A STUDY ON THE SANDBAR AND VEGETATION AREAS ALTERATION AT THE DOWNSTREAM OF DAM

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Abstract

The purpose of this study is to analyze areas variation, alteration index, alteration degree, temporal variation of the sandbar and vegetation at the downstream of dam. Sandbar area was decreased 16.73% and alteration index of sandbar were -0.2599 ~ -0.9921 after dam construction. Vegetation areas was increased 12.84% and alteration index of vegetation were 0.2699 ~ 12.0736 after dam construction. Annual extreme flow, sandbar and vegetation were analyized at the An Dong, Im Ha, Hap Chun dam. 1-day minimum flow was increased 203% at An Dong, 167% at Im Ha, 677% at Hap Chun dam and 1-day maximum flow was decreased 84% at An Dong, 63% at Im Ha, 81% at Hap Chun dam. Temporal analysis of the sandbar was decreased 42,600㎡ per year and vegetation was increased 51,700㎡ per year. Sandbar decreasing velocity was more fast than vegetation increasing. The most important alteration of sandbar and vegetation are peak discharge decreasing and lowflow increasing at the downstream of dam.

Keyword : sandbar, vegetation, degree of alteration

1. Introduction

In Korea, study on the sandbar and vegetation at the dam downstream are " Yeo, W., etc(2004); A study of river bed change, vegetation & flood at the downstream of An-dong & Im-ha dam after construction.", "Choi, S., (2004; 2005); A study on flood, terrain, biological changes and vegetation the downstream of Hap-chun dam, after the dam construction, "Lee, S., Ok, K.,(2007); A study on temporal variation of vegetation at downstream of an-dong dam and changes of the bend sandbar with the hydraulic model expement of the study.

From the foreign country "Shafroth, etc.(2002) ; A study on riparian vegetation change on Williams River where gets a disturbance and the stress with Arozona Alamo dam constructions in United States and about change of Santa Maria River river which do not undergo the influence of the dam researched.",

" Gordon & Meentemeyer, (2006); Analysis of the terrain and vegetation changes at the downstream presented timely spatial influence of construction of Russian River Warm Springs Dam on California basin and changes in land use." "Richard. etc. (2005); A study on the terrain and vegetation change of floodplain researched according to construction Jackson Lake Dam at Snake River in Wyoming. America."

Since 1960, many dams were constructed in Korea,. But, the investigation and research of vegetation change which are fixed quantity after the dam construction are insufficient. Consequently, The purpose of this study is to analyze areas variation, alteration index, alteration degree, temporal variation of the sandbar and vegetation at the downstream of dam.

2. Collection of data and analytical method

The study saw downstreams of soyanggang dam etc. 21 dams in the objective in order to analyze the timely & spatial alteration of the sandbar and vegetation. The timely & spatial alteration of the sandbar and vegetation was compared and analyzed by the aerial photographies of before & after dam construction that was purchased from N.G.I(national geographic information). Analyzing the sandbar and vegetation which uses the aerial photographies was useful of grasping the land use change of neighboring area, alterating area of the sandbar and vegetation. But, the information was limited to fix quantity with photographing time, method, analytical method etc. Consequently, in order to improve the precision, misconduct photographing information from wamis and drawings from rivers maintenance basic plan were compared and analyzed simultaneously.

