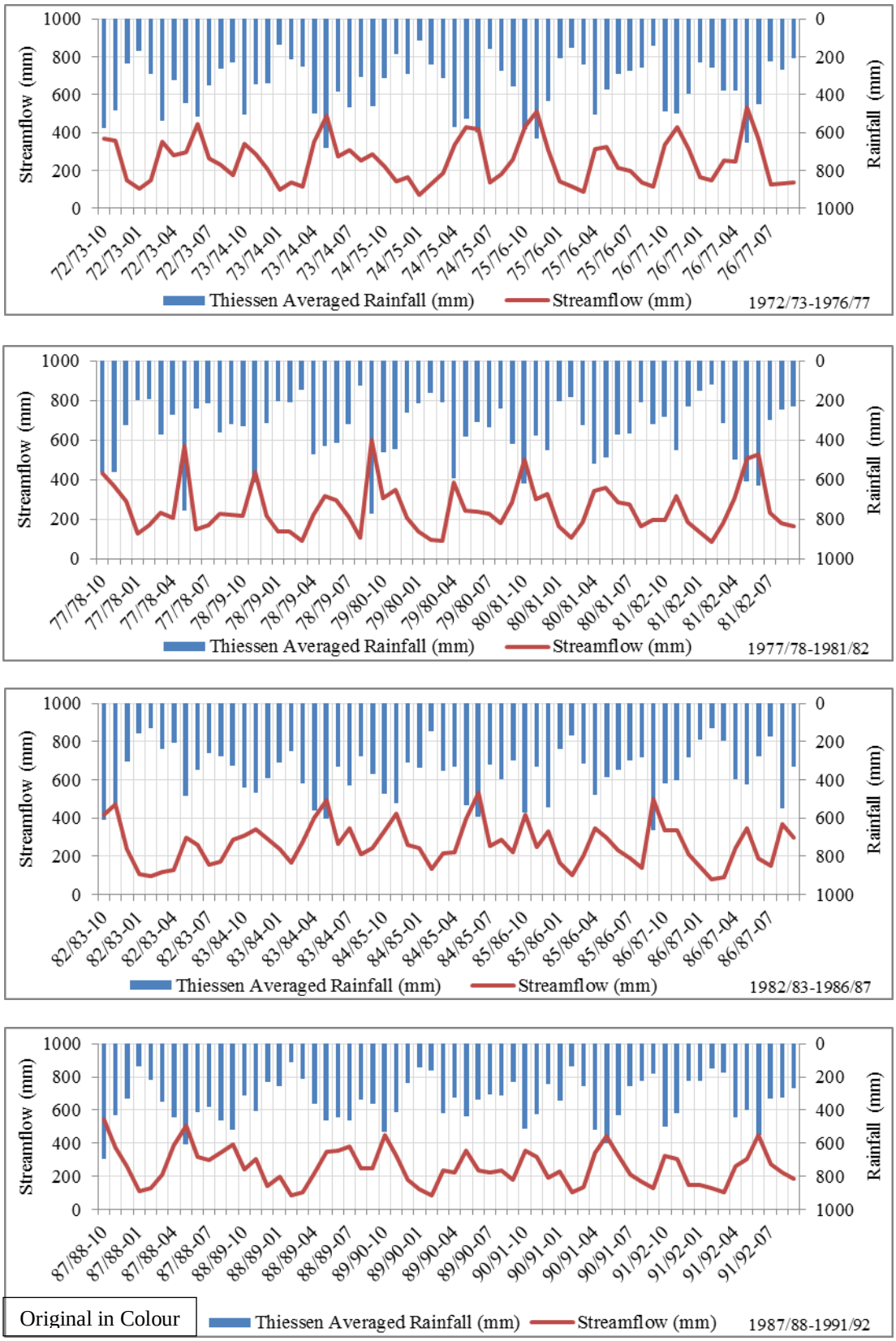


Figure B- 2: Streamflow Corresponding Monthly Rainfall for Gin Ganga (1972-1992)

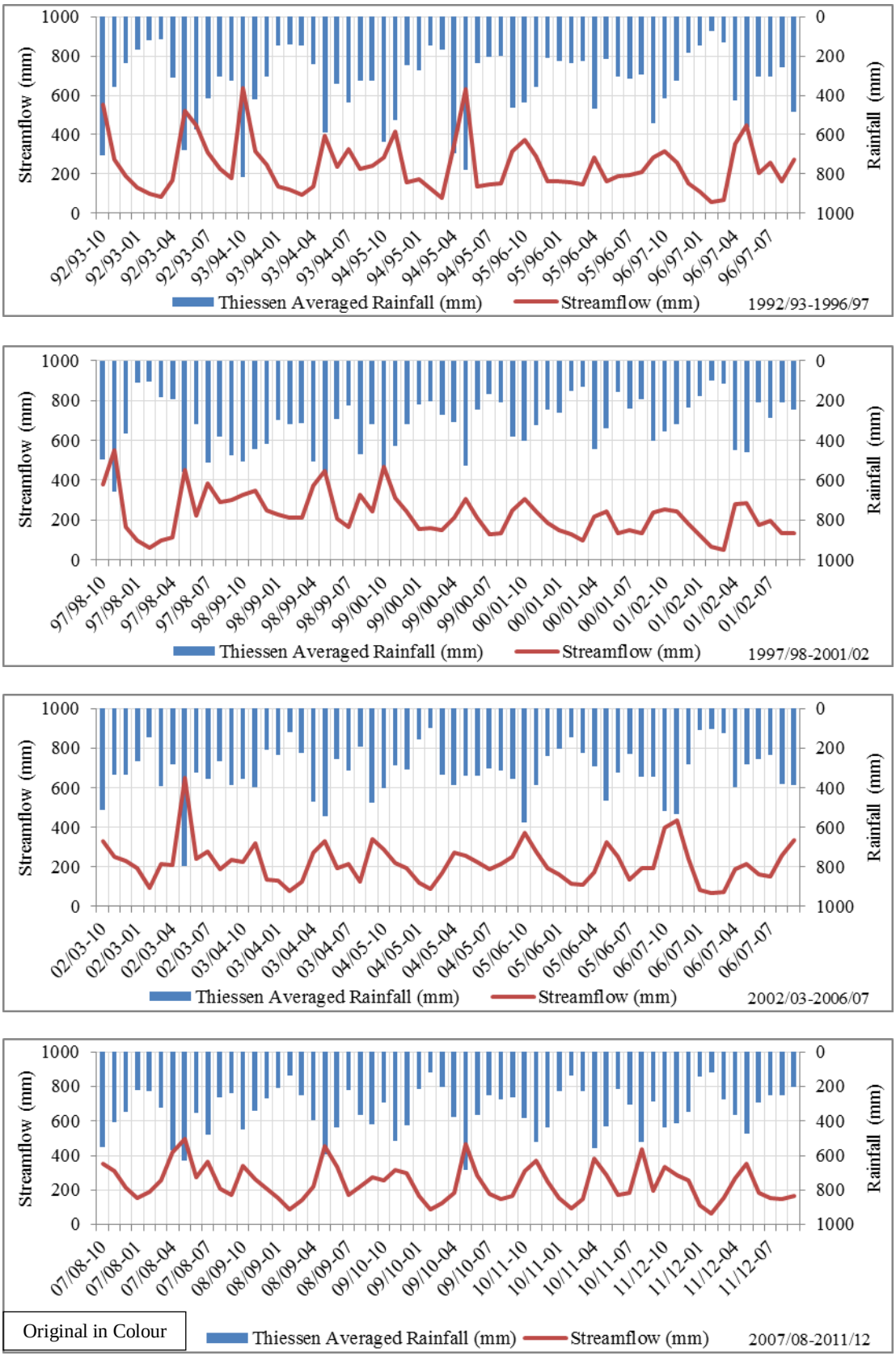


Figure B- 3: Streamflow Corresponding Monthly Rainfall for Gin Ganga (1992-2012)

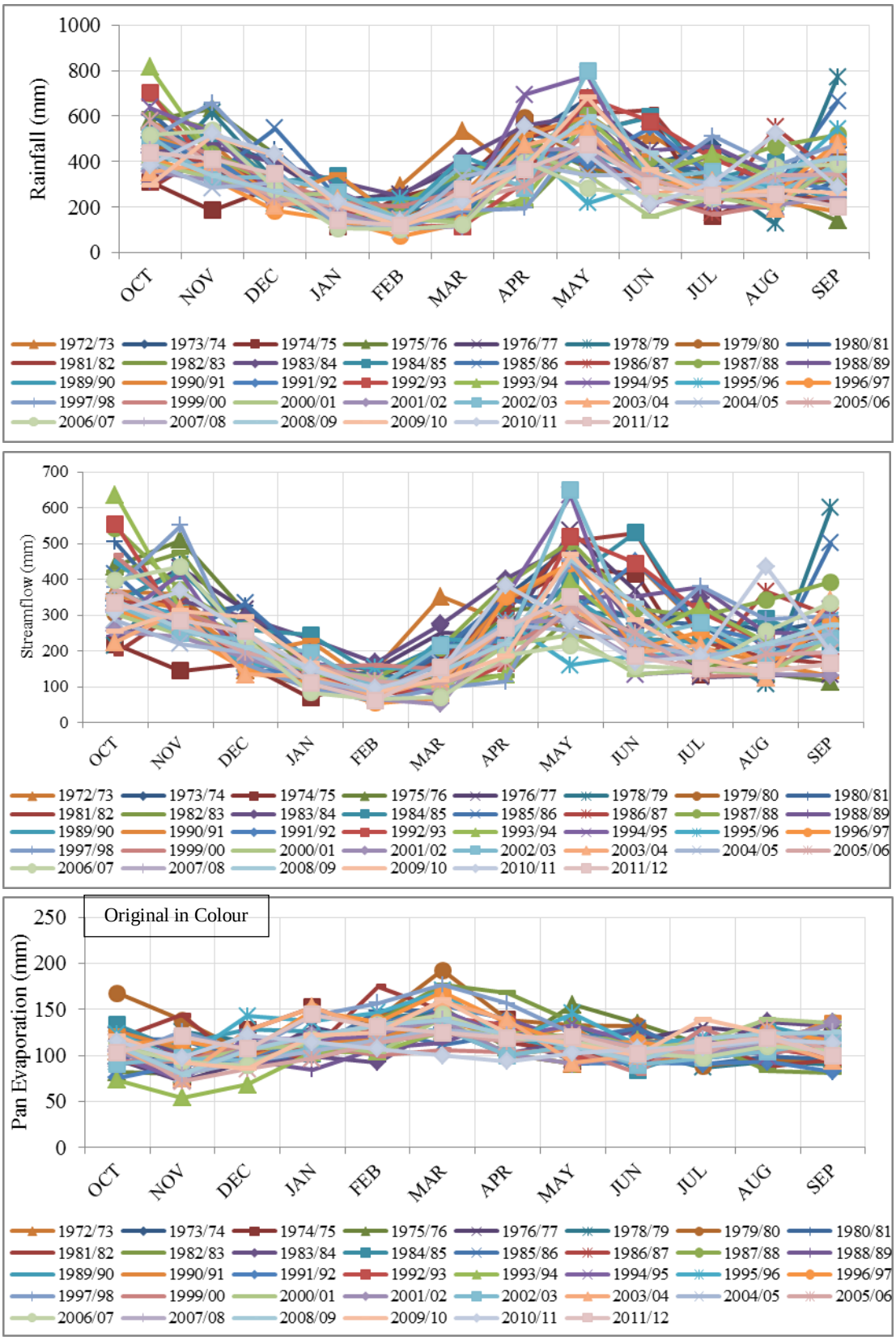


Figure B- 4: Monthly Rainfall, Streamflow and Evaporation for Gin Ganga (1972-2012)

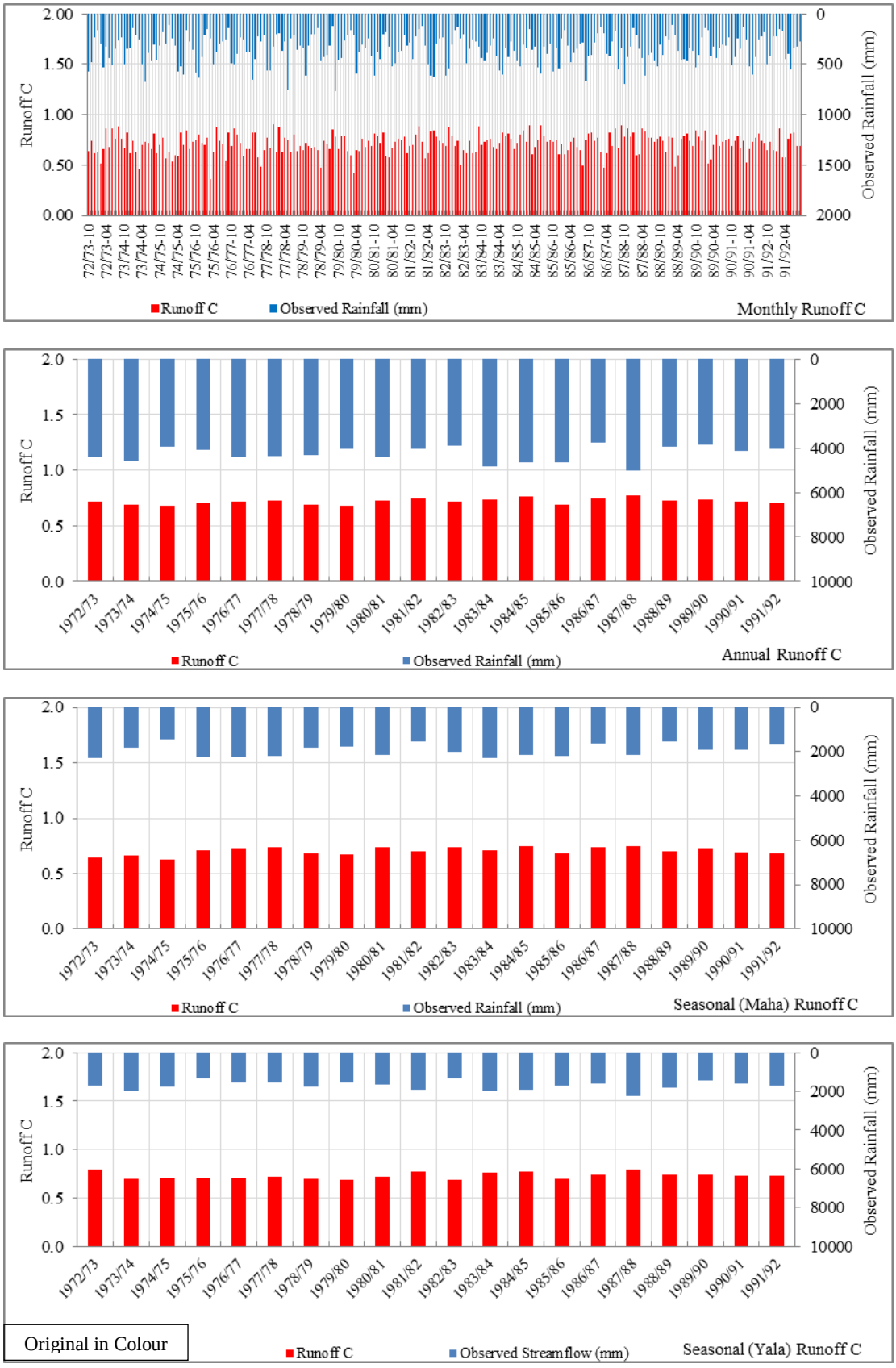


Figure B- 5: Monthly, Annual & Seasonal Runoff Coefficient for Gin Ganga (1972-1992)

