SEDIMENTATION AND CLIMATE CHANGE ON RESERVOIRS IN NORTHERN PERU

Conference Paper · July 2015

CITATIONS
0

READS
295

2 authors:

Juan Walter Cabrera Cabrera
Universidad Nacional de Ingeniería (Peru)
13 PUBLICATIONS **13** CITATIONS
SEE PROFILE

Julio Isaac Montenegro Gambini
Universidad Nacional de Ingeniería (Peru)
19 PUBLICATIONS **8** CITATIONS
SEE PROFILE

SEDIMENTATION AND CLIMATE CHANGE ON RESERVOIRS IN NORTHERN PERU

JUAN W. CABRERA CABRERA (1)
JULIO I. MONTENEGRO GAMBINI (2)

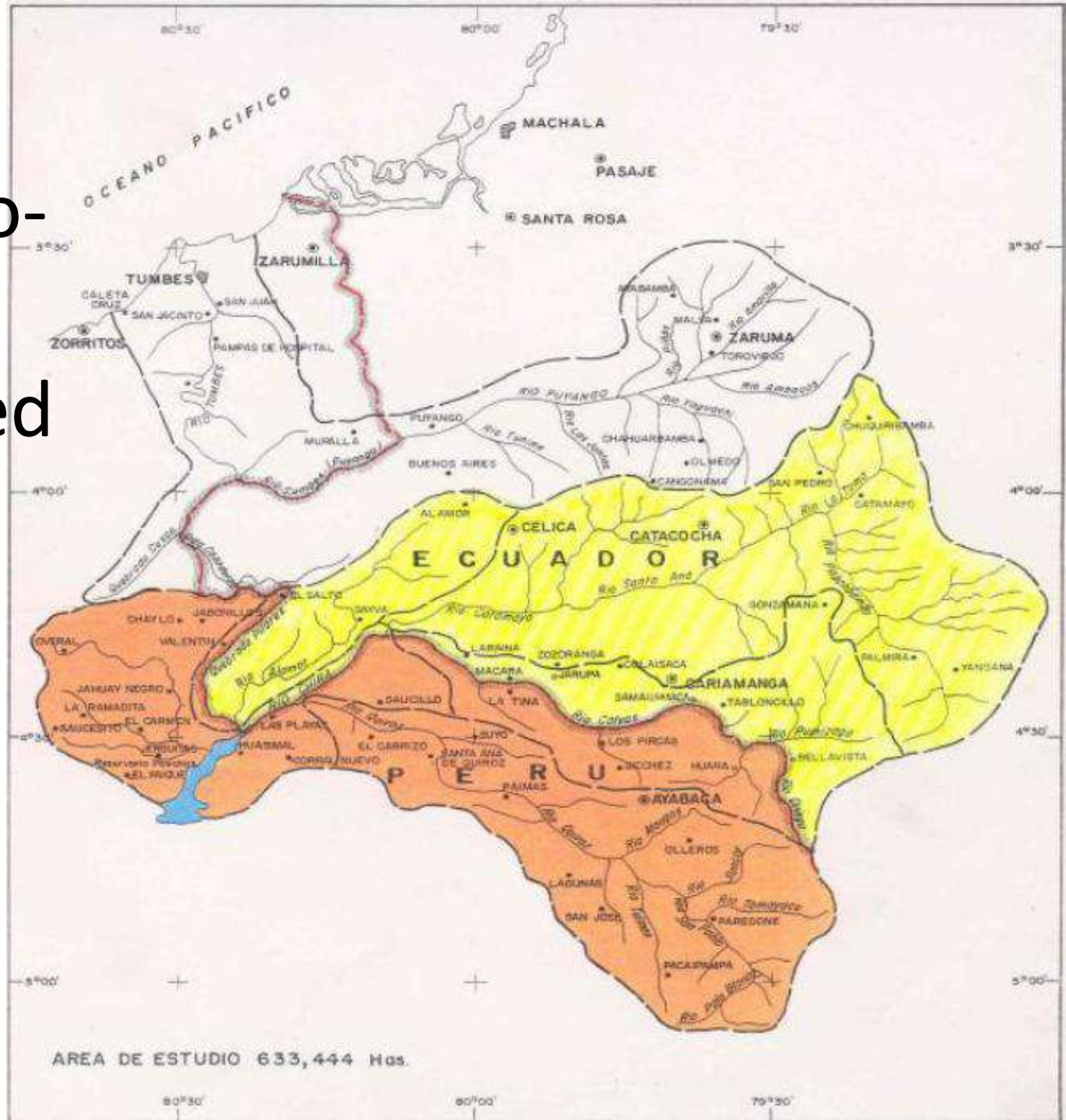
(1) juancabrera@uni.edu.pe
(2) montega_5@hotmail.com