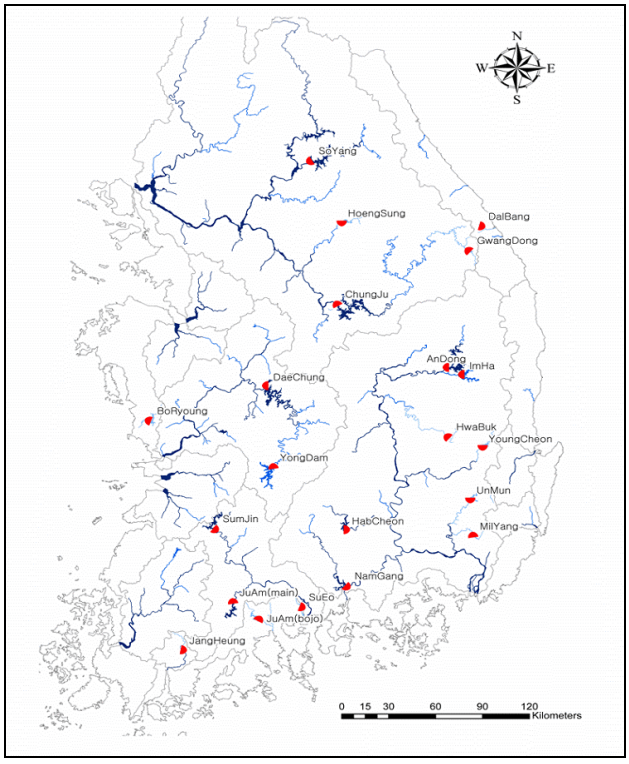


Fig. 1. Location map of the dam

Table 1. Dams and Aerial photographs

River Basin	Dam	River	Analysis Reach	Reach length (㎞)	Sequence of aerial photographs	Dam construction peroid
Han	So Yang	So Yang	Dm-Bak Han Gang Conflu.	11.3	1979,2000	'67 ~ '73
	Chung Ju	Nam Han	Dam-Sum Gang Conflu.	46.0	1974,1995 ~ 2006	'78 ~ '85
	Hoing Sung	Gye	Dam-Han Gang Conflu.	65.0	1977 ~ 81,2000 ~ 06	'93 ~ '00
	Koang Dong	Gol Gi	Dam-Im Gye Chun Conflu.	31.0	1981,2005	'85 ~ '88
	Dang Bamg	Sin Heung	Dam-Jun Chun Conflu.	17.1	1979,1996	'86 ~ '90
Geum	Dae Chung	Geum	Dam-Mi Ho Chun Conflu.	26.0	1968,1983,1995,2003	'75 ~ '81
	Young Dam	Geum	Dam-Dae Chunh Dam	117.0	1984-85,1992,2002-03	'92 ~ '01
	Bo Rung	Ung Chun	Dam-Ung Chun Conflu.	14.0	1984,1992,2003	'92 ~ '98
SumJin	Sum Jin	Sum Jin	Dam-O Su Chun Conflu.	27.6	1970,1985,1993,2003	'60 ~ '65
	Ju Am(main)	Bo Sung	Main dam-Sum Jin Gang	26.5	1970,1985,1996,2003	'84 ~ '92
	Ju Am(bojo)	I Sa	Bojo Dam-I Sa Chun Conflu.	13.0	1979,1985,1994,2002	'84 ~ '92
	So Eo	Do Ea	Dam-So Eo Chun Conflu.	9.0	1970,1985,1996,2003	'74 ~ '77
YoungSan	Jang Hung	Tam Jin	Dam-Tam Jin Conflu.	27.3	1985,1994,2002	'97 ~ '06
NakDong	An Dong	Nak Dong	Dam-Nae Sung Chun Conflu.	65.0	1970-71,1979-81,1991,2005	'71 ~ '77
	Im Ha	Ban Byeo	Dam-Nak Dong Gang Conflu.	15.2	1979-81,1991,2005	'84 ~ '93
	Hwa Buk	Ui	Dam-Bam Chun Conflu.	29.3	1992,2004	'00 ~ '08
	Young Chun	Ja Ho	Dam-Geum Ho Gang Conflu.	13.0	1977,2000-04	'74 ~ '80
	Hab Chun	Hang	Dam-Nak Dong Gang Conflu.	51.5	1976,1982,1993,2004	'82 ~ '89
	Nam Gang	Nam	Dam-Nak Dong Gang Conflu.	78.4	1987,1993,2004	'87 ~ '03
	Un Mun	Dong Chung	Dam-Mil Gang Conflu.	28.7	1982,1993,2004	'85 ~ '94
	Mil Yang	Dan Jang	Dam-Mil Gang Conflu.	20.2	1982,1993,2004	'90 ~ '02

3. Analyzing area of the sandbar and vegetation at the downstream of dam

3.1 Degree of alteration

The area of the sandbar and vegetation will be able to present with fixed quantity analyzing the aerial photography. But, nothing dimension or the standardization process is necessary because the analytical segment and duration etc is different in the rivers by. In this study, The index of alteration which is the possible to showing the degree of alteration was introduced and analyzed (Richter et al., 1996).

$$D = \frac{A_{post} - A_{pre}}{A_{pre}}$$

From here, D; degree of alteration, Apost; after dam construction, Apre; before dam construction is the area of the sandbar or vegetation. The change degree is as the absolute value of degree of alteration big as high, and it is as near in '0'as low. The positive number is increasing tendency and negative number means decrement tendency. From the study, it was classified, if the absolute value of 'D' of the sandbar and vegetation was 0~0.33 scope, "low-end change (Low alteration: L)", 0.33~0.67 "intermediate change (Moderate alteration: M)", above of 0.68 "high change (High alteration: H) "(Richter et al., 1996).