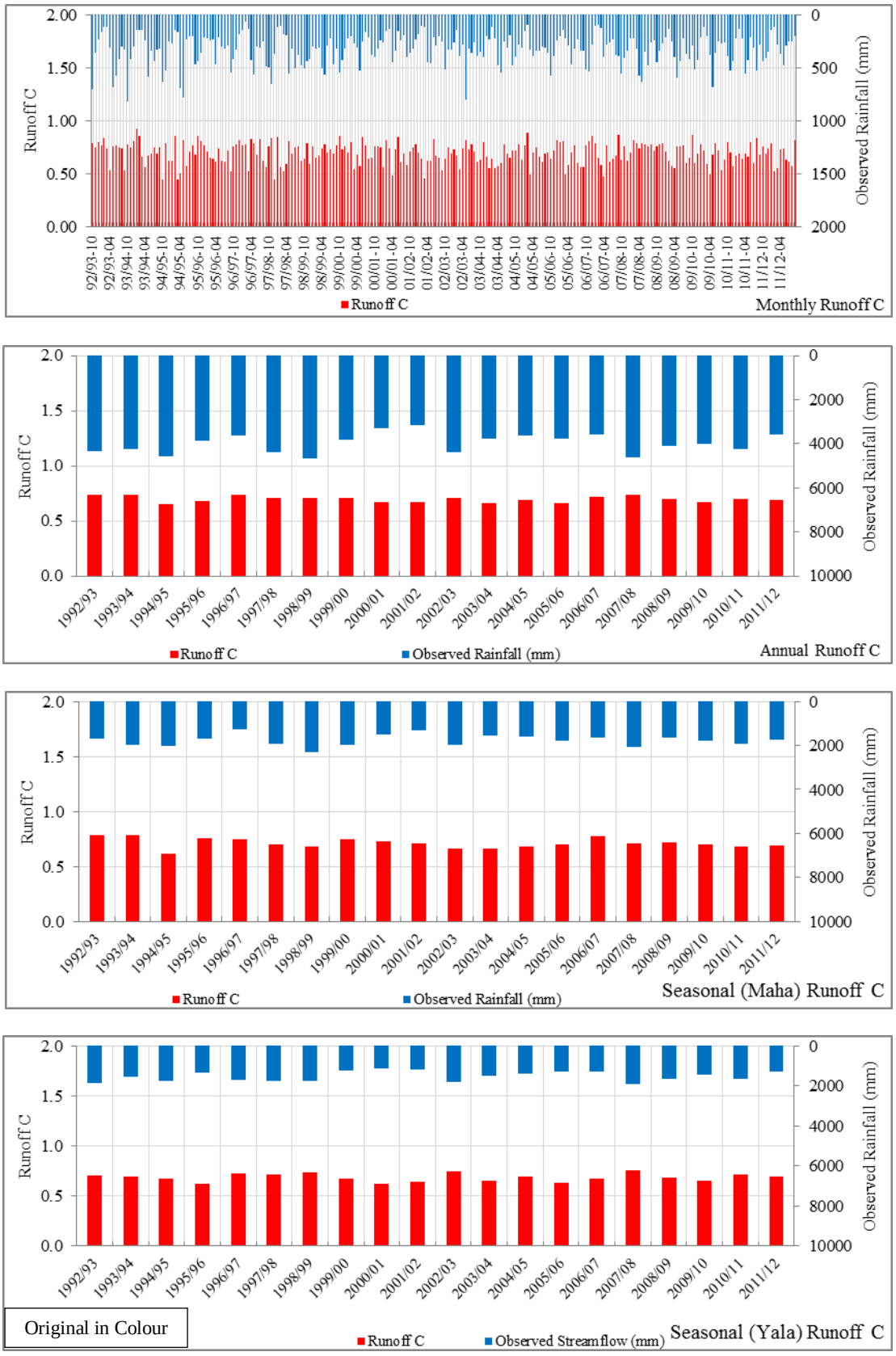
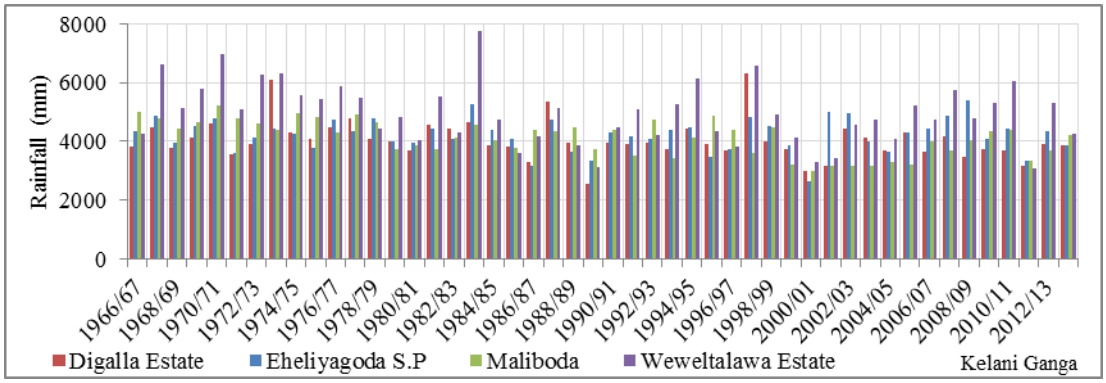
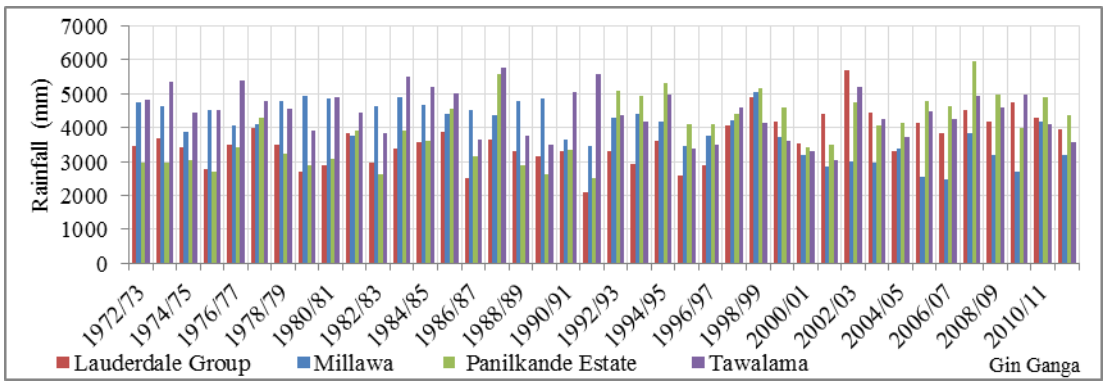
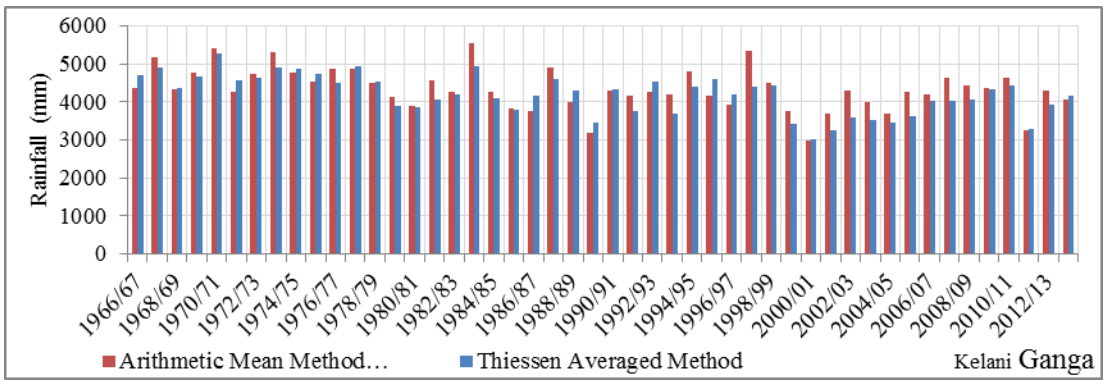


Figure B- 6: Monthly, Annual & Seasonal Runoff Coefficient for Gin Ganga 1992-2012







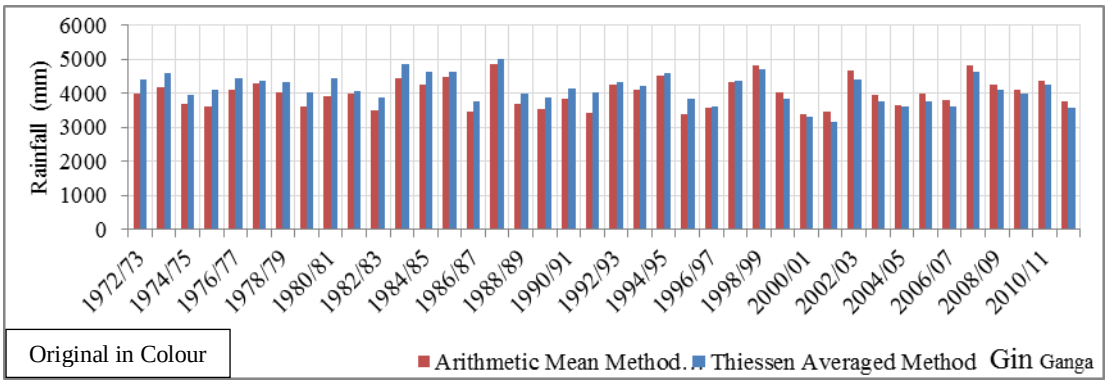


Figure B- 7: Variability of rainfall station wise and Total Rainfall by Thiessen Average and Arithmetic Mean Method for Kelani Ganga & Gin Ganga.

Table B- 1: Parameter Optimization using MRAE for Gin Ganga

c/SC	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
411	0.3316	0.2400	0.1878	0.1636	0.1693	0.1948	0.2427	0.3042	0.3698	0.4329
703	0.3236	0.2560	0.1664	0.1263	0.1189	0.1497	0.2065	0.2732	0.3399	0.4044
850	0.3360	0.2438	0.1846	0.1145	0.1005	0.1299	0.1903	0.2579	0.3256	0.3910
1114	0.3612	0.2655	0.1786	0.1273	0.0835	0.1079	0.1657	0.2338	0.3033	0.3695
1292	0.3776	0.2811	0.1922	0.1169	0.0971	0.1027	0.1541	0.2200	0.2897	0.3565
1434	0.3900	0.2933	0.2033	0.1258	0.0849	0.1120	0.1472	0.2108	0.2797	0.3469
1839	0.4223	0.3254	0.2347	0.1564	0.1103	0.1080	0.1424	0.1929	0.2564	0.3231
2409	0.4616	0.3642	0.2739	0.1984	0.1509	0.1318	0.1440	0.1829	0.2374	0.2982
3156	0.5022	0.4042	0.3173	0.2452	0.1951	0.1664	0.1618	0.1848	0.2261	0.2804
4450	0.5539	0.4576	0.3733	0.3044	0.2506	0.2138	0.1970	0.2017	0.2273	0.2673

Table B- 2: Parameter Optimization using Nash-Sutcliffe efficiency for Gin Ganga

c/SC	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
411	0.11	0.526	0.697	0.791	0.813	0.7725	0.676	0.529	0.341	0.116
703	0.33	0.48	0.771	0.867	0.892	0.8533	0.758	0.613	0.424	0.199
850	0.37	0.627	0.71	0.898	0.922	0.8831	0.787	0.642	0.453	0.227
1114	0.39	0.654	0.829	0.87	0.950	0.9114	0.816	0.670	0.482	0.256
1292	0.39	0.656	0.832	0.929	0.92	0.9174	0.823	0.678	0.490	0.265
1434	0.39	0.650	0.828	0.927	0.954	0.9041	0.823	0.680	0.493	0.269
1839	0.35	0.617	0.800	0.903	0.935	0.9019	0.82	0.672	0.488	0.267
2409	0.27	0.550	0.741	0.852	0.891	0.8645	0.781	0.67	0.467	0.251
3156	0.17	0.459	0.660	0.780	0.828	0.8096	0.733	0.606	0.46	0.222
4450	0.01	0.320	0.535	0.669	0.729	0.7225	0.657	0.539	0.374	0.21

Table B- 3: Best Sets of Optimized Parameters for Gin Ganga

Parameters	C	SC
1	0.51	1292.0
2	0.51	1277.1
3	0.51	1322

APPENDIX-C

ANALYSIS KELANI GANGA

APPENDIX-C: ANALYSIS KELANI GANGA

Table C- 1: Warming up period for soil water content at Kelani Ganga (1966-1990)

Warming up Period	St-1 (mm)
0	0
1	138.88
2	138.88
3	139.06
4	138.88
5	138.88

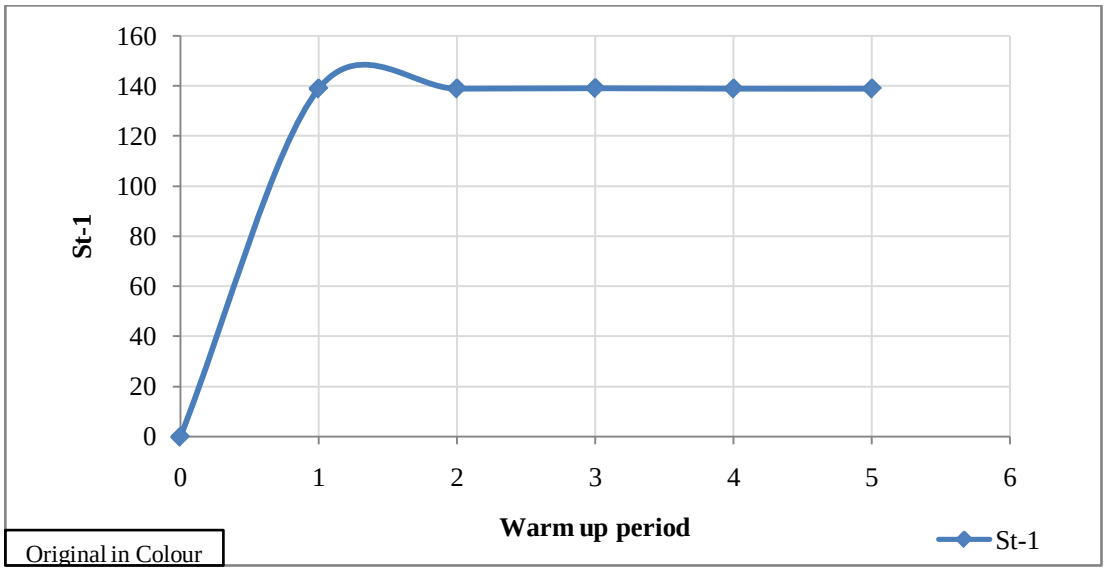


Figure C- 1: Warming up period for soil water content at Kelani Ganga (1966-1990)