Outline

1. Situation.
2. Solid discharge- liquid discharge relationship
3. Projected time series
4. Abc model
5. Results and discussion
6. Conclusions

1. Situation

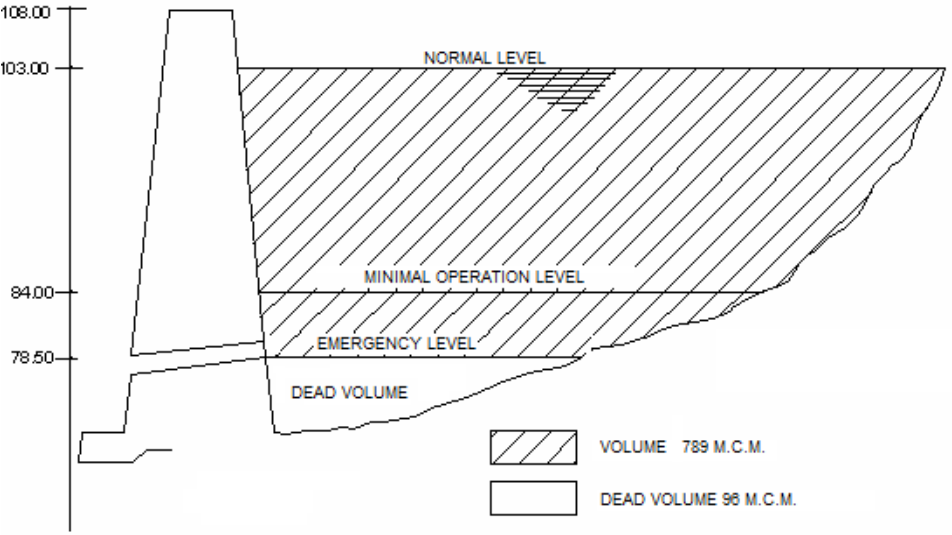
Catamayo-Chira Watershed



Poechos dam

- 4.5° S latitud - 80.5° W lenght.
- Built in 1972-1978.

1.0 VIDA UTIL	:50 AÑOS
2.0 ALTITUD	:108 m.s.n.m
3.0 TIPO	:PRESA DE TIERRA
4.0 LONG.DE LA CORONA	:11 Km.
5.0 ALTURA	:48 M
6.0 VOLUMEN DE DISEÑO	:1000 MMC
7.0 COTA MAX. DE OPERACIÓN	:103
8.0 VOL. OPER. EN LA COTA 103	:887 MMC
9.0 SUPERF. ESPEJO DE AGUA	:62 Km2
10.0 CAPAC. DE DESCARGA POR ALIVIADERO	:5.500 M3/SEG