3.2 Analyzing alteration of sandbar area

Sandbar area was decreased 16.73% and alteration index of sandbar were -0.2599 ~ -0.9921 after dam construction.

Before dam construction, the area of sandbar was average 37.60% of the analyzing segment. But, after dam construction, it was average 20.89%, 16.73% decreased. Analytical result of 'D', the area of sandbar at Soyanggang and Hoengsong dam increased with 0.9123 and 2.9528, that of Chung-ju etc. 19 dams decreased on a large scale with -0.2599 ~ -0.9921. Dal-bang, Sum-jin, Ju-am, Su-woe, An-dong, Hwa-buk, Nam-gang 7 dams were classified low-end change (L), Chang-hung, Hap-chun, Mil-yang 3 dams were classified intermediate change (M), Soyanggang etc. 11 dams were were classified high (H). 'D'of Hoeng-song dam (2.9528) went over '1,000' and the fact that the degree is high quite was analyzed.

3.3 Analyzing alteration of vegetation area

Before dam construction, the area of the vegetation in the analytical segment was 11.00%. But, after dam construction, it increased 23.85% with 12.84%. Analytical result of 'D', the area of vegetation at Kwang-dong and Dal-bang dam decreased with -0.2820 and -0.8908, 'D' of Soyanggang etc. 19 dams increased on a large scale with 0.2699 ~ 12.0736. 'D' of 3 dams of Hoeng-song, Kwang-dong and Hwa-buk were classified low-end change (L), Chung-ju, Sum-jin 2 dams were classified intermediate change (M). 'D' of Soyanggang etc. 15 dams were classified high (H) with. The Soyanggang dam 12.0736 (H) was highest, and the Hwa-buk dam 0.1625 (L) was analyzed with the low end most.

Table 2. Analysis of Sandbar Area.

Dam	Pre-impact (A)		Pre-impact (B)		Alteration (A-B)		Degree of Alteration	
	area× 1,000 (m^2)	%	area× 1,000 (m^2)	%	area× 1,000 (m^2)	%	degree	state
So Yang	385.1	12.56	736.3	25.57	351.3	13.01	0.9123	H
Chung Ju	2,167.2	35.84	714.0	8.46	-1,453.1	-27.38	-0.6705	H
Hoing Sung	63.1	7.05	249.2	36.19	186.2	29.14	2.9528	H

Koang Dong	264.5	199.77	79.1	137.59	-185.3	-62.19	-0.7009	H
Dang Bamg	84.8	73.04	71.1	47.08	-13.7	-25.95	-0.1620	L
Dae Chung	1,380.4	18.36	399.5	5.51	-980.9	-12.85	-0.7106	H
Young Dam	1,503.9	32.59	301.8	6.51	-1,202.2	-26.08	-0.7993	H
Bo Rung	328.9	16.51	16.8	0.75	-312.1	-15.76	-0.9489	H
Sum Jin	69.0	2.55	51.0	1.97	-17.9	-0.58	-0.2599	L
Ju Am(main)	522.4	14.74	4.1	0.11	-518.3	-14.63	-0.9921	H
Ju Am(bojo)	30.2	2.42	21.4	1.71	-8.8	-0.71	-0.2920	L
So Ea	1,211.8	48.52	1,120.4	51.02	-91.4	2.50	-0.0754	L
Jang Hung	381.2	15.33	132.0	5.04	-249.1	-10.29	-0.6536	M
An Dong	3,774.3	43.57	815.6	9.41	-2,958.7	-34.15	-0.7839	L
Im Ha	1,924.8	34.31	456.7	8.14	-1,468.1	-26.17	-0.7627	H
Hwa Buk	527.8	24.73	442.6	20.74	-85.2	-3.99	-0.1615	L
Young Chun	1,125.3	47.84	276.8	11.77	-848.4	-36.07	-0.7540	H
Hab Chun	1,859.2	45.99	799.7	19.78	-1,059.5	-26.21	-0.5699	M
Nam Gang	2,082.0	15.59	2,092.4	15.67	10.4	0.08	0.0050	L
Un Mun	2,551.5	47.23	371.7	6.88	-2,179.8	-40.35	-0.8543	H
Mil Yang	1,719.3	51.05	617.5	18.33	-1,101.8	-32.71	-0.6408	M
Average	-	37.60	-	20.89	-	-16.73	-	-