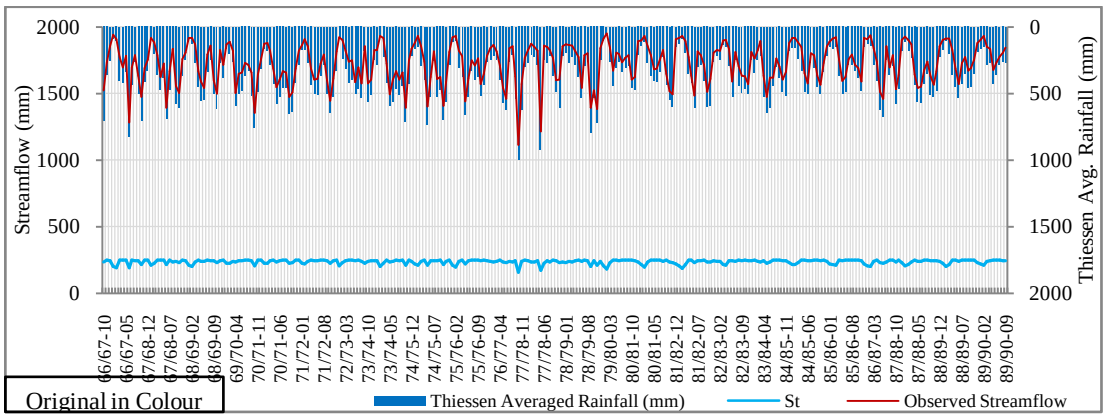


Figure C- 2: Soil Moisture Content corresponding to observed Rainfall & Streamflow for Kelani Ganga (1966-1990)

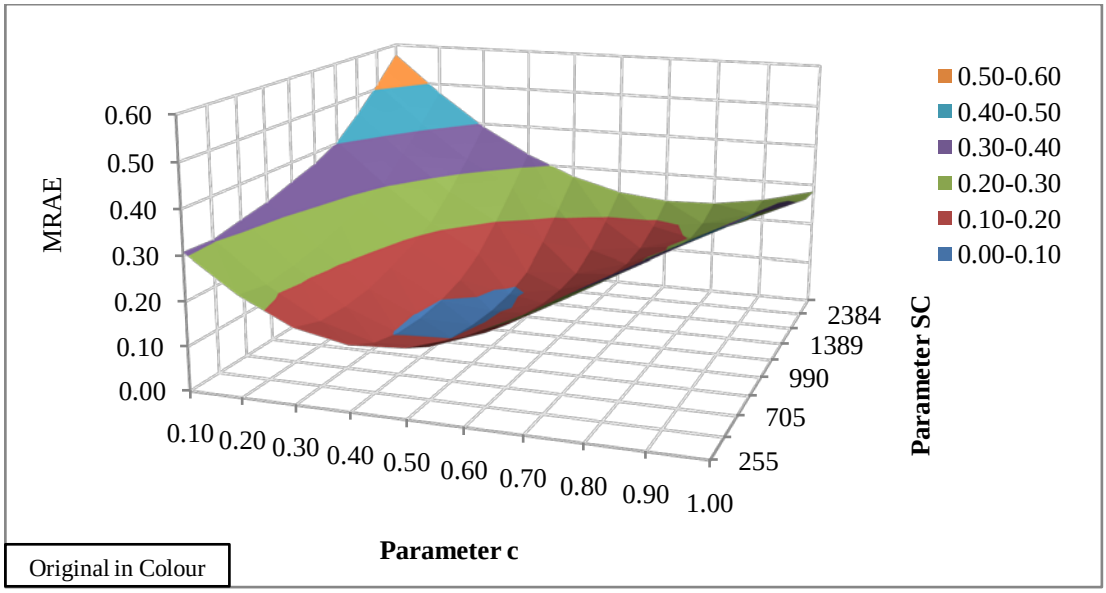


Figure C- 3: Parameter Optimization Using MRAE at Kelani Ganga

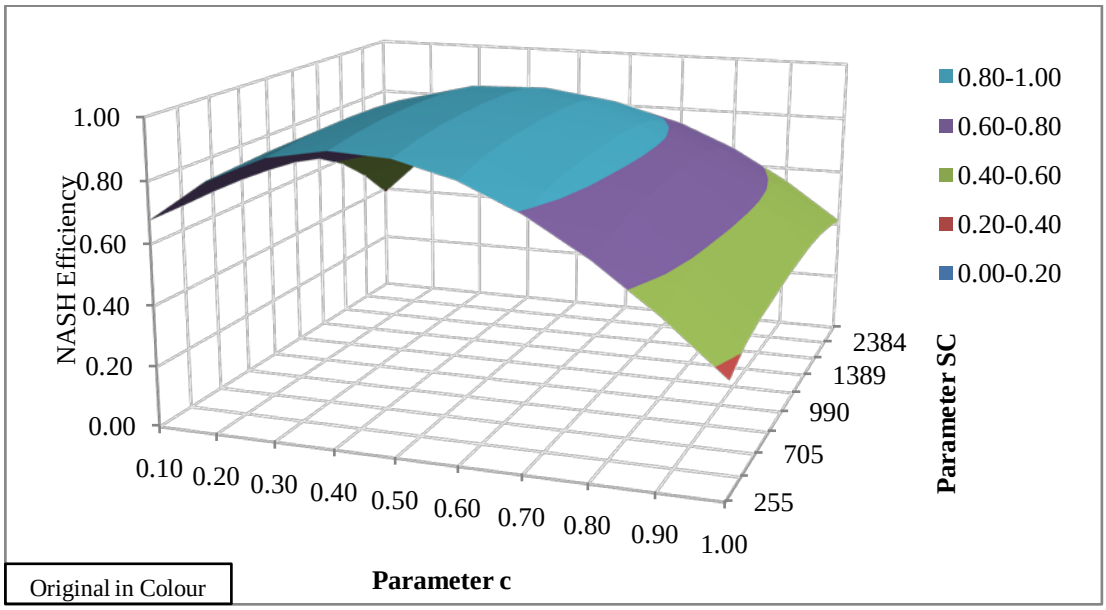


Figure C- 4: Parameter Optimization Using Nash-Sutcliffe efficiency at Kelani Ganga

Table C- 2: MRAE Monthly Water Balance for Kelani Ganga (1966-1990)

Parameter c	MRAE SC=255	MRAE SC=538	MRAE SC=705	MRAE SC=818	MRAE SC=990	MRAE SC=1148	MRAE SC=1389	MRAE SC=1820	MRAE SC=2384	MRAE SC=3123
0.10	0.307	0.304	0.319	0.332	0.353	0.373	0.403	0.454	0.511	0.573
0.20	0.227	0.216	0.224	0.236	0.256	0.276	0.306	0.356	0.413	0.476
0.30	0.170	0.147	0.144	0.149	0.166	0.186	0.215	0.267	0.327	0.392
0.40	0.146	0.113	0.096	0.093	0.099	0.115	0.146	0.200	0.261	0.326
0.50	0.154	0.118	0.099	0.090	0.088	0.093	0.113	0.159	0.215	0.275
0.60	0.192	0.163	0.142	0.131	0.119	0.116	0.122	0.149	0.192	0.243
0.70	0.251	0.230	0.210	0.196	0.179	0.166	0.158	0.165	0.190	0.229
0.80	0.322	0.300	0.281	0.268	0.248	0.232	0.213	0.202	0.209	0.233
0.90	0.391	0.369	0.350	0.337	0.317	0.300	0.278	0.253	0.244	0.252
1.00	0.457	0.434	0.415	0.402	0.383	0.366	0.343	0.311	0.291	0.284

Table C- 3: MRAE Seasonal Water Balance (Maha) for Kelani Ganga (1966-1990)

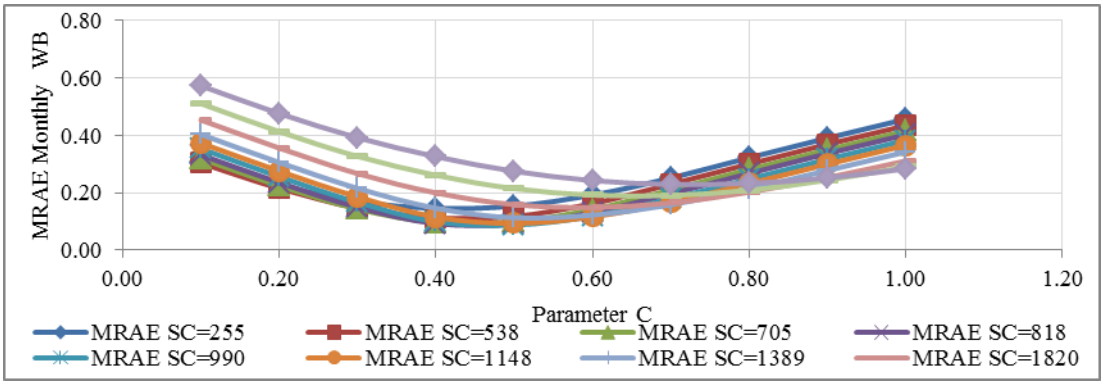
Parameter c	MRAE SC=255	MRAE SC=538	MRAE SC=705	MRAE SC=818	MRAE SC=990	MRAE SC=1148	MRAE SC=1389	MRAE SC=1820	MRAE SC=2384	MRAE SC=3123
0.10	0.264	0.266	0.281	0.293	0.312	0.329	0.354	0.395	0.441	0.490
0.20	0.172	0.177	0.193	0.204	0.223	0.240	0.265	0.306	0.350	0.398
0.30	0.087	0.095	0.109	0.120	0.138	0.155	0.180	0.220	0.263	0.314
0.40	0.046	0.041	0.042	0.048	0.061	0.075	0.098	0.140	0.186	0.235
0.50	0.088	0.072	0.059	0.050	0.038	0.035	0.040	0.068	0.111	0.159
0.60	0.159	0.145	0.128	0.115	0.096	0.080	0.060	0.041	0.049	0.087
0.70	0.233	0.217	0.199	0.186	0.168	0.151	0.128	0.092	0.061	0.047
0.80	0.303	0.285	0.267	0.254	0.236	0.219	0.197	0.162	0.124	0.086
0.90	0.370	0.349	0.331	0.318	0.300	0.284	0.262	0.228	0.192	0.155
1.00	0.433	0.410	0.392	0.379	0.361	0.346	0.324	0.292	0.257	0.221

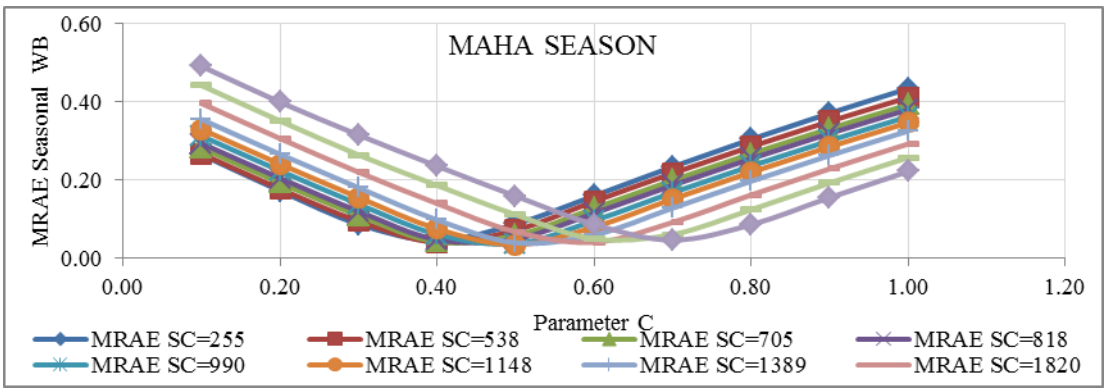
Table C- 4: MRAE Seasonal Water Balance (Yala) for Kelani Ganga (1966-1990)

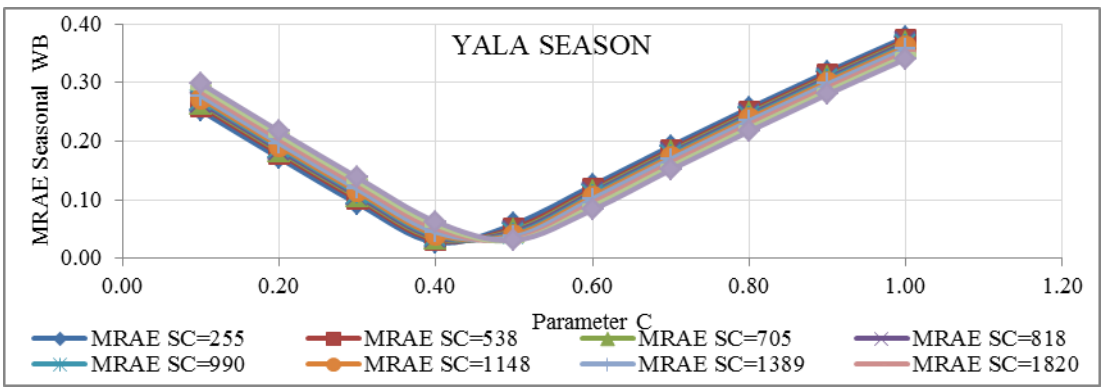
Parameter c	MRAE SC=255	MRAE SC=538	MRAE SC=705	MRAE SC=818	MRAE SC=990	MRAE SC=1148	MRAE SC=1389	MRAE SC=1820	MRAE SC=2384	MRAE SC=3123
0.10	0.252	0.260	0.264	0.266	0.270	0.273	0.277	0.284	0.292	0.298
0.20	0.171	0.179	0.183	0.185	0.189	0.192	0.196	0.203	0.210	0.217
0.30	0.093	0.101	0.105	0.107	0.110	0.113	0.118	0.125	0.132	0.138
0.40	0.027	0.031	0.034	0.036	0.038	0.041	0.045	0.051	0.057	0.063
0.50	0.059	0.052	0.048	0.046	0.043	0.040	0.037	0.033	0.031	0.031
0.60	0.124	0.118	0.114	0.112	0.109	0.106	0.102	0.095	0.089	0.083
0.70	0.192	0.185	0.182	0.180	0.177	0.174	0.170	0.163	0.157	0.151
0.80	0.256	0.250	0.247	0.245	0.242	0.239	0.235	0.229	0.222	0.217
0.90	0.318	0.313	0.310	0.307	0.304	0.301	0.297	0.291	0.285	0.280
1.00	0.378	0.372	0.369	0.367	0.364	0.361	0.357	0.351	0.345	0.340

Table C- 5: MRAE Annual Water Balance for Kelani Ganga (1966-1990)

Parameter c	MRAE SC=255	MRAE SC=538	MRAE SC=705	MRAE SC=818	MRAE SC=990	MRAE SC=1148	MRAE SC=1389	MRAE SC=1820	MRAE SC=2384	MRAE SC=3123
0.10	0.255	0.260	0.269	0.275	0.285	0.294	0.308	0.329	0.352	0.377
0.20	0.170	0.176	0.185	0.192	0.202	0.211	0.224	0.245	0.268	0.291
0.30	0.088	0.095	0.104	0.111	0.121	0.130	0.143	0.163	0.186	0.209
0.40	0.0248	0.028	0.034	0.039	0.046	0.052	0.065	0.085	0.107	0.130
0.50	0.067	0.058	0.050	0.045	0.036	0.031	0.0254	0.027	0.039	0.059
0.60	0.140	0.130	0.120	0.114	0.104	0.095	0.083	0.064	0.046	0.034
0.70	0.209	0.199	0.189	0.183	0.173	0.164	0.152	0.133	0.113	0.093
0.80	0.276	0.265	0.255	0.249	0.239	0.230	0.219	0.200	0.181	0.161
0.90	0.340	0.328	0.318	0.312	0.302	0.294	0.282	0.264	0.246	0.227
1.00	0.400	0.388	0.378	0.372	0.362	0.354	0.343	0.326	0.308	0.290