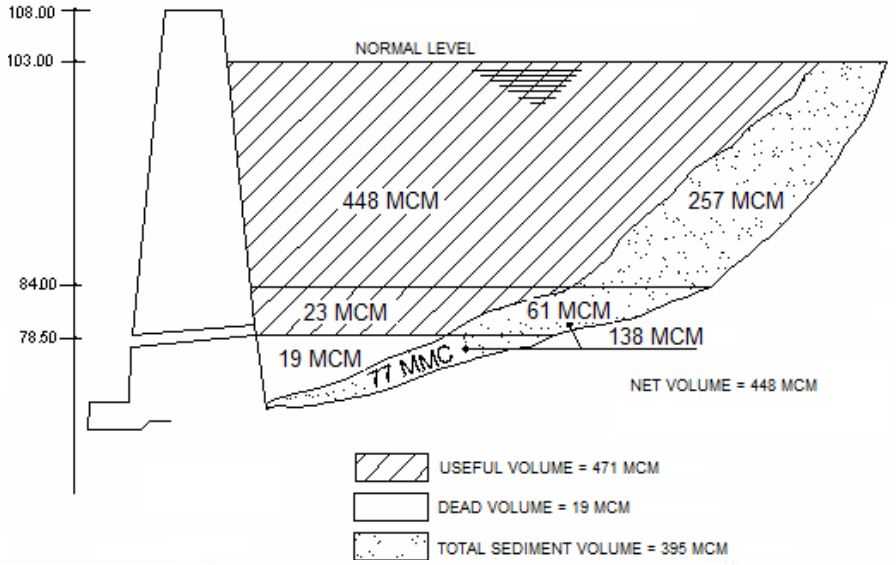
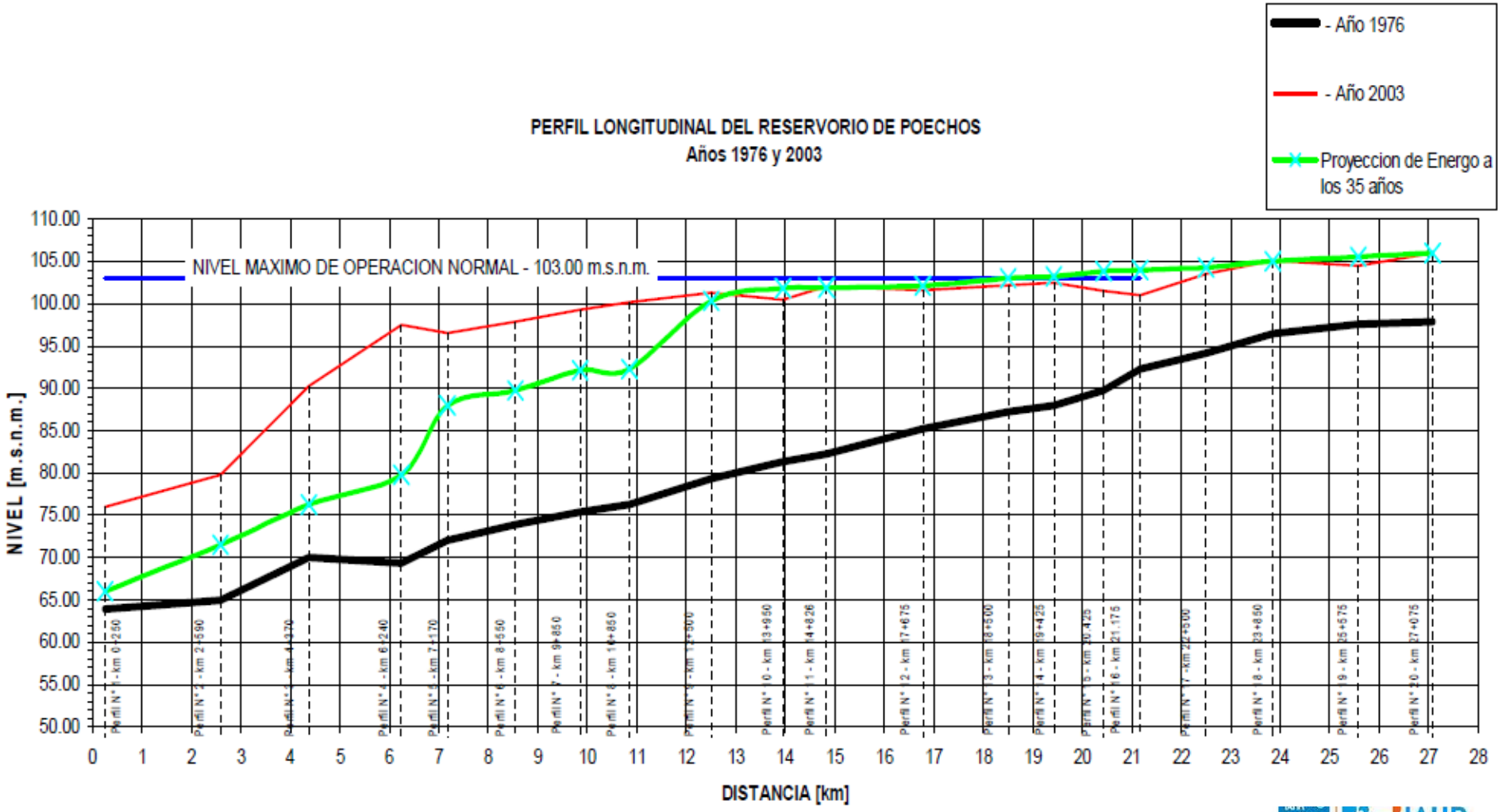


Figure 1 Volume of Poechos reservoir. Left, design volume in 1978. Right, useful volume in 2002. Down, useful volume in 2010.

Sedimentation



2. Solid discharge- liquid discharge relationship

Qliq-Qsol

- Morocho (2005) found a relationship between these variables:

$$G_{mens} = 6.5765\ Q^{2.1891}_{mens}$$

where:

Gmens = monhtly suspended sediments in Poechos reservoir

Qmens = Monthly contribution of water in Poechos reservoir

- This relationship was re-evaluated.