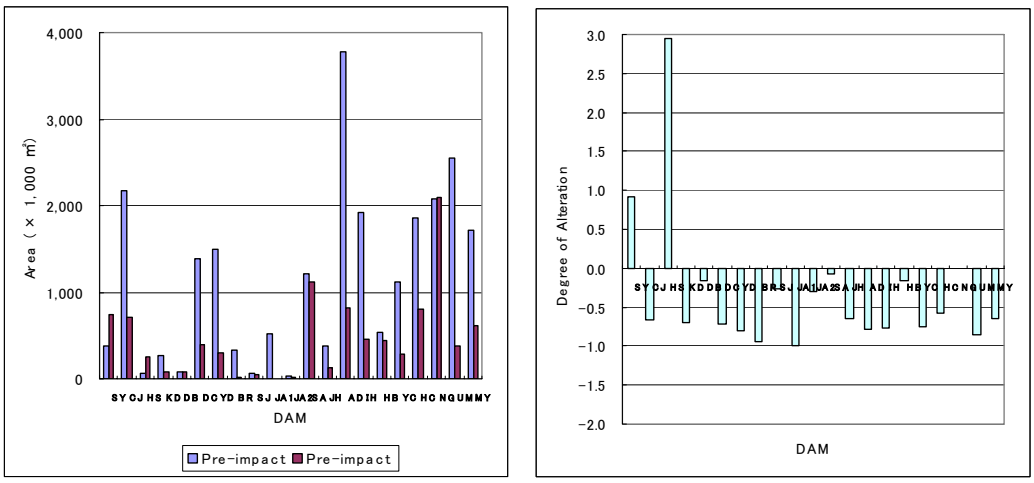


Fig. 2. Analysis of sandbar alteration

Table 3. Analysis of Vegetation Area

Dam	Pre-impact (A)		Pre-impact (B)		Alteration (A-B)		Degree of Alteration	
	area× 1,000 (㎡)	%	area× 1,000 (㎡)	%	area× 1,000 (㎡)	%	degree	state
So Yang	9.5	0.31	123.9	4.30	114.4	3.99	12.0736	H
Chung Ju	311.7	5.15	429.0	5.08	117.3	-0.07	0.3763	M
Hoing Sung	410.0	45.87	520.7	75.61	110.7	29.73	0.2699	L
Koang Dong	28.4	21.43	20.4	35.42	-8.0	13.99	-0.2820	L
Dang Bamg	23.0	19.79	40.9	27.13	18.0	7.34	0.7821	H
Dae Chung	72.2	0.96	540.5	7.46	468.2	6.50	6.4819	H
Young Dam	79.6	1.72	559.8	12.08	480.2	10.36	6.0363	H
Bo Rung	110.3	5.54	486.4	21.57	376.0	16.03	3.4090	H
Sum Jin	666.8	24.66	252.8	9.78	-413.9	-14.89	-0.6208	M
Ju Am(main)	180.8	5.10	628.9	16.72	448.1	11.62	2.4791	H
Ju Am(bojo)	14.9	1.19	35.6	2.85	20.7	1.66	1.3970	H
So Ea	195.2	7.82	21.3	0.97	-173.9	-6.85	-0.8908	H
Jang Hung	271.9	10.94	811.6	30.98	539.7	20.04	1.9848	H
An Dong	289.7	3.34	2,121.6	24.49	1,831.9	21.15	6.3245	H
Im Ha	389.8	6.95	1,921.7	34.26	1,531.9	27.31	3.9298	H
Hwa Buk	565.2	26.48	657.1	30.79	91.8	4.30	0.1625	L
Young Chun	79.4	3.38	976.1	41.50	896.7	38.12	11.2900	H
Hab Chun	383.3	9.48	1,183.2	29.27	799.9	19.79	2.0871	H
Nam Gang	1,572.1	11.77	2,651.6	19.86	1,079.5	8.08	0.6867	H
Un Mun	758.6	14.04	1,873.4	34.67	1,114.8	20.63	1.4695	H
Mil Yang	179.2	5.32	1,217.3	36.14	1,038.2	30.82	5.7937	H
Average	-	**11.01**	-	**23.85**	-	**12.84**	-	-