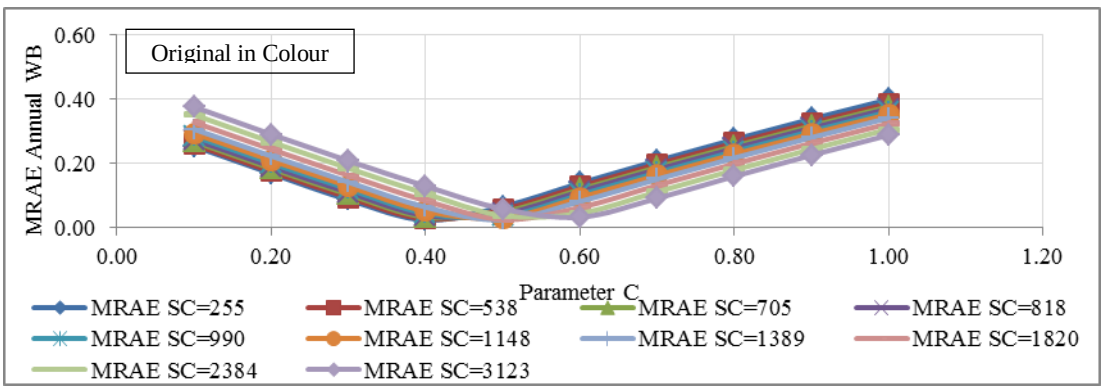


Figure C- 5: MRAE Monthly, Seasonal and Annual Water Balance for Kelani Ganga (1966-1990)

APPENDIX-D

ANALYSIS GIN GANGA

APPENDIX-D: ANALYSIS GIN GANGA

Table D- 1: Warming up period for soil water content at Gin Ganga (1972-1992)

Warm up Period	St-1
0	0
1	280.00
2	280.00
3	280.00
4	280.00
5	280.00

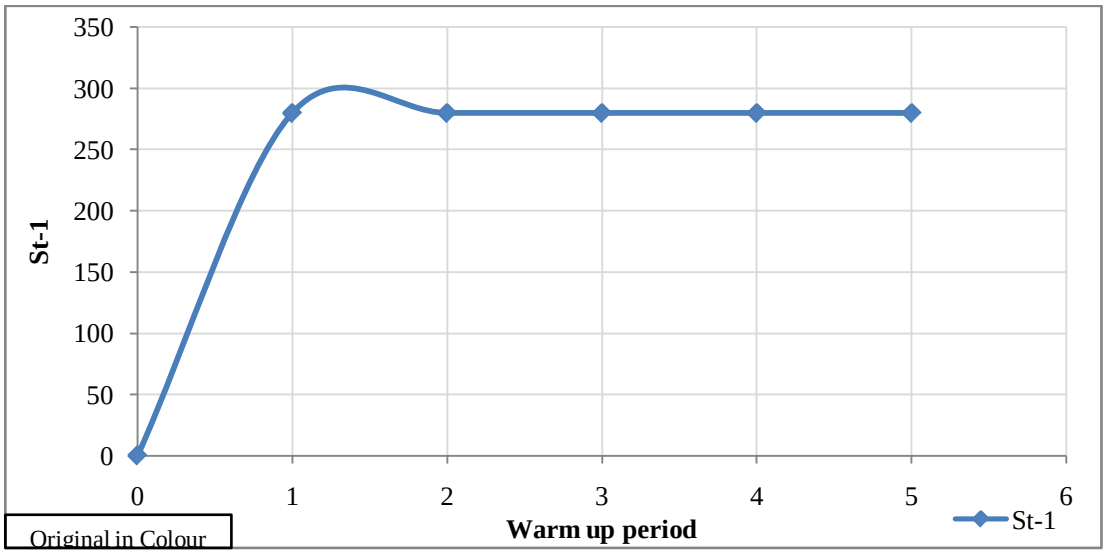


Figure D- 1: Warming up period for soil water content at Gin Ganga (1972-1992)

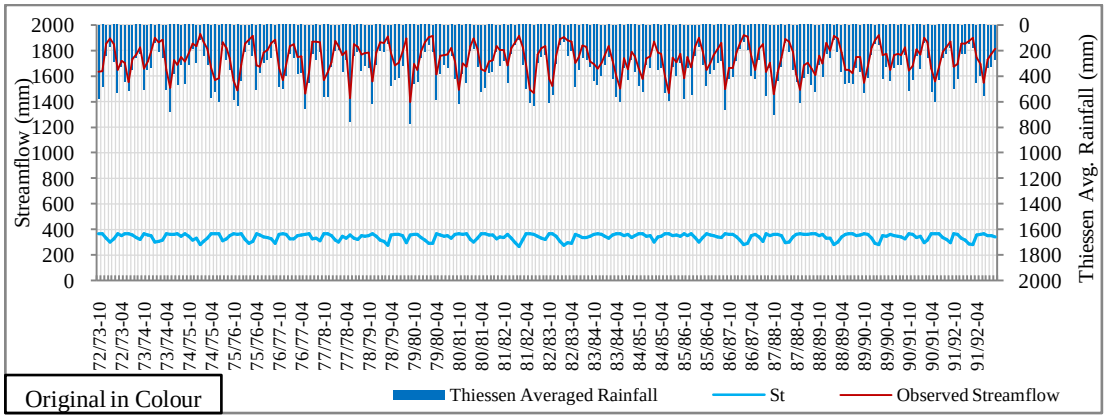


Figure D- 2: Soil Moisture Content corresponding to observed Rainfall & Streamflow for Gin Ganga (1972-1992)

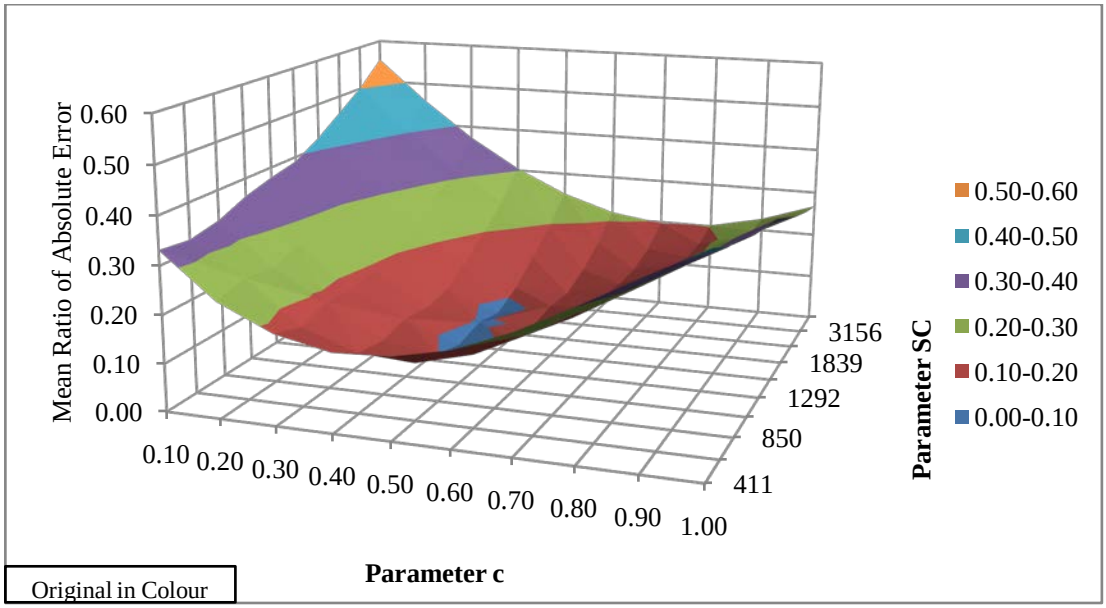


Figure D- 3: Parameter Optimization Using MRAE at Gin Ganga

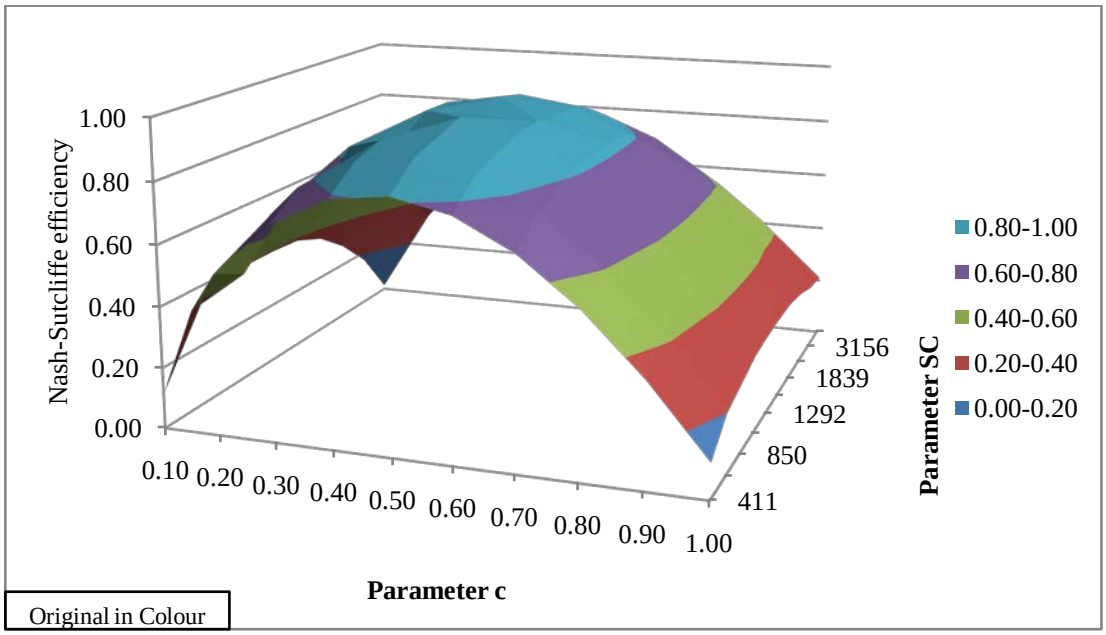


Figure D- 4: Parameter Optimization Using Nash-Sutcliffe efficiency at Gin Ganga

Table D- 2: MRAE Monthly Water Balance for Gin Ganga (1972-1992)

Parameter c	MRAE SC=411	MRAE SC=703	MRAE SC=850	$MRAE_{SC=1114}$	MRAE SC=1292	MRAE SC=1434	MRAE SC=1839	MRAE SC=2409	MRAE SC=3156	MRAE SC=4450
0.10	0.332	0.324	0.336	0.361	0.378	0.390	0.422	0.462	0.502	0.554
0.20	0.240	0.256	0.244	0.265	0.281	0.293	0.325	0.364	0.404	0.458
0.30	0.188	0.166	0.185	0.179	0.192	0.203	0.235	0.274	0.317	0.373
0.40	0.164	0.126	0.114	0.127	0.117	0.126	0.156	0.198	0.245	0.304
0.50	0.169	0.119	0.101	0.084	0.097	0.085	0.110	0.151	0.195	0.251
0.60	0.195	0.150	0.130	0.108	0.103	0.112	0.108	0.132	0.166	0.214
0.70	0.243	0.207	0.190	0.166	0.154	0.147	0.142	0.144	0.162	0.197
0.80	0.304	0.273	0.258	0.234	0.220	0.211	0.193	0.183	0.185	0.202
0.90	0.370	0.340	0.326	0.303	0.290	0.280	0.256	0.237	0.226	0.227
1.00	0.433	0.404	0.391	0.370	0.356	0.347	0.323	0.298	0.280	0.267

Table D- 3: MRAE Seasonal Water Balance (Maha) for Gin Ganga (1972-1992)

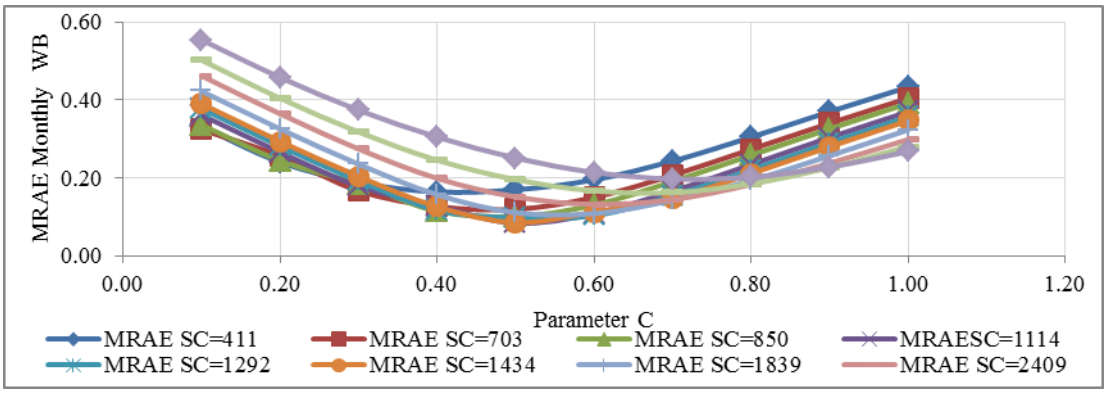
Parameter c	MRAE SC=411	MRAE SC=703	MRAE SC=850	$MRAE_{SC=1114}$	MRAE SC=1292	MRAE SC=1434	MRAE SC=1839	MRAE SC=2409	MRAE SC=3156	MRAE SC=4450
0.10	0.303	0.317	0.326	0.344	0.356	0.365	0.388	0.415	0.444	0.479
0.20	0.209	0.224	0.233	0.252	0.263	0.272	0.295	0.322	0.350	0.384
0.30	0.119	0.134	0.144	0.162	0.174	0.183	0.206	0.232	0.259	0.297
0.40	0.053	0.055	0.061	0.077	0.089	0.097	0.120	0.145	0.173	0.215
0.50	0.073	0.054	0.048	0.041	0.041	0.042	0.050	0.070	0.098	0.137
0.60	0.140	0.118	0.106	0.085	0.072	0.063	0.050	0.053	0.063	0.080
0.70	0.207	0.187	0.176	0.158	0.147	0.138	0.118	0.094	0.079	0.080
0.80	0.278	0.258	0.247	0.229	0.218	0.210	0.190	0.167	0.144	0.119
0.90	0.346	0.325	0.315	0.297	0.286	0.278	0.259	0.237	0.215	0.189
1.00	0.410	0.389	0.379	0.361	0.351	0.343	0.324	0.303	0.282	0.258

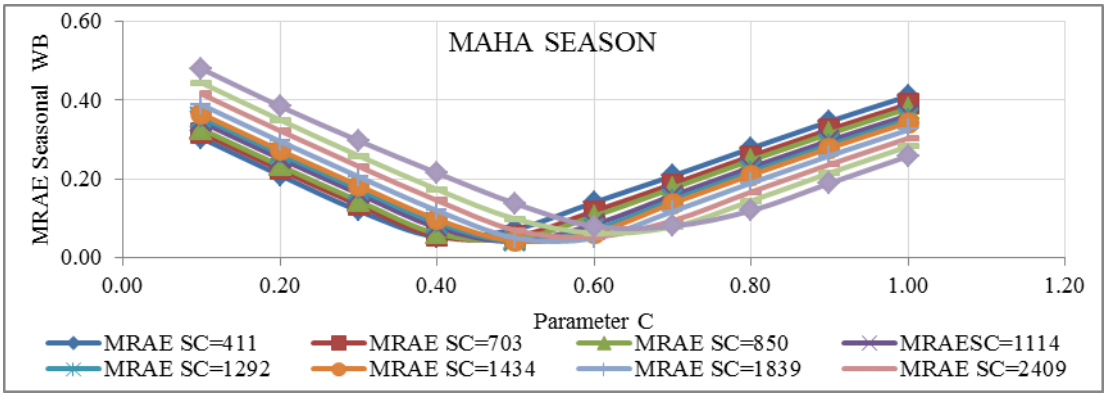
Table D- 4: MRAE Seasonal Water Balance (Yala) for Gin Ganga (1972-1992)