Qliq-Qsol

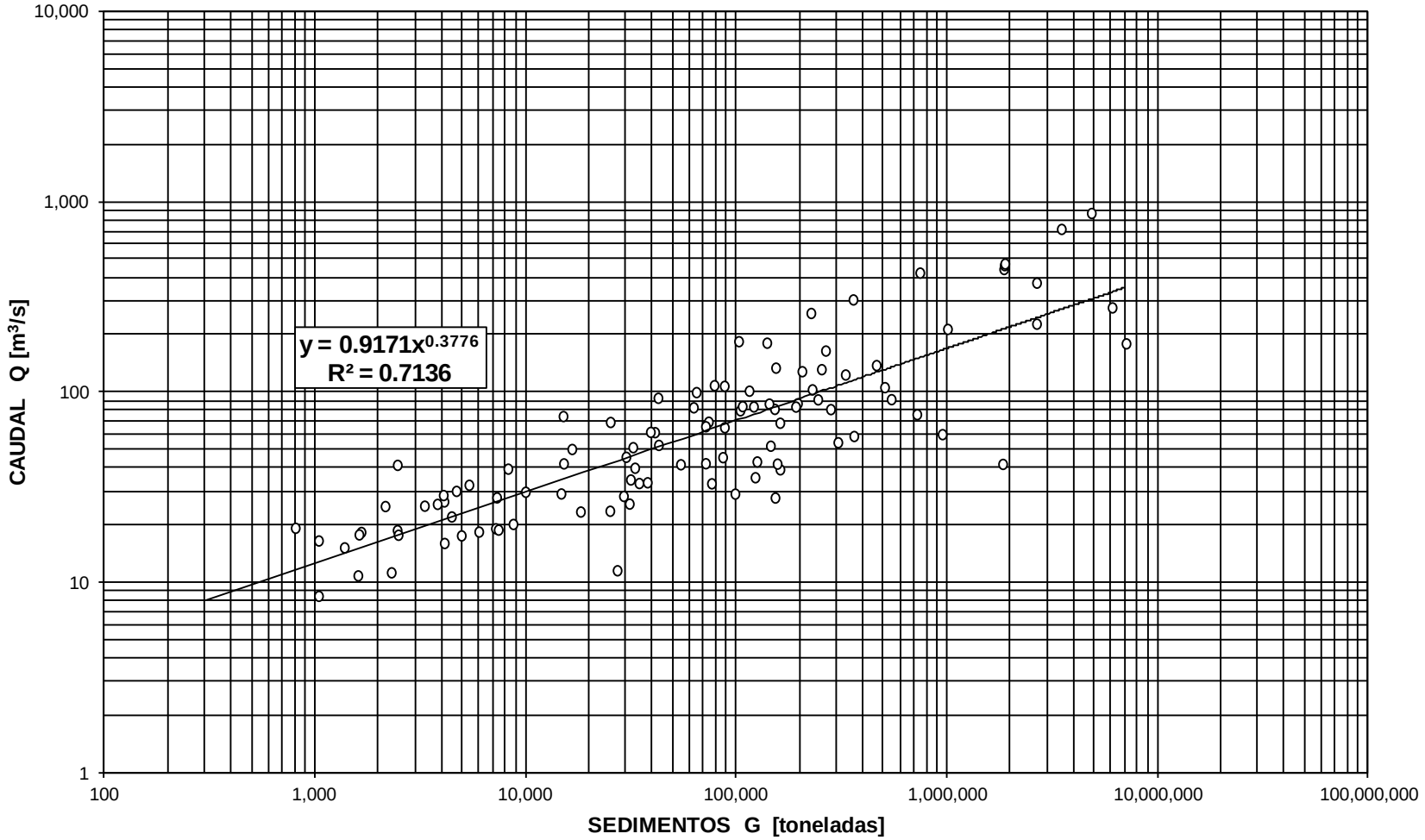


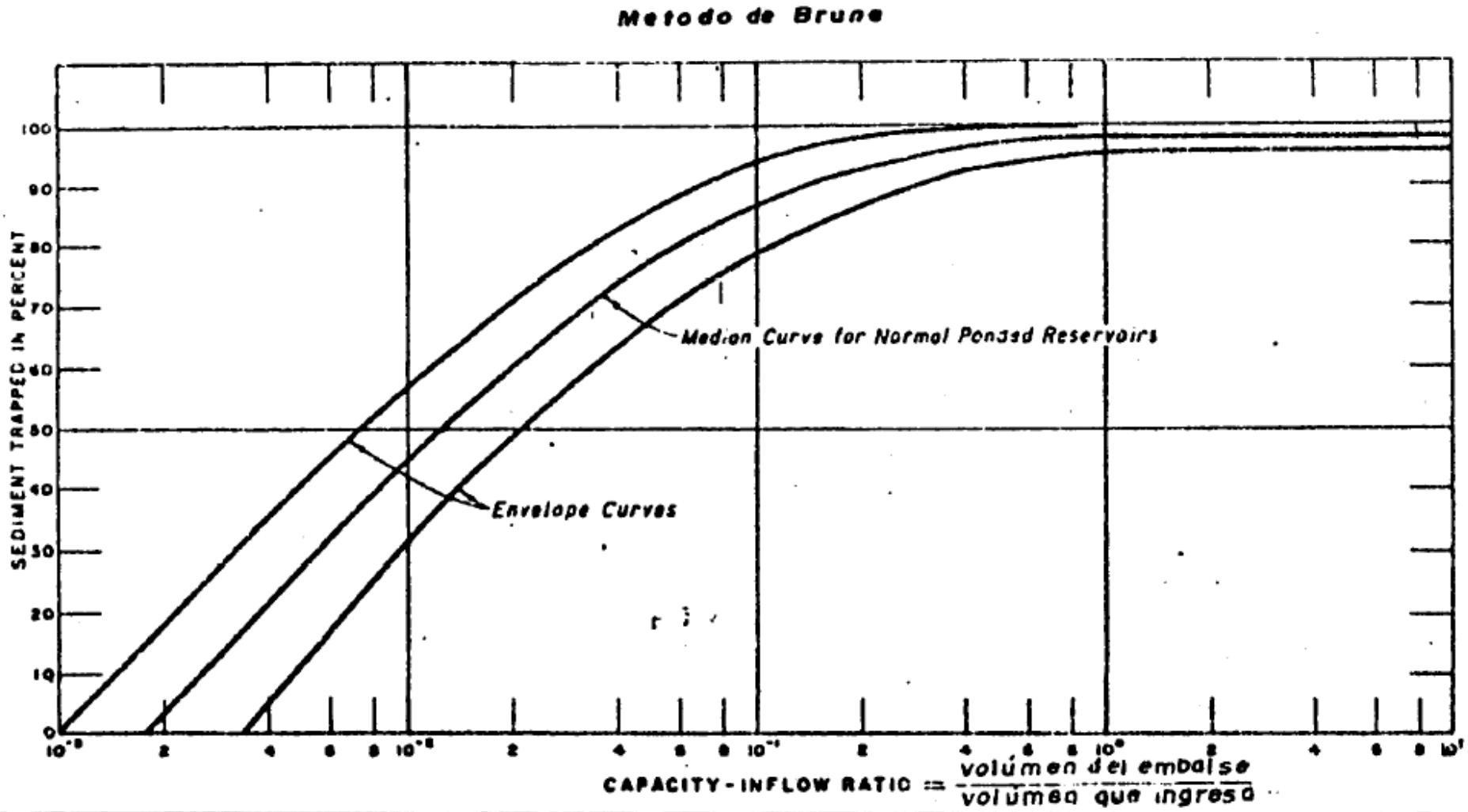
Figure 3. Suspended sediment vs. intake flow. Section 19. Chira River. Period 1976-2011.

Brune method

- Brune (1953) built a group of curves to evaluate efficience of retention in reservorios like lakes based in empirical measurements.

- Brune obtained a relationship between retention efficiency of a reservoir, the percentage of input sediment which is trapped by it, and the relationship between “the capacity of the reservoir and the average annual flow of water that entered”.