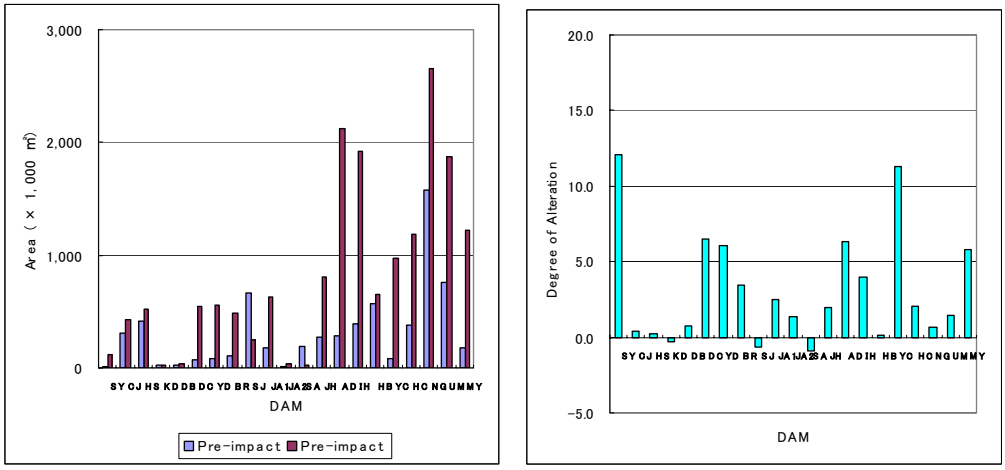


Fig. 3. Analysis of vegetation alteration

4. Secular change analysis of the sandbar and vegetation

4.1 maximum & minimum flow changes

Annual extreme flow was analyzed at Andong, Im-ha & Hap-chun dam by Applying IHA(Indicators of Hydrologic Alteration, Richter et aluminiums., 1996),

The 1-day minimum flow with the dam operation was increased 203% from 0.59 ㎥/sec with 1.78 ㎥/sec at An-dong, 167% from 0.17 ㎥/sec with 0.46 ㎥/sec at Im-ha, 677% from 0.54 ㎥/sec to 4.16 ㎥/sec at Hap-Chun dam

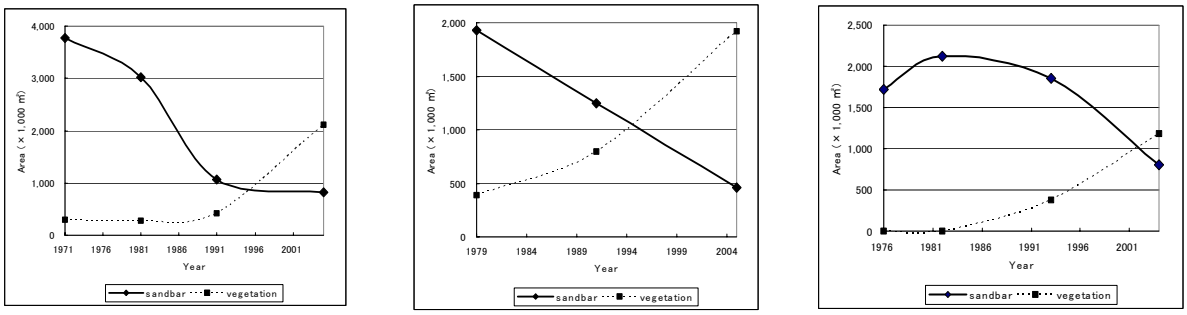
The 1-day minimum flow with the dam operation was decreased 84% from 1,090.00 ㎥/sec with 174.80 ㎥/sec at An-dong, 63% from 1,141.00 ㎥/sec with 424.30 ㎥/sec at Im-ha, 81% from 648.20 ㎥/sec to 121.90 ㎥/sec at Hap-Chun dam.

4.2 Analysis of Sandbar and vegetation condition

The sandbar area of An-dong dam was decreased from 3,774 × 10^3 ㎡ (1971) with 816 × 10^3 ㎡ (2005) in annual increments of 84,534 ㎡. On the other hand, The vegatation area was increased from 290 × 10^3 ㎡ (1971) with 2,122 × 10^3 ㎡ (2005) in annual increments of 52,340 ㎡. In particular, The vegatation area was growing rapidly since 1991.