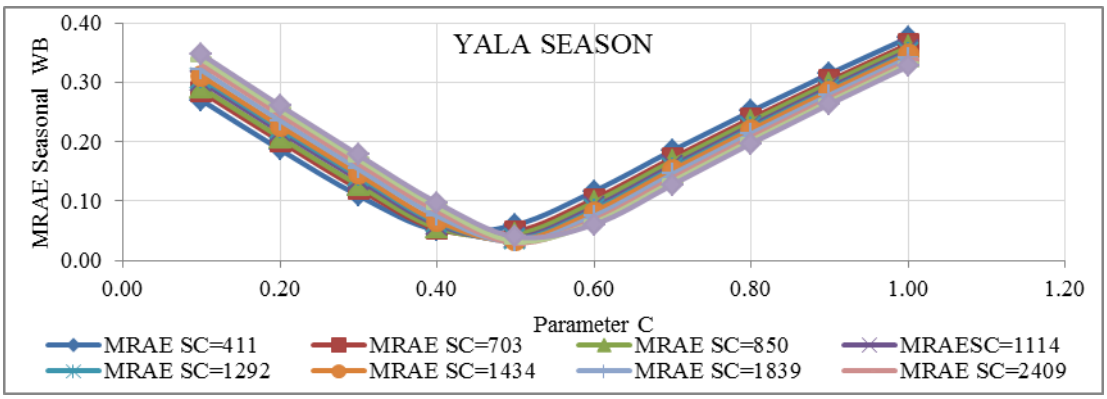
Parameter c	MRAE SC=411	MRAE SC=703	MRAE SC=850	$MRAE_{SC=1114}$	MRAE SC=1292	MRAE SC=1434	MRAE SC=1839	MRAE SC=2409	MRAE SC=3156	MRAE SC=4450
0.10	0.270	0.284	0.291	0.301	0.307	0.311	0.321	0.331	0.339	0.348
0.20	0.187	0.201	0.208	0.217	0.223	0.227	0.236	0.245	0.253	0.261
0.30	0.109	0.121	0.127	0.136	0.142	0.145	0.154	0.163	0.170	0.178
0.40	0.051	0.053	0.055	0.060	0.064	0.067	0.075	0.083	0.090	0.097
0.50	0.060	0.049	0.044	0.038	0.035	0.033	0.031	0.030	0.033	0.040
0.60	0.117	0.104	0.098	0.090	0.086	0.082	0.075	0.068	0.064	0.060
0.70	0.186	0.173	0.168	0.160	0.156	0.153	0.146	0.139	0.133	0.128
0.80	0.252	0.240	0.235	0.227	0.223	0.220	0.214	0.207	0.202	0.197
0.90	0.315	0.303	0.299	0.292	0.288	0.285	0.279	0.273	0.268	0.264
1.00	0.375	0.364	0.360	0.353	0.350	0.347	0.342	0.336	0.331	0.327

Table D- 5: MRAE Annual Water Balance for Gin Ganga (1972-1992)

Parameter c	MRAE SC=411	MRAE SC=703	MRAE SC=850	$MRAE_{SC=1114}$	MRAE SC=1292	MRAE SC=1434	MRAE SC=1839	MRAE SC=2409	MRAE SC=3156	MRAE SC=4450
0.10	0.284	0.297	0.305	0.318	0.326	0.332	0.347	0.364	0.380	0.400
0.20	0.197	0.210	0.218	0.231	0.239	0.245	0.259	0.276	0.292	0.310
0.30	0.112	0.126	0.134	0.147	0.155	0.160	0.175	0.191	0.206	0.224
0.40	0.043	0.049	0.054	0.066	0.073	0.079	0.093	0.108	0.123	0.140
0.50	0.054	0.043	0.038	0.030	0.027	0.027	0.030	0.036	0.049	0.067
0.60	0.121	0.106	0.099	0.087	0.080	0.074	0.061	0.048	0.040	0.036
0.70	0.193	0.178	0.170	0.159	0.151	0.146	0.134	0.120	0.107	0.092
0.80	0.261	0.246	0.239	0.227	0.220	0.215	0.203	0.190	0.177	0.163
0.90	0.326	0.311	0.304	0.293	0.286	0.281	0.270	0.257	0.245	0.232
1.00	0.388	0.373	0.366	0.355	0.349	0.344	0.333	0.321	0.310	0.297







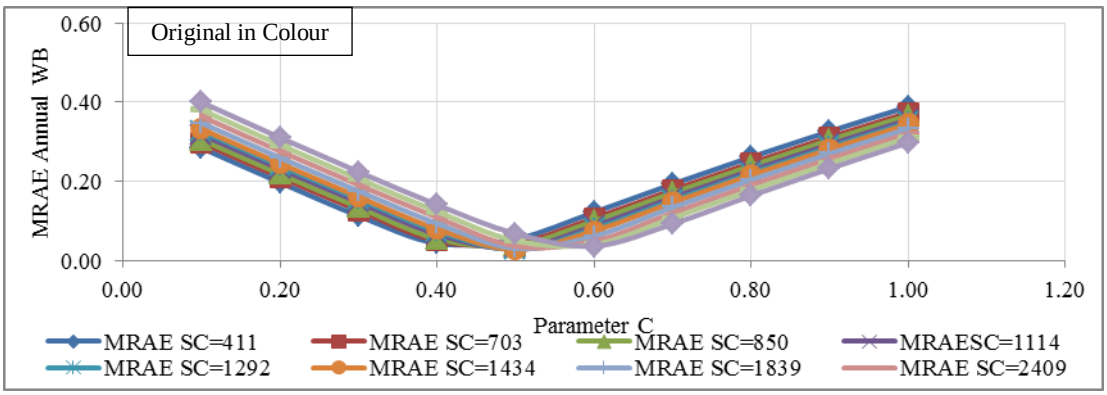


Figure D- 5: MRAE Monthly, Seasonal &Annual Water Balance for Gin Ganga (1972-1992)

APPENDIX-E

RESULTS KELANI GANGA

(CALIBRATION)

APPENDIX-E: CALIBRATION RESULTS KELANI GANGA

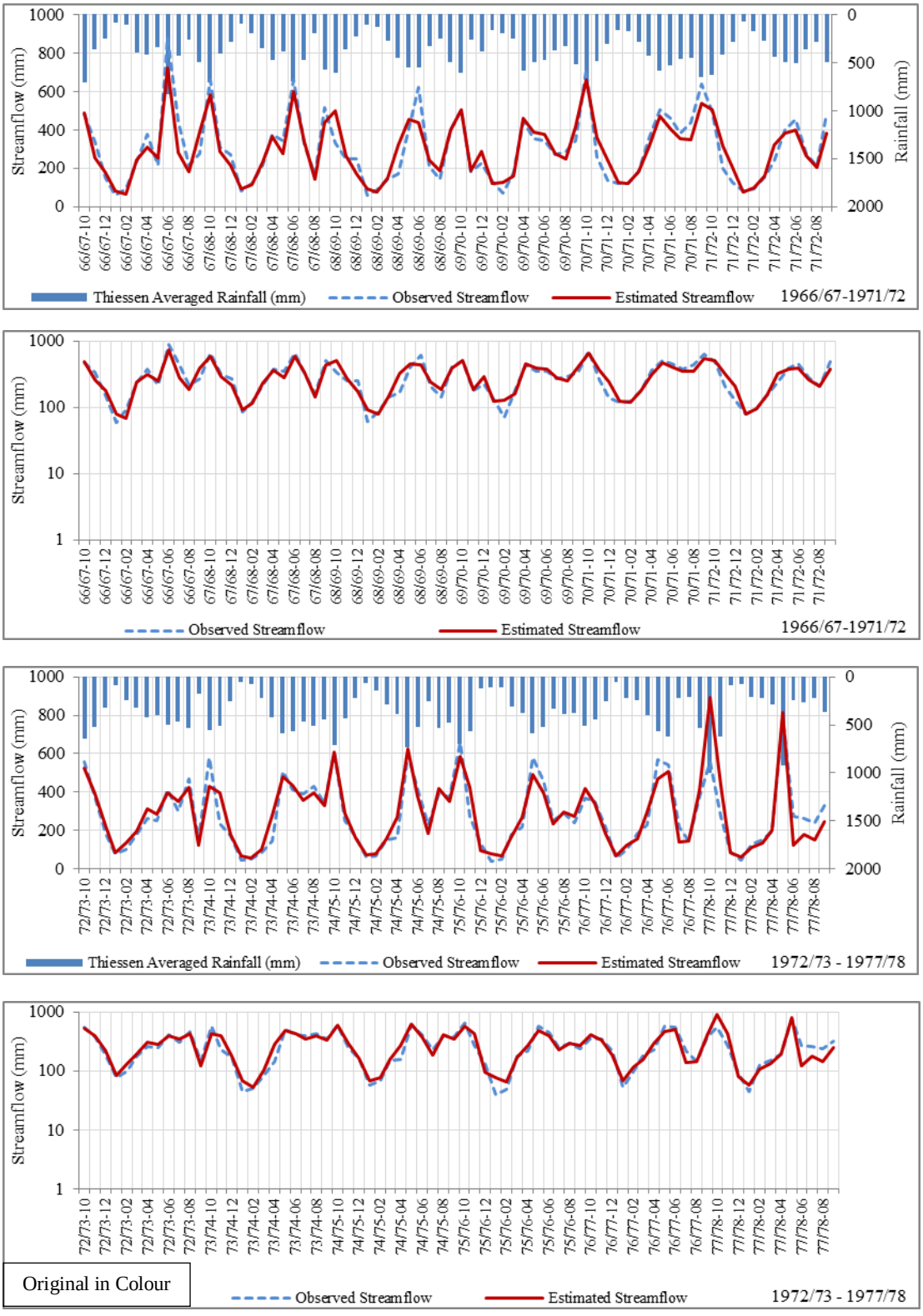


Figure E- 1: Outflow Hydrograph for Kelani Ganga 1966-1978 (Normal & Logarithmic Plot)

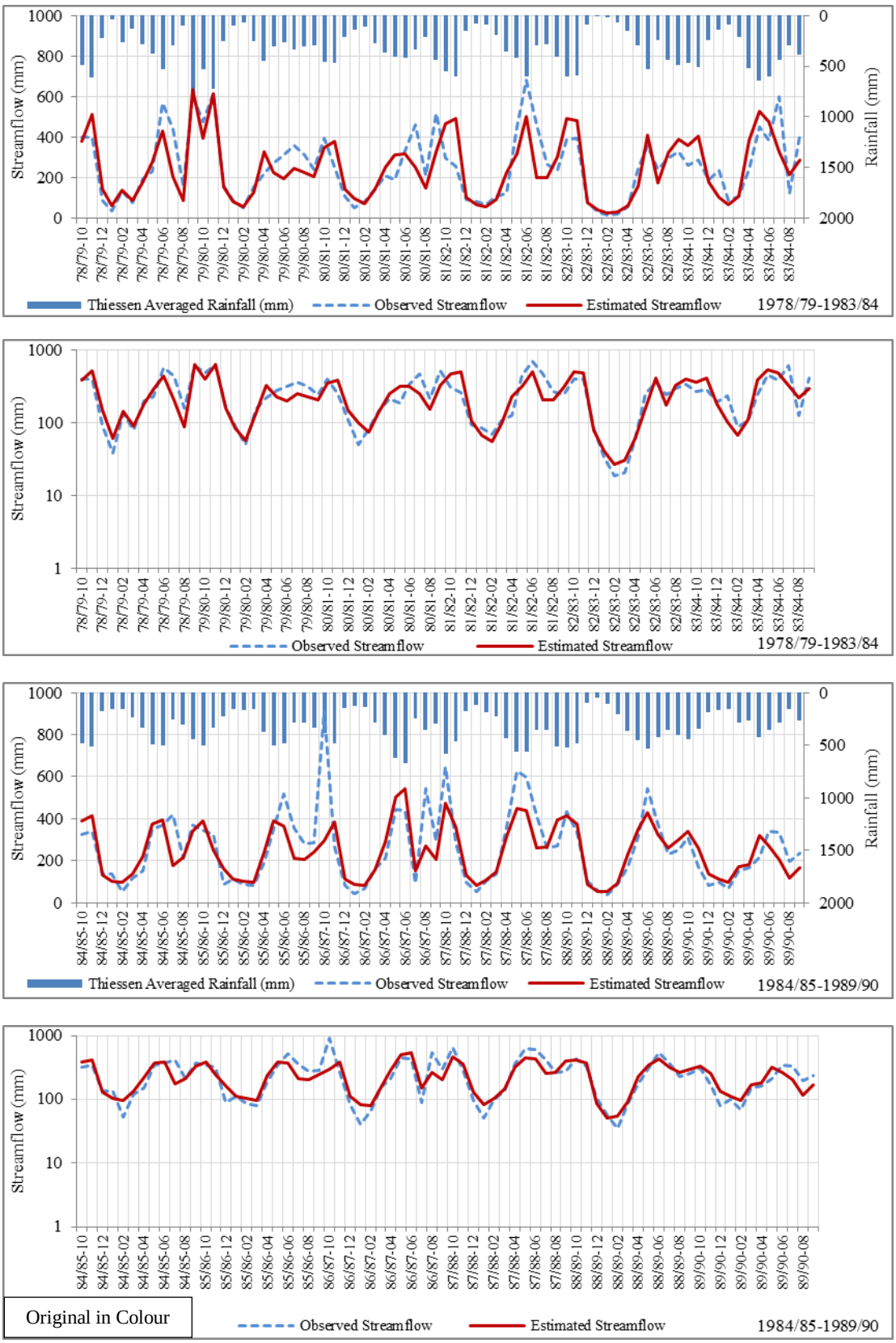


Figure E- 2: Outflow Hydrograph for Kelani Ganga 1978-1990 (Normal & Logarithmic Plot)