Brune method



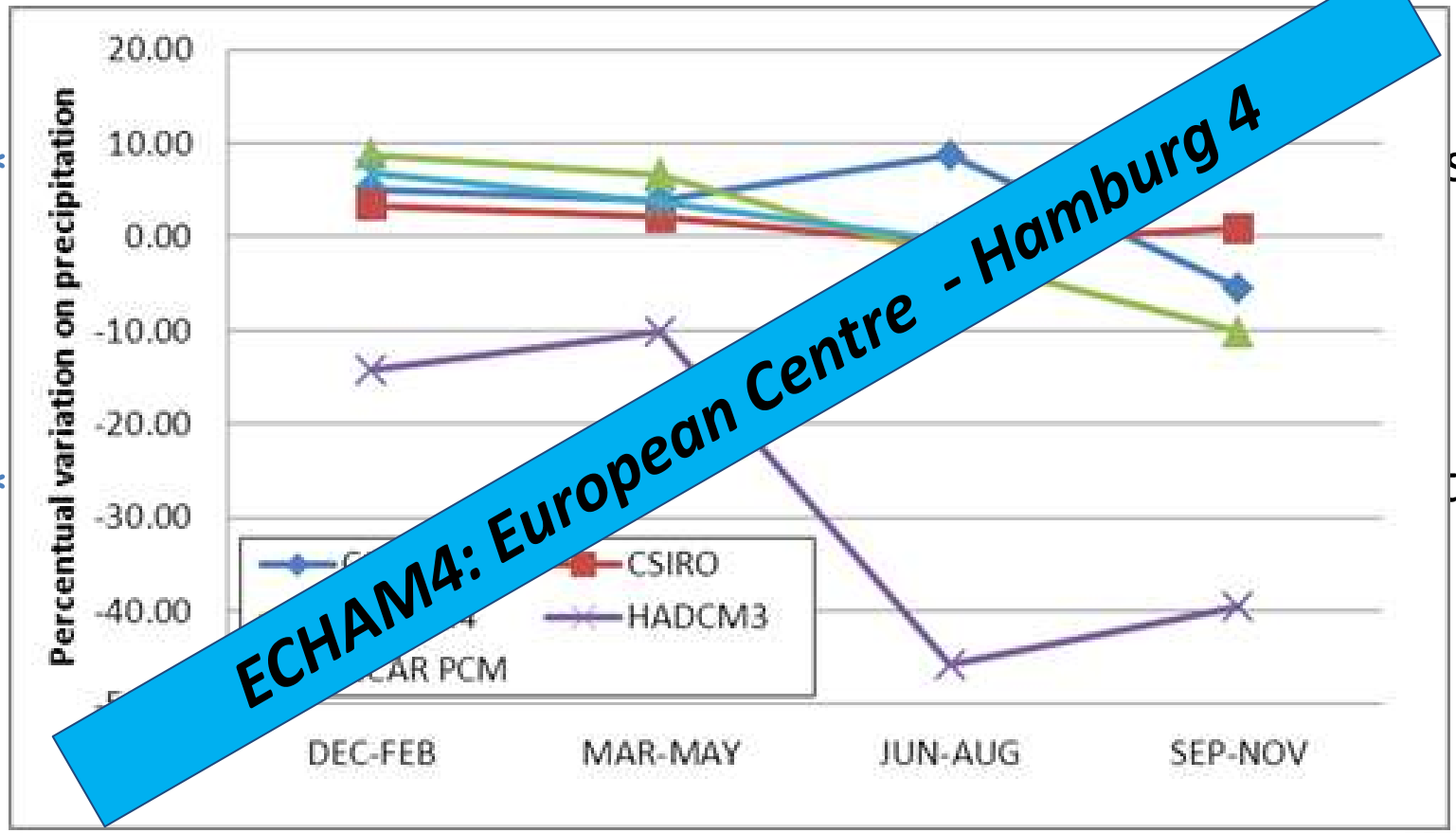
3. Projected time series

AOGCMs

MODEL	COUNTRY	GRID	N	L	DT_{glob} (°C)
CCSR/NIES	Japan	5.6X5.6°	2048	20	4.4
CGCM2	Canada	3.8x3.8°	4608	10	3.5
CSIRO Mk2	Australia	3.2x5.6°	3584	9	3.4
ECHAM4/OPYC3	Germany	2.8x2,8°	8192	19	3.3
GFDL R30	U.S.A.	2.2x3.8°	7680	14	3.1
HadCM3	United Kingdom	2.5x3.8°	7008	19	3.2
NCAR DOE PCM	U.S.A.	2.8x2.8°	8192	18	2.4

Ruostenoja et al. (2003)

AOGCMs



ECHAM4: European Centre - Hamburg 4

*

*

Projected time series

* Deltas methodologies was applied to get projected time series from temperature and precipitation.

$$P_i^{'} = (1 + \Delta P) P_i \qquad T_i^{'} = T_i + \Delta T$$

* To get discharges projected time series, is necessary to use a rainfall-runoff model. The abc conceptual model was chosen and calibrated.