The sandbar area of Im-ha dam was decreased from 1,925 × 10^3 ㎡ (1979) with 457 × 10^3 ㎡ (2005) in annual increments of 54,375 ㎡. On the other hand, The vegatation area was increased from 390 × 10^3 ㎡ (1979) with 1,922 × 10^3 ㎡ (2005) in annual increments of 56,738 ㎡.

The sandbar area of the Hap-chun dam was 1,725 × 10^3 in 1976, 2,119 × 10^3 ㎡ in 1982, 1,859 × 10^3 ㎡ in 1993 and 800 × 10^3 ㎡ in 2004. In 1982, it increased suddenly and decreased rapidly in annual increments of 31,917 ㎡. Vegatation area was increased from 390 × 10^3 ㎡ (1979) with 1,922 × 10^3 ㎡ (2005) in annual increments of 56,738 ㎡. In 1976, 1982, there was not an area of the vegetation almost. Since then, that was 383 × 10^3 ㎡ in 1993, 1,183 × 10^3 ㎡ in 2004, after 1991 that suddenly increased. that was analyzed in annual increments of 40,880 ㎡.



a) An Dong b) Im Ha c) Hap-chun

Fig. 4. Temporal variation of the sandbar and vegetation

a) 1971 yr. b) 1981 yr c) 2005 yr

Fig. 5. Aerial photographs of the pre & post dam (An Dong Dam)

a) 1979 yr. b) 1991 yr. c) 2005 yr.

Fig. 6. Aerial photographs of the pre & post dam (Im Ha)

a) 1982 yr. b) 1993 yr. c) 2004 yr.

Fig. 7. Aerial photographs of the pre & post dam (Hap-chun)

5. Conclusion

The interest objects which was principal in river plan was physical structure and quality as rivers section, bed slope and bed material etc. But, in recent, vegetation of channel is recognized with the important element. In this study, change of the sandbar & vegetation, alterlation index, change degree and secular change were analyzed at the downstreams of 21 dams(soyanggang etc,) in Korea.

The important element to influence of dam which affect in the sandbar and vegetation of the downstream were judged to sudden changes in flood as decreasing of peak flood and increasing of low flood etc. change which that flow increase etc. is sudden. The study was limited in area change of the sandbar and vegetation at the downstream of dam. Consequently, the change of sandbar and vegetation, variety of the vegetation spcies, detailed. and there is a necessity to research affects of environment and ecosystem of the downstream continuously.

References

Yeo, W., Lim, K., Lee, S., Jee, H., Lee, T. (2004). “Vegetation mechanism and reduction flood ability at the downstream of dam” Korean water resources academic society, 2004 scientific announcement thesis, pp. 922-926.

Lee, S., Ok, K. (2007). “The vegetation reverse advancement process which leads a soil investigation from the sand four pillar of the mobile phase river course.” Korean water resources academic society, 2007 scientific announcement thesis, pp. 1050-1062.

Choi,S., Yoon, B., Woo, H., Cho, G., (2004). “From the downstream river course which follows in the sulfur change in compliance with a dam construction change of rivers terrain school register change and the vegetation clothing: Hwang river total thousand dam instances.” Korean water resources academic society, Korean water resources academic society thesis, vol 37th, pp. 55-66.

Gordon, E., Meentemeyer, R.K. (2006). "Effects of Dam Operation and Land Use on Stream Channel Morphology and Riparian Vegetation." *Geomorphology*, Vol. 82, pp. 412-429.

Richard, A. M., Mills, J. D., Wrazien, D. R., Bassett, B., Splinter, D. K. (2005). "Effects of Jacjson Lake Dam on the Snake River and its Floodplain Grand Teton National Park, Wyoming, USA." *Geomorphology*, No. 71, pp. 79-98.

Richther, B. D., Baumgartner, J. F., Powell, J., Braun, D. P. (1996). "A Method for Assessing Hydrologic Alterations within Ecosystems." *Conservation Biology*, Vol. 10, No. 4, pp. 1163-1174.

Shafroth P. B., Stromberg J. C., Patten D. T. (2002). "Riparian Vegetation Response to Altered Disturbance and Stress Regimes." *Ecological Applications*, Vol. 12, No. 1, pp. 107-123.