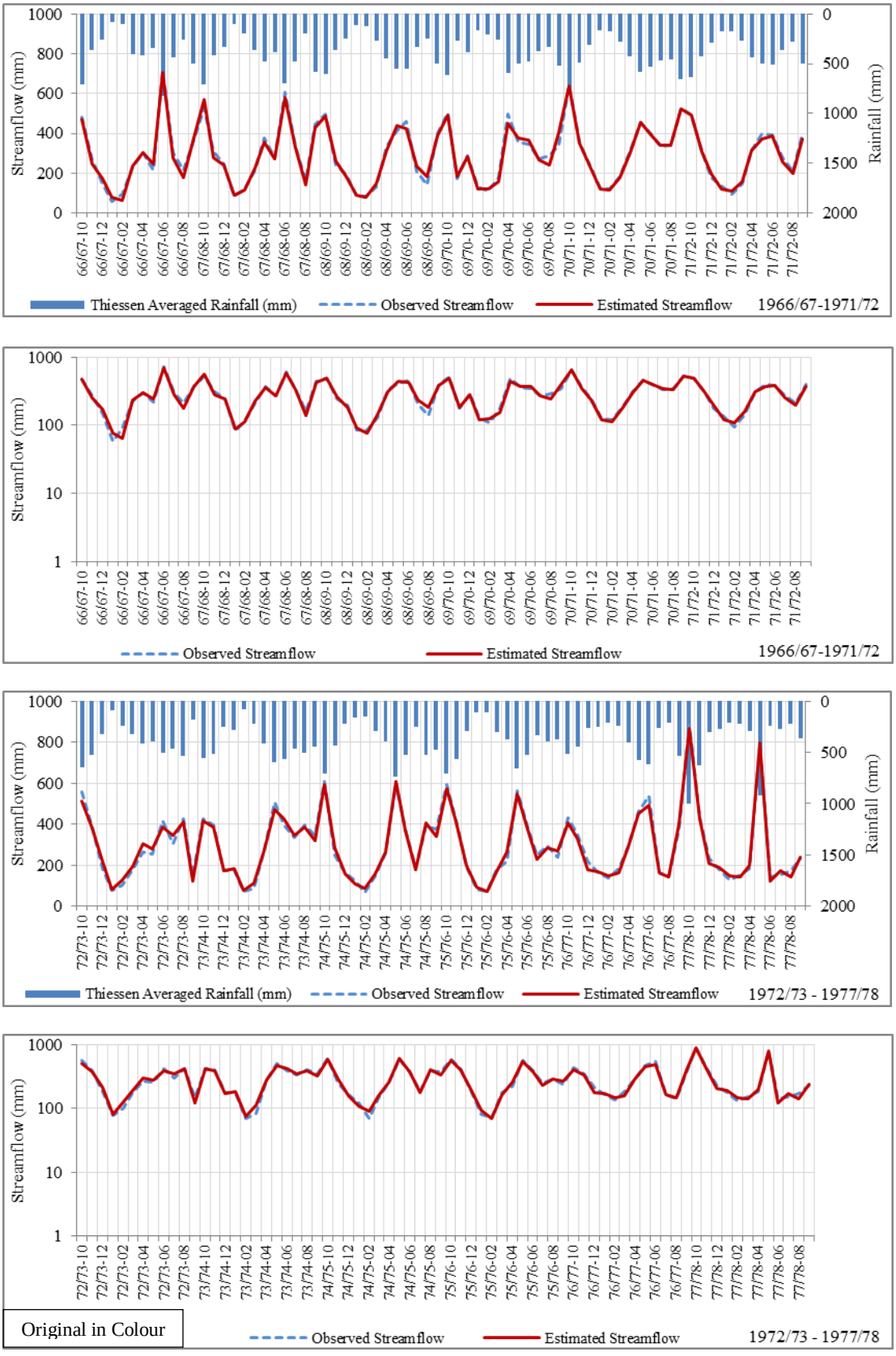


Figure E- 3: Outflow Hydrograph for Kelani Ganga 1966-1978 (Normal & Logarithmic Plot)

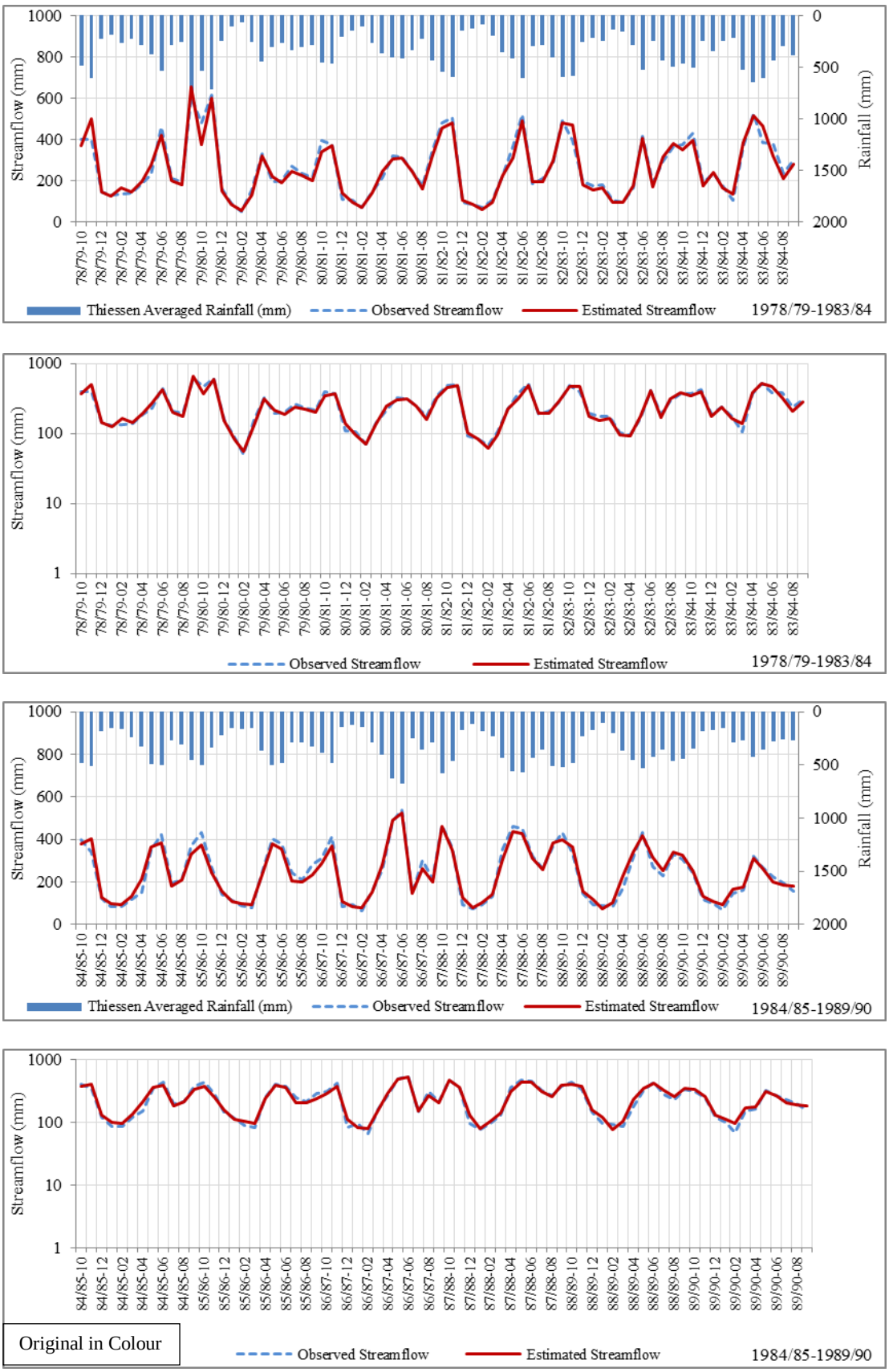


Figure E- 4: Outflow Hydrograph for Kelani Ganga 1978-1990 (Normal & Logarithmic Plot)

APPENDIX-F

RESULTSGIN GANGA

(CALIBRATION)

Figure F- 1: Outflow Hydrograph for Gin Ganga 1972-1982 (Normal & Logarithmic Plot)

Figure F- 2: Outflow Hydrograph for Gin Ganga 1982-1992 (Normal & Logarithmic Plot)

APPENDIX-F: CALIBRATION RESULTS GIN GANGA

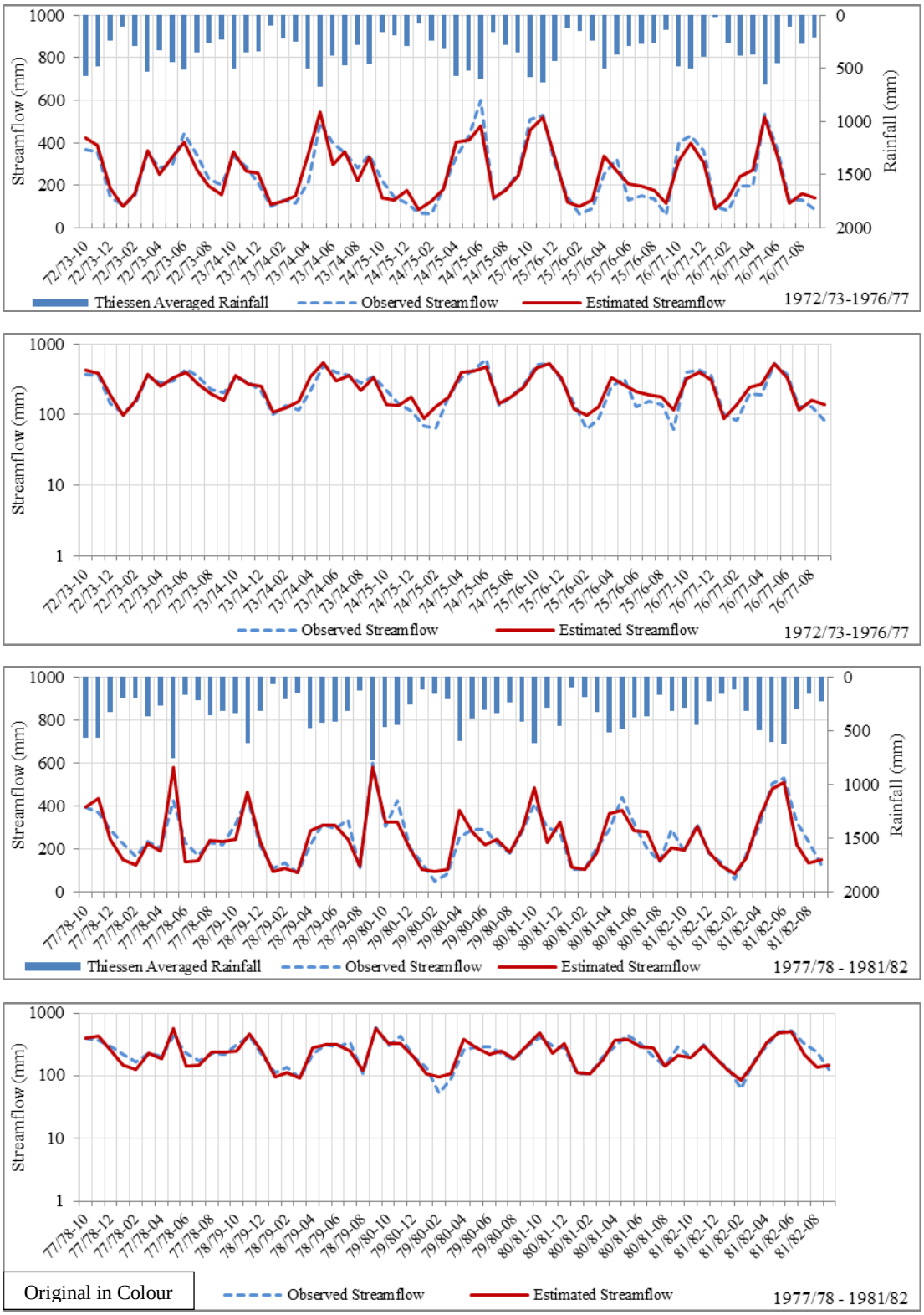


Figure E- 5: Outflow Hydrograph for Gin Ganga 1972-1982 (Normal & Logarithmic Plot)

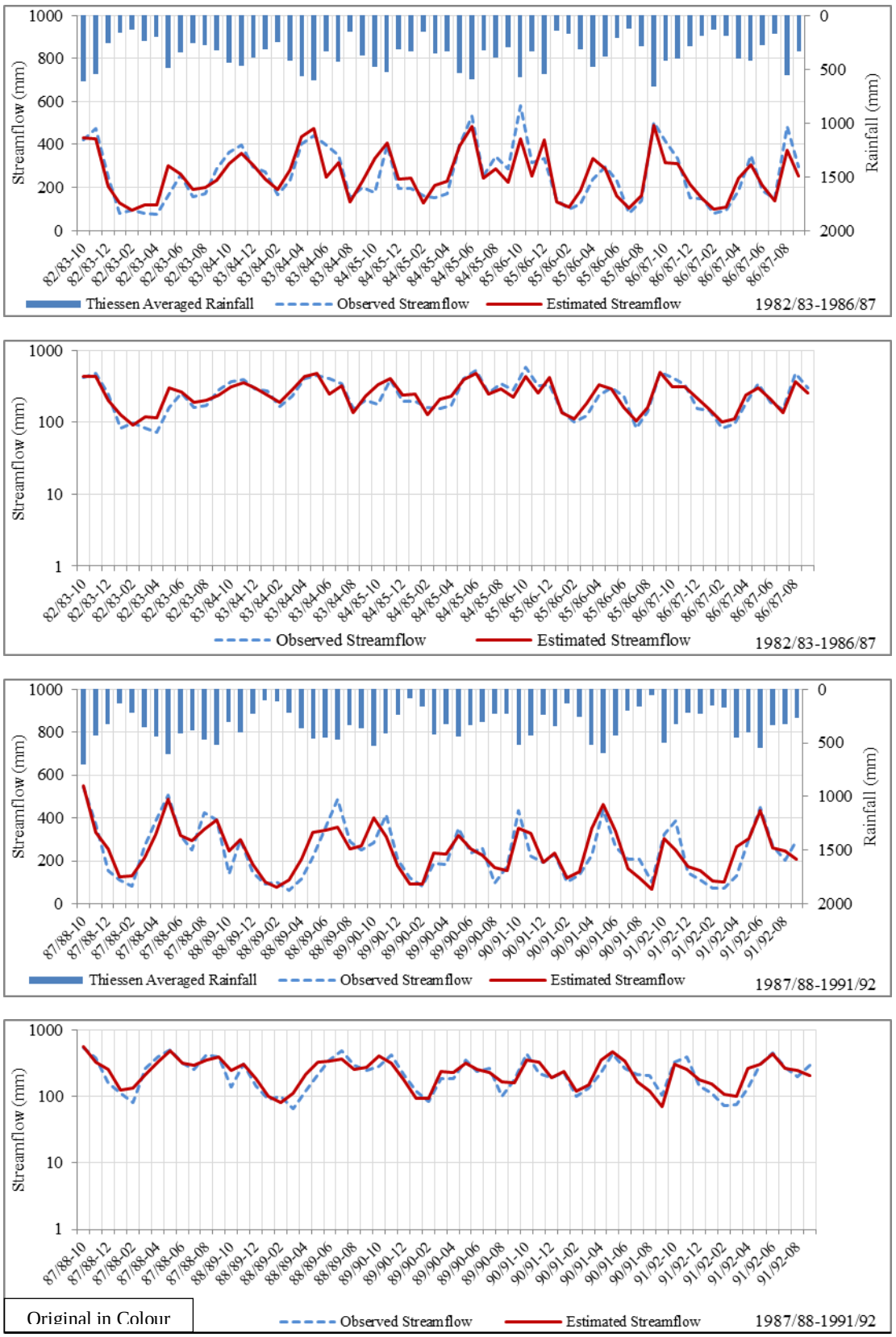


Figure E- 6: Outflow Hydrograph for Gin Ganga 1972-1992 (Normal & Logarithmic Plot)