4. Abc model

Abc Model

$$SR_t = aP_t$$

$$I_t = (1-a)P_t$$

$$E_t = bI_t$$

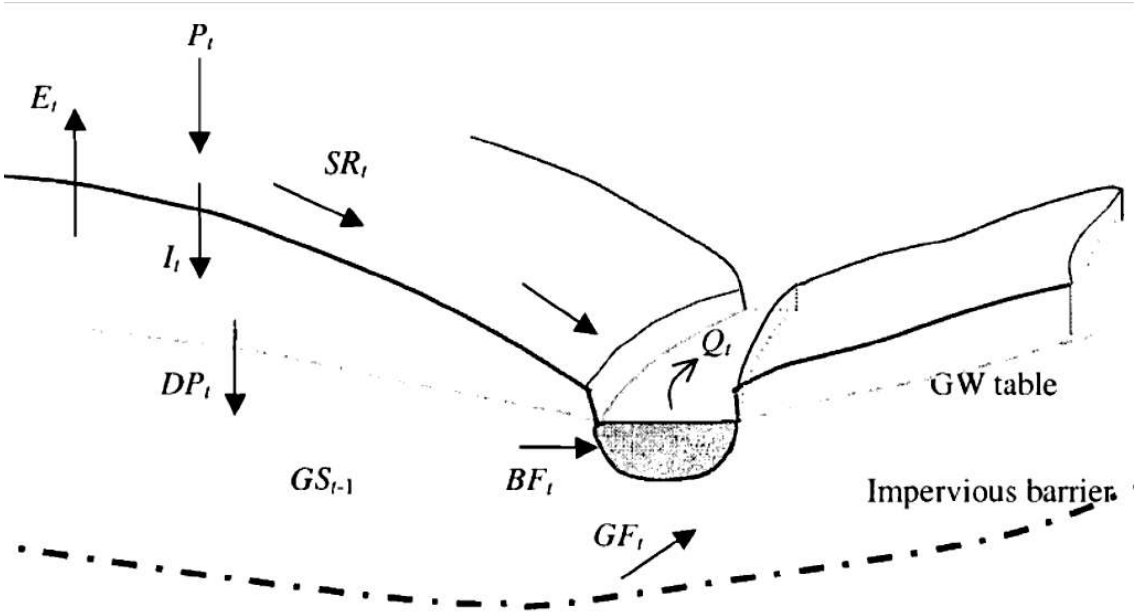
$$DP_t = (1-b)I_t$$

$$BF_t = cGS_{t-1}$$

$$GF_t = dGS_{t-1}$$

$$GS_t = (GS_{t-1} - BF_t - GF_t) + DP_t$$

$$Q_t = SR_t + BF_t$$

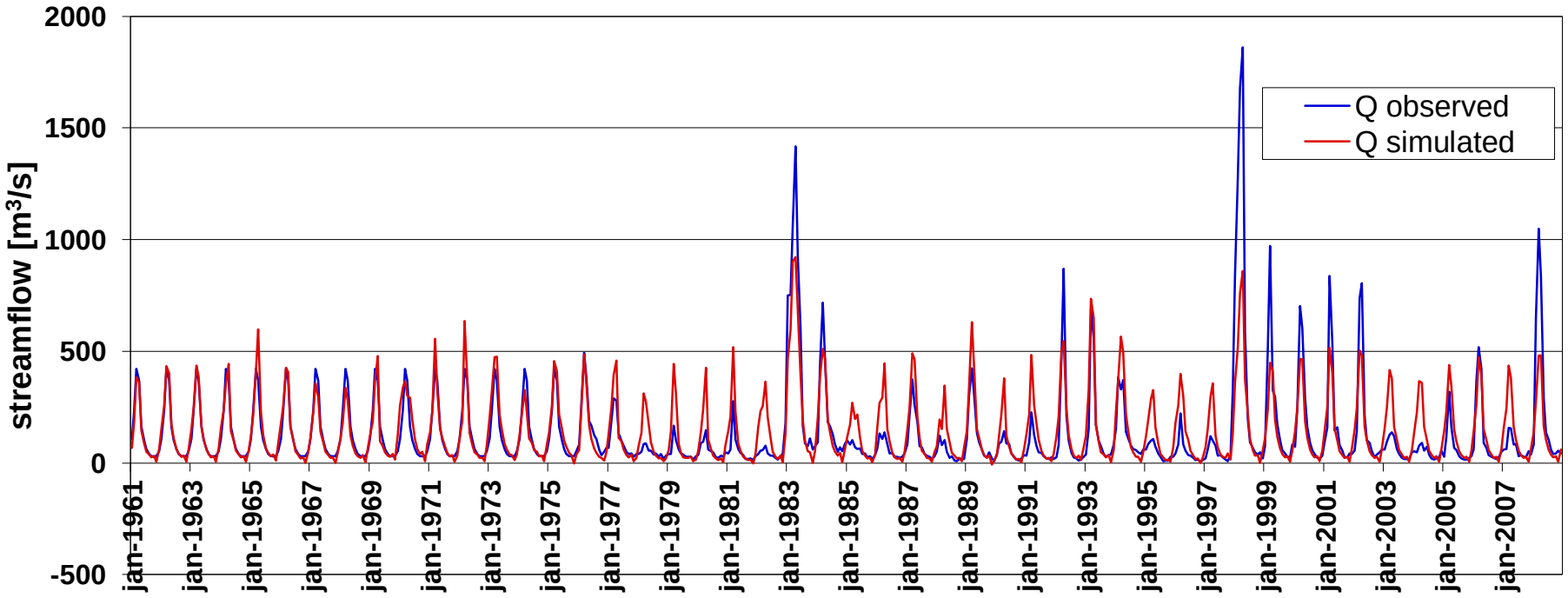


(*)More information : www.imefen.uni.edu.pe

5. Results and discussion

Results

Comparison between historical and simulated streamflow.
Chira River. Period 1961-2009.



IAHR 2015

Results

Table 1.- Reduction of useful volume in Poechos Reservoir. Period 2030-2039. Emission scenario: A1FI.