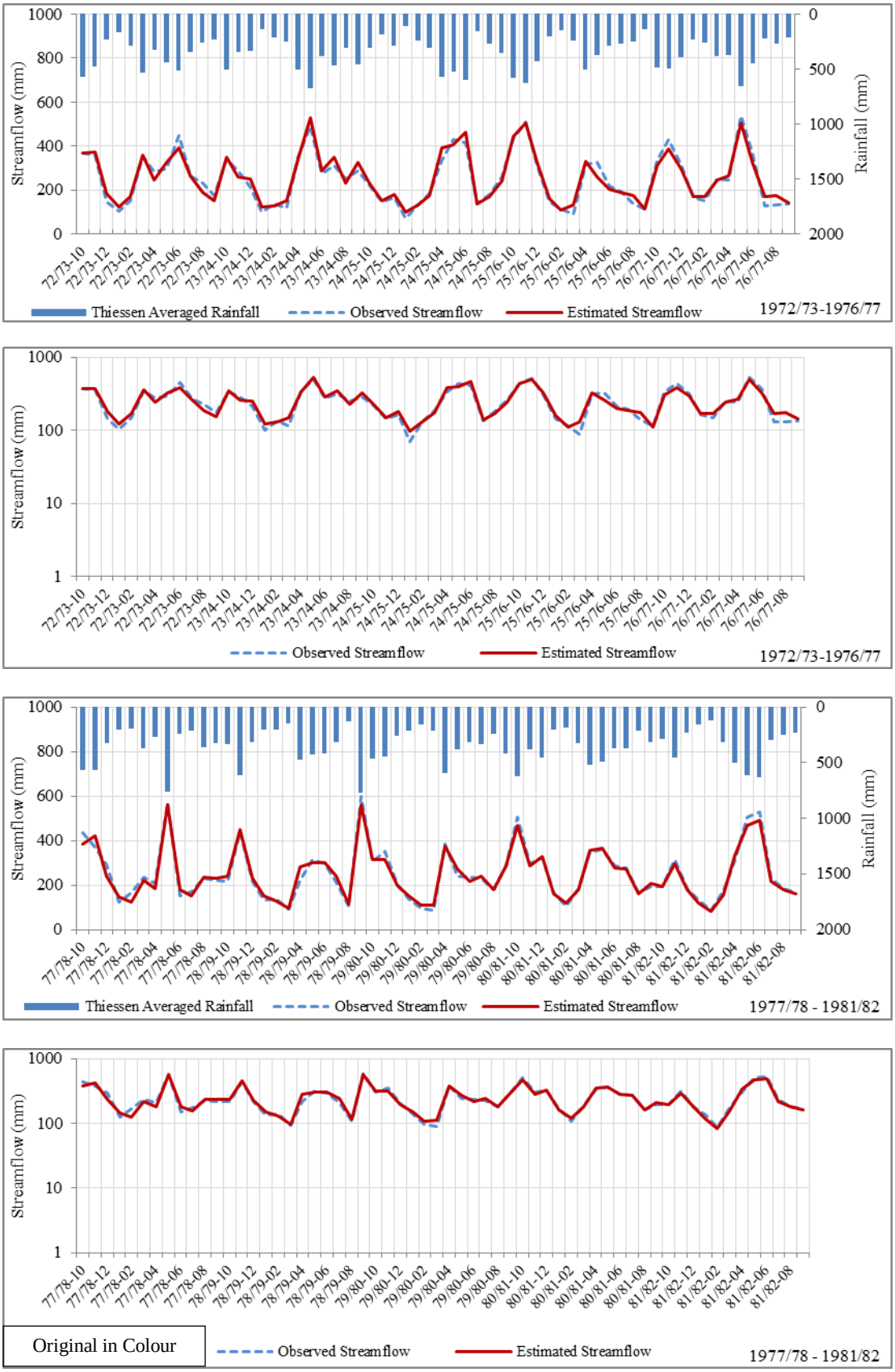


Figure F- 1: Outflow Hydrograph for Gin Ganga 1972-1982 (Normal & Logarithmic Plot)

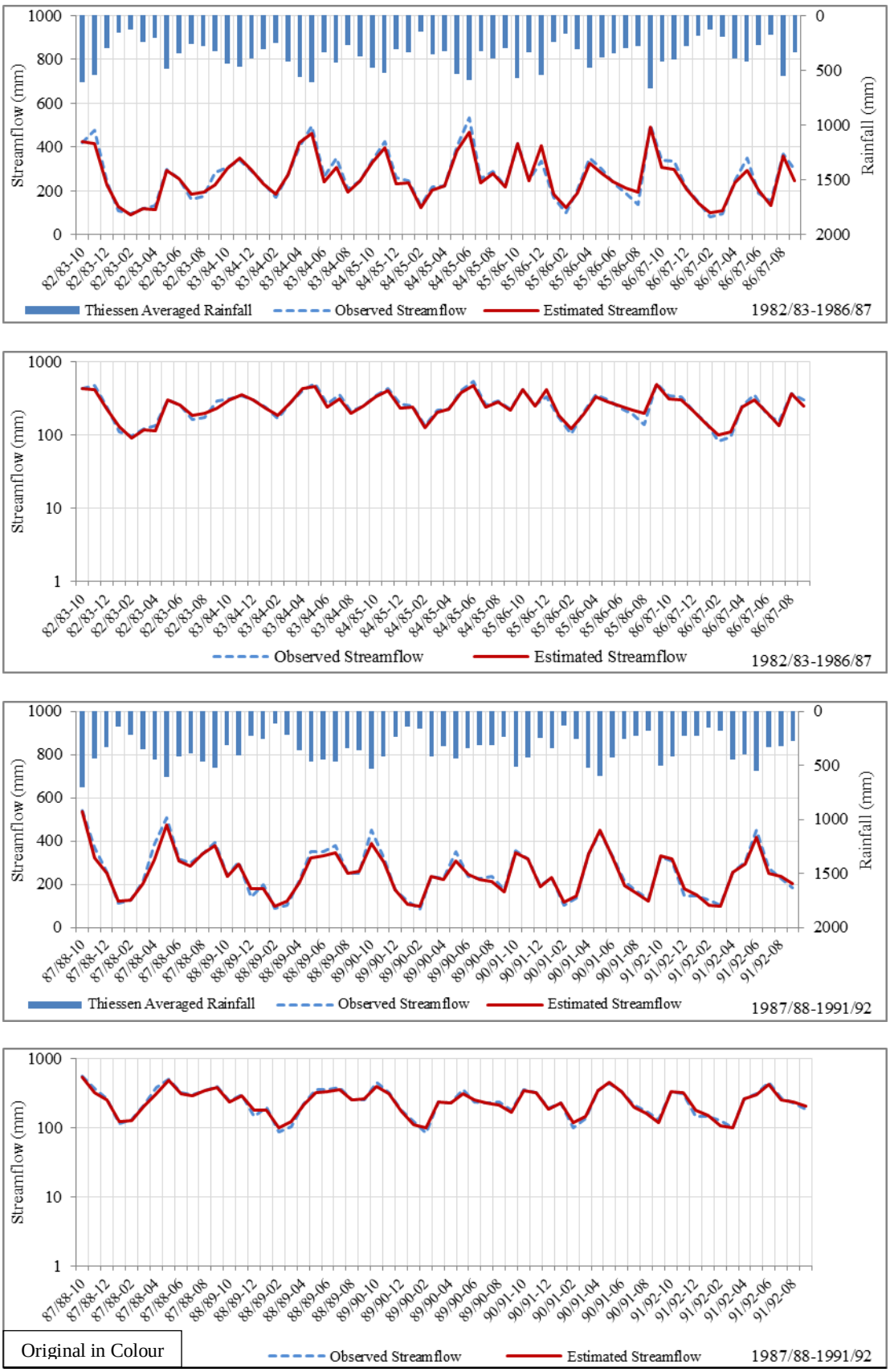


Figure F- 2: Outflow Hydrograph for Gin Ganga1982-1992 (Normal & Logarithmic Plot)

APPENDIX-G

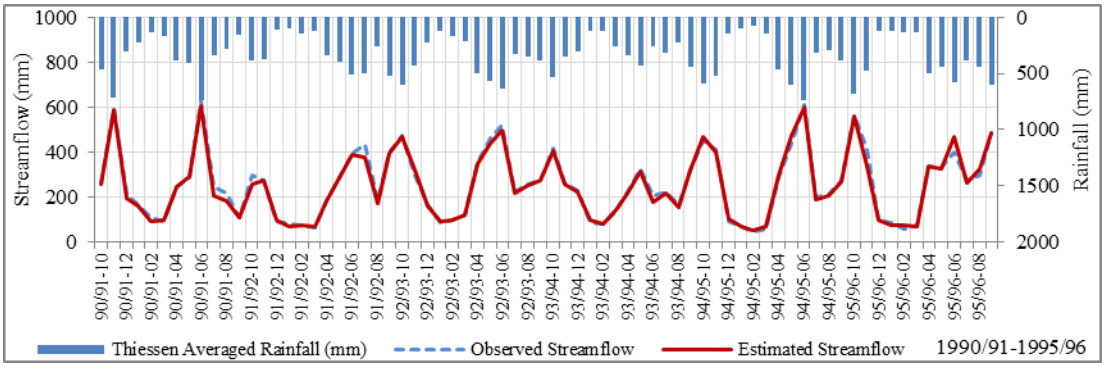
RESULTS KELANI GANGA

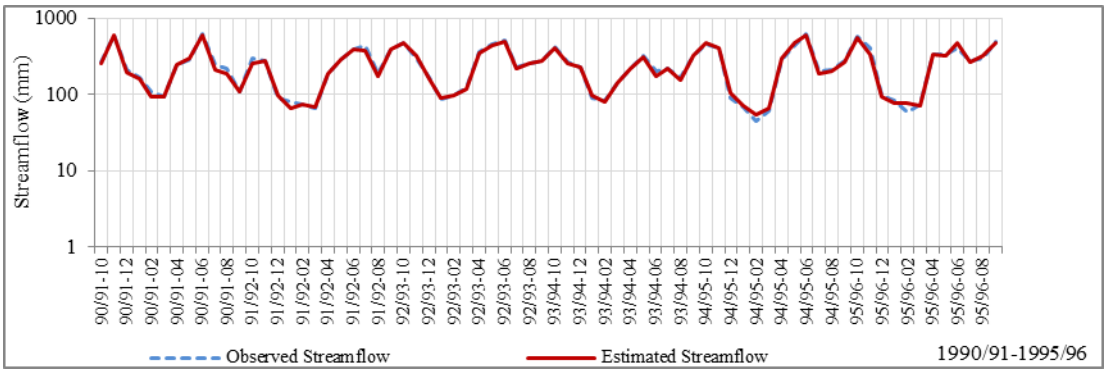
(VERIFICAITON)

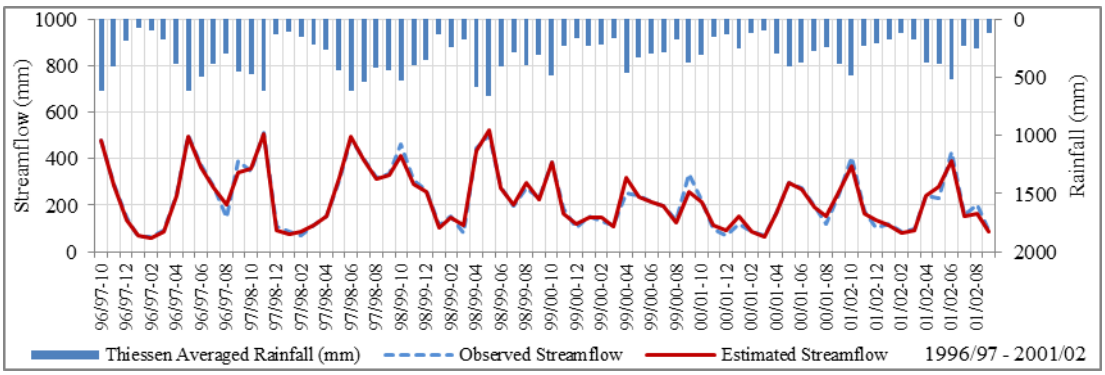
Figure G- 1: Outflow Hydrograph for Kelani Ganga 1990-2002 (Normal & Logarithmic Plot)

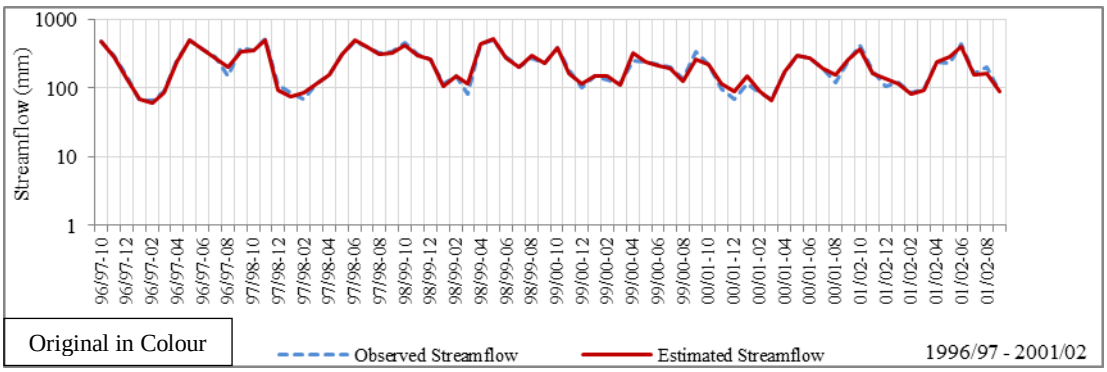
Figure G- 2: Outflow Hydrograph for Kelani Ganga 2002-2014 (Normal & Logarithmic Plot)

APPENDIX-G: VERIFICATION RESULTS KELANI GANGA









Original in Colour

Figure G- 1: Outflow Hydrograph for Kelani Ganga 1990-2002 (Normal & Logarithmic Plot)

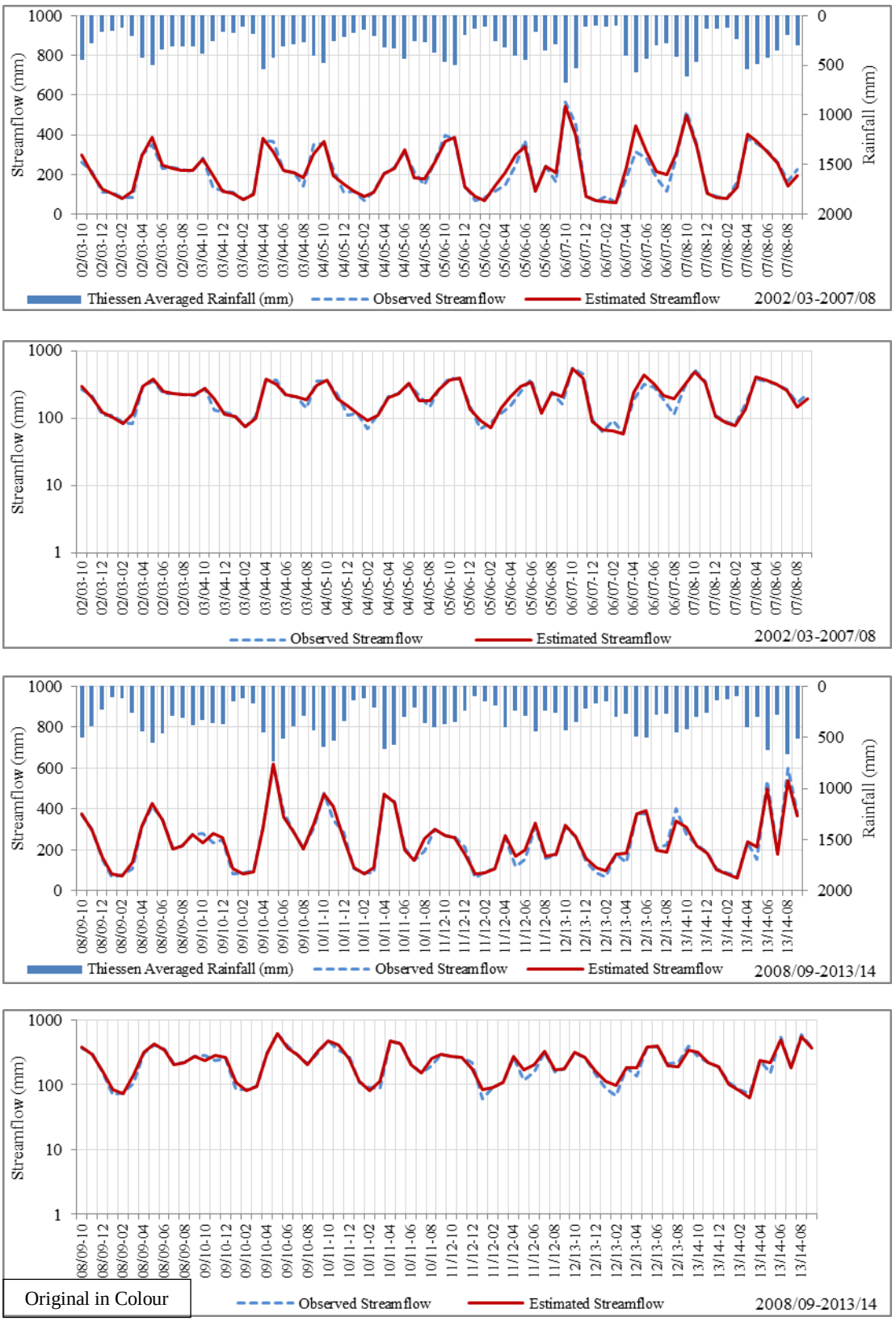


Figure G- 2: Outflow Hydrograph for Kelani Ganga 2002-2014 (Normal & Logarithmic Plot)

APPENDIX-H

RESULTS GIN GANGA

(VERIFICATION)

Figure H- 1: Outflow Hydrograph for Gin Ganga 1992-2002 (Normal & Logarithmic Plot)

Figure H- 2: Outflow Hydrograph for Gin Ganga 2002-2012 (Normal & Logarithmic Plot)

APPENDIX-H: VERIFICATION RESULTS GIN GANGA

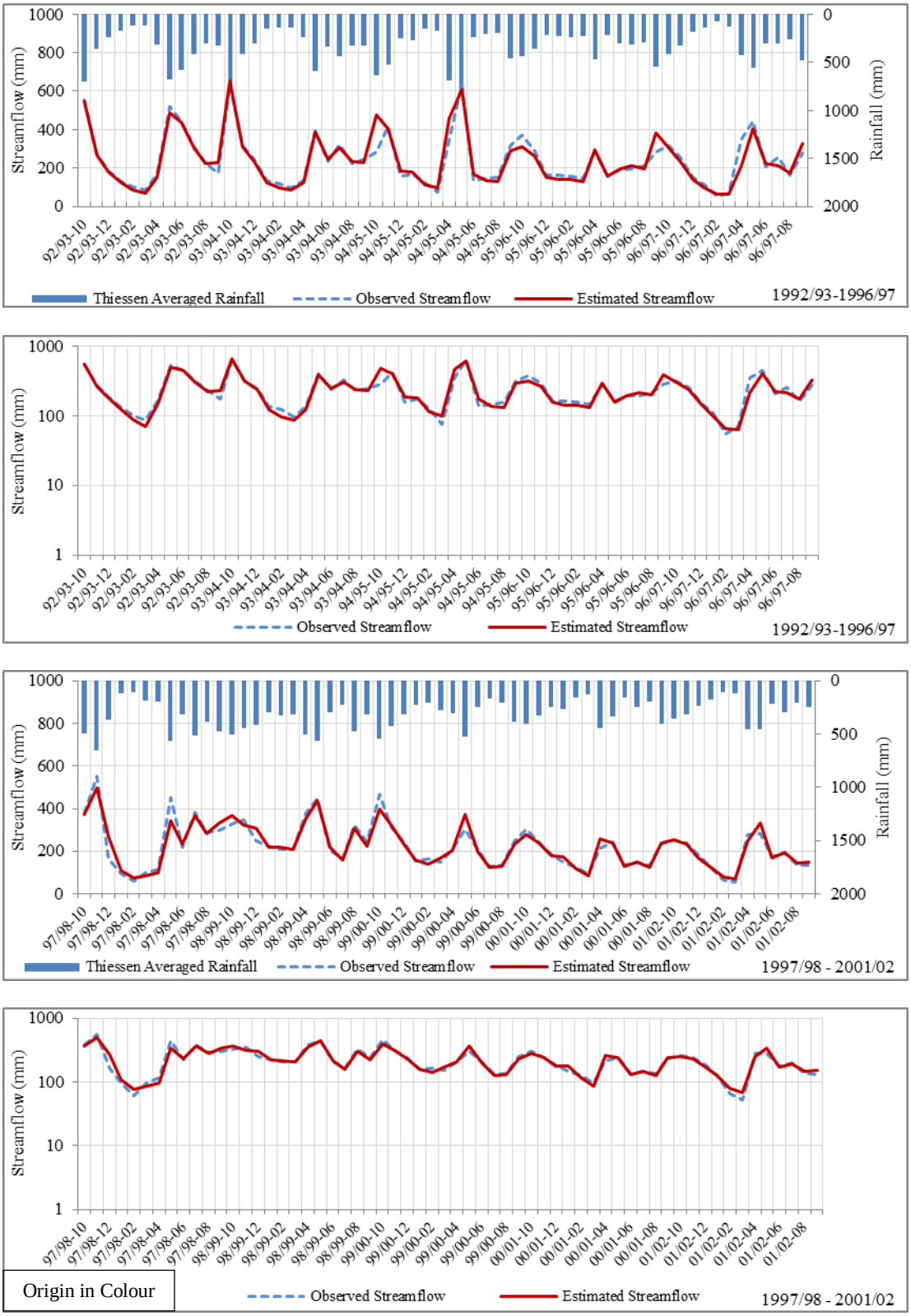


Figure H- 1: Outflow Hydrograph for Gin Ganga 1992-2002 (Normal & Logarithmic Plot)

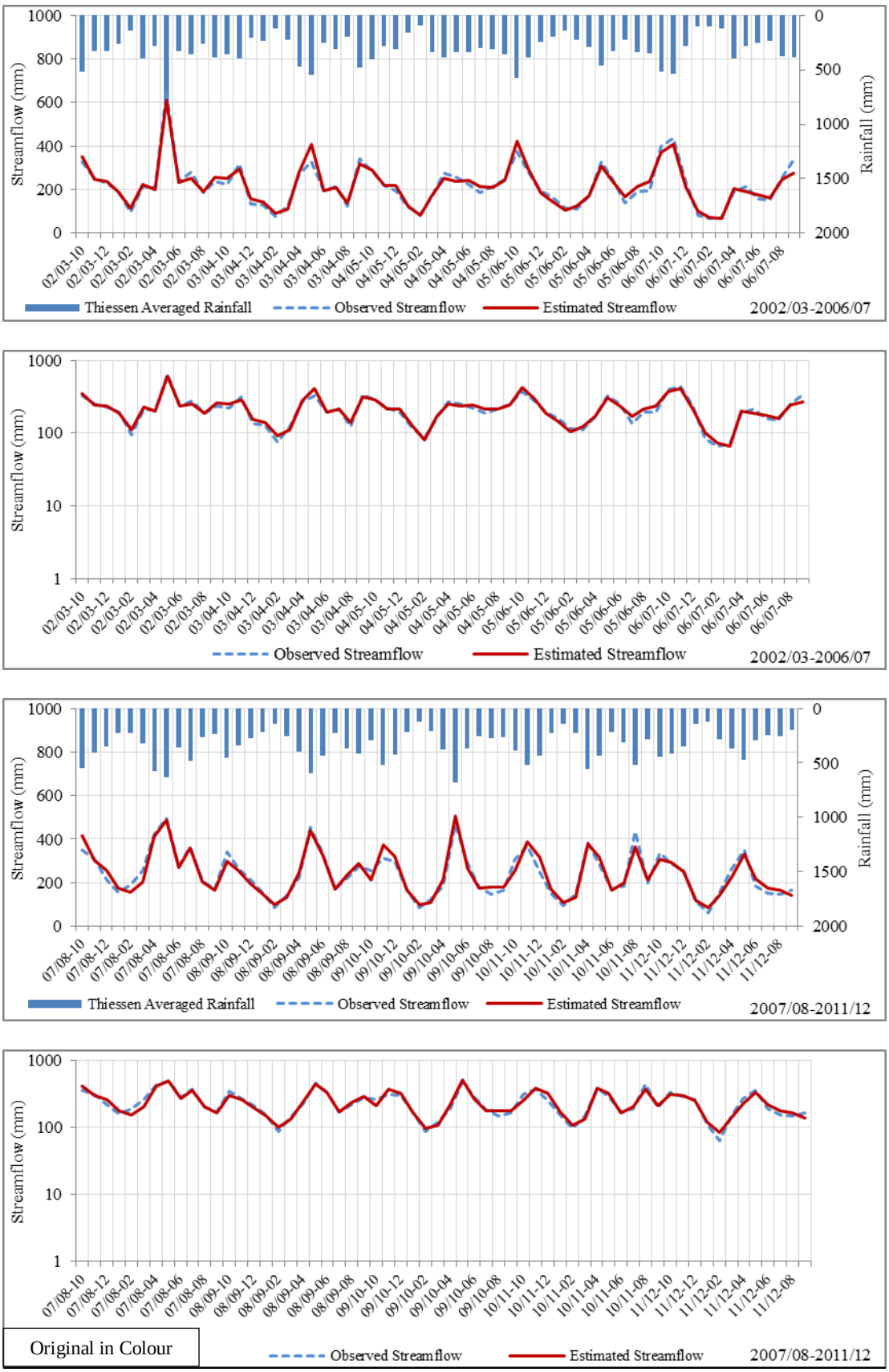


Figure H- 2: Outflow Hydrograph for Gin Ganga 2002-2012 (Normal & Logarithmic Plot)

APPENDIX-I

SPECIMEN CALCULATIONS

APPENDIX-I: SPECIMEN CALCULATIONS

Specimen Calculation for Kelani Ganga

Consider Year 1966/67-10 (First Row)

Model Input Data

Monthly Thiessen Averaged Rainfall P(t) = 707.02 mm

Monthly Pan Evaporation EP(t) = 114.39 mm

Model Parameter (Optimized)

Monthly Evaporation Coefficient c = 0.46

Field Capacity of Catchment SC = 899.48 mm

Actual Evapotranspiration is given by:

$$E(t) = c \times EP(t) \times \tanh\left(\frac{P(t)}{EP(t)}\right)$$

E(t) = 52.619 mm

Condition Applied:

Actual Evaporation should not be less than Zero

If (E(t)<0,0,E(t))

Actual Evaporation should not be more than Pan Evaporation

If (E(t)<EP(t),E(t),EP(t))

The water content at the end of the (t-1)-th Month is given by S(t-1)

Initial S(t-1) is obtained from 5-Hydrologic Cycle and next month S(t-1) value is equal to S(t) of the first month.

S(t-1) = 138.88 mm

Monthly Runoff can be calculated by

$$Q(t) = (S(t-1) + P(t) - E(t)) \times \tanh\left[\frac{(S(t-1) + P(t) - E(t))}{SC}\right]$$

Q(t) = 561.156 mm

Condition Applied:

Runoff should not be less than Zero

If (Q(t)<0,0,Q(t))

The water content at the end of the t-th Month can be computed by

$$S(t) = S(t-1) + P(t) - E(t) - Q(t)$$

S(t) = 232.125 mm

This can be used as the initial storage in the following month 1966/67-11

Condition Applied:

Soil Moisture Content should not be less than Zero.

If (S(t)<0,0,S(t))

Runoff Coefficient C can be calculated as;

$$C = \frac{Q(t)}{P(t)}$$

C = 0.794

The Average runoff coefficient in the calibration period is the average value in calibration data set

Cavg = 0.84

Catchment Area = 182.54 km^2

Estimated Streamflow can be computed by;

$$Q = Q(t) \times Cavg \times A \times \frac{10^6}{(1000 \times 31 \times 24 \times 60 \times 60)}$$

Q = 32.125 m^3/s or 472.87 mm

Error Estimation& Optimization

1. Nash Sutcliffe Efficiency (E)

Mean flow during calibration period Qc = 272.88 mm

Observed Streamflow Qo = 479.35 mm

Simulated Streamflow Qs = 472.87 mm

$F = (Qo - Qs)^2$

$F = (479.53 - 472.87)^2 = 41.99$ mm

$Fo = (Qo - Qc)^2$

$Fo = (479.53 - 272.88)^2 = 42629.81$ mm

But sum of Fo and F is

Fo = 6348208.15 mm

F = 172348.74 mm

$$E = \frac{(Fo - F)}{Fo}$$

$$E = \frac{(6348208.15 - 172348.74)}{6348208.15}$$

E = 0.973

2. Mean Ratio of Absolute Error (MRAE)

$$MRAE = \left(\frac{1}{n}\right) \times \left[\sum_{i}\left(\frac{Abs(Qo - Qs)}{Qo}\right)\right]$$

Sum of (Qo-Qs)/Qo = 24.31 mm

MRAE = (1/288)*(24.31) = 0.0843

Specimen Calculation for Gin Ganga

Consider Year 1972/73-10 (First Row)

Model Input Data

Monthly Thiessen Averaged Rainfall P(t) = 574.70mm

Monthly Pan Evaporation EP(t) = 104.37mm

Model Parameter (Optimized)

Monthly Evaporation Coefficient c = 0.51

Field Capacity of Catchment SC = 1322mm

Actual Evapotranspiration is given by:

$$E(t) = c \times EP(t) \times \tanh\left(\frac{P(t)}{EP(t)}\right)$$

E(t) = 53.23mm

Condition Applied:

Actual Evaporation should not be less than Zero

If (E(t)<0,0,E(t))

Actual Evaporation should not be more than Pan Evaporation

If (E(t)<EP(t),E(t),EP(t))

The water content at the end of the (t-1)-th Month is given by S(t-1)

Initial S(t-1) is obtained from 5-Hydrologic Cycle and next month S(t-1) value is equal to S(t) of the first month.

S(t-1) = 280mm

Monthly Runoff can be calculated by

$$Q(t) = (S(t-1) + P(t) - E(t)) \times \tanh\left[\frac{(S(t-1) + P(t) - E(t))}{SC}\right]$$

Q(t) = 434.05mm

Condition Applied:

Runoff should not be less than Zero

If (Q(t)<0,0,Q(t))

The water content at the end of the t-th Month can be computed by

$$S(t) = S(t-1) + P(t) - E(t) - Q(t)$$

S(t) = 367.42mm

This can be used as the initial storage in the following month 1972/73-11

Condition Applied:

Soil Moisture Content should not be less than Zero.

If (S(t)<0,0,S(t))

Runoff Coefficient C can be calculated as;

$$C = \frac{Q(t)}{P(t)}$$

C = 0.755

The Average runoff coefficient in the calibration period is the average value in calibration data set

Cavg = 0.84

Catchment Area = 368.75km^2

Estimated Streamflow can be computed by;

$$Q = Q(t) \times Cavg \times A \times \frac{10^6}{(1000 \times 31 \times 24 \times 60 \times 60)}$$

Q = 50.36m^3/s or 365.76mm

Error Estimation & Optimization

1. Nash Sutcliffe Efficiency (E)

Mean flow during calibration period Qc = 256.07mm

Observed Streamflow Qo = 368.27mm

Simulated Streamflow Qs = 365.76mm

$F = (Qo - Qs)^2$

$F = (368.27 - 365.76)^2 = 6.30mm$

$Fo = (Qo - Qc)^2$

$Fo = (368.27 - 256.07)^2 = 12588.764mm$

But sum of Fo and F is

Fo = 3143183.115mm

F = 141473.6304 mm

$$E = \frac{(Fo - F)}{Fo}$$

$$E = \frac{(3143183.115 - 141473.6304)}{3143183.115}$$

E = 0.955

2. Mean Ratio of Absolute Error (MRAE)

$$MRAE = \left(\frac{1}{n}\right) \times \left[\sum_{i}\left(\frac{Abs(Qo - Qs)}{Qo}\right)\right]$$

Sum of (Qo-Qs)/Qo = 19.711mm

MRAE = (1/240)*(19.711) = 0.082