Año	Q_a m^3/s	V_a $\times 10^6 m^3$	V_r $\times 10^6 m^3$	V_r/V_a	K_m %	G_a $\times 10^6$ tonel.	$G_a \times K_m$ $\times 10^6$ tonel.	K_{ar} %	$G_a \times K_m \times K_{ar}$ $\times 10^6$ tonel.	G_c $\times 10^6$ tonel.	Reduction (% de Vuseful)
2030	31.838	1004.029	259.944	0.259	0.934	11.288	10.548	1.011	10.662	9.596	70.628
2031	24.098	759.953	251.948	0.332	0.950	11.025	10.470	1.012	10.592	9.533	71.531
2032	10.099	318.479	244.004	0.766	0.787	8.345	6.568	1.016	6.673	6.006	72.429
2033	111.715	3523.037	238.999	0.068	0.814	3.497	2.848	1.128	3.212	2.891	72.994
2034	59.426	1874.066	236.590	0.126	0.894	38.686	34.580	1.051	36.340	32.706	73.267
2035	32.261	1017.395	209.334	0.206	0.919	20.579	18.920	1.044	19.753	17.778	76.346
2036	17.149	540.819	194.520	0.360	0.952	11.172	10.631	1.042	11.074	9.966	78.020
2037	5.124	161.598	186.214	1.152	0.992	5.939	5.891	1.045	6.155	5.540	78.959
2038	0.492	15.510	181.598	11.709	1.200	1.775	2.129	1.014	2.160	1.944	79.480
2039	48.788	1538.585	179.978	0.117	0.888	0.170	0.151	1.011	0.153	0.138	79.663

Source: Authors.

Results

- Results show that useful volume of Poechos will get only 20% of 885MCM at the end of 2039. These results include possible effects of climate change under A1FI emission scenario and ECHAM4 projected variations. This estimation doesn't include possible occurrence of El Niño Phenomenon.

- According with Rocha (2006) reduction of useful volume in Poechos is around 6MCM by year, that's mean 222MCM from 2002 to 2039 and a useful volume of 278 (32% of total volume) which means that climate change could produce an increment of sediment volume around 106MCM (12% of total volume) and the consequently reduction of life.

Conclusions and Recomendations

- Analysis shows that Poechos reservoir will be silted in 70% by 2039, under the A1FI emission scenario and considering ECHAM4 model projections. Furthermore, analysis by Brune method shows a reduction near of 80% in working volume.
- Every analysis in Northern Peru should include possible effects of El Niño Phenomenon because this region is affected for this periodically.
- It is recommended to apply downscaling processes to improve accuracy variations projected by AOGCM model. Also, it's recommended to develop a new analysis under the new emission scenarios included in the Fifth Report of the IPCC.
- Finally, it's recommended a new simulation replacing the rainfall runoff model by a semi-distributed or distributed model which has a better performance to represent El Niño Phenomenom and their effects on sedimentation processes.

IAHR 2015

REFERENCES

- Burlando, P. (2011). "Abc model". Wasserhaushalt, SS 2011. Institute of Environmental Engineering, Chair of Hydrology and Water Resources Management, ETH Zürich. Switzerland.
- Montenegro, J. (2013). “Evaluación de la sedimentación del reservorio de Poechos”. Unpublished paper.
- Morocho Calle, F. (2004). “Sedimentación del reservorio de Poechos y recuperación de volumen de agua de regulación para Sistema Chira-Piura”. PECH.
- Ruosteenoja, K., Carter, T., Jylhä, K. and Tuomenvirta,H. (2003). Future climate in world regions: an intercomparison of model-based projections for the new IPCC emissions scenarios. The Finnish Environment Institute. Helsinki, Finland.
- Rocha, A.(2006). “La problemática de la sedimentación de embalses en el aprovechamiento de los ríos peruanos aplicada al embalse de Poechos”. Proceedings del “Primer Congreso Internacional de Hidráulica, Hidrología, Saneamiento y Medio Ambiente - Hidro 2006”.ICG.
- Salas, J. D. (2003). "Conceptual Model of a Watershed at Seasonal Time Scales (SEAMOD-03)". Hydrology and Water Resources Program, Dep. of Civil Engineering, Colorado State University. USA.

IAHR 2015

UNIVERSIDAD NACIONAL MAYOR DE SAN MARCOS

PONTIFICIA UNIVERSIDAD CATÓLICA DEL PERÚ

UNIVERSIDAD NACIONAL DE INGENIERÍA

UNIVERSIDAD NACIONAL AGRARIA LA MOLINA

IAHR AIRH

Supported by CEDEX

XXVII Congreso Latinoamericano de HIDRÁULICA 2016

JW Marriott Hotel Lima, 26 al 30 setiembre 2016

www.ladhi2016.org

CREAR AMAZONÍA

CENTER FOR RESEARCH AND EDUCATION OF THE AMAZONIAN RAINFOREST

AUTORIDAD NACIONAL DEL AGUA

COLEGIO DE INGENIEROS DEL PERÚ