Annual Journal of Hydraulic Engineering, JSCE, Vol.54, 2010, February

ENSO INFLUENCE ON THE 1982-2000 HYDROLOGICAL PROPERTIES OF THE PANTABANGAN-CARRANGLAN WATERSHED

Patricia Ann JARANILLA-SANCHEZ[1], Lei WANG[3] and Toshio KOIKE[2]

[1]Student Member of JSCE, Ph.D. Student. Department of Civil Engineering, University of Tokyo, (Tokyo, Japan)
[2]Member of JSCE, Ph.D., Professor, Department of Civil Engineering, University of Tokyo, (Tokyo, Japan)
[3]Member of JSCE, Ph.D., Researcher, Department of Civil Engineering, University of Tokyo, (Tokyo, Japan)

With the aid of the distributed biosphere hydrological model WEB-DHM, this study investigates the ENSO influence on the 1982-2000 hydrological properties of the Pantabangan-Carranglan Watershed, Philippines. First, the model is evaluated with the 19-year monthly observed discharges. Second, time-series trends of five hydrological properties (observed rainfall and discharge as well as simulated evapotranspiration, surface and root zone soil wetness) are considered focusing on the influences of El Niño and La Niña phenomena on these properties. Reversals in the anomalies of the hydrological properties occur for El Niño and La Niña.

Key Words : *ENSO, hydrological property, watershed, Philippines*

I. INTRODUCTION

The IPCC 4th assessment report clearly proves that the world's climate is changing as a result of natural and anthropogenic activities[1]. It is very important to be able to determine with certainty the impacts of this changing climate at a more localized scale (e.g. watershed level) because this directly impacts the society in it. This study has temporal and spatial data constraints so the analyses are limited to the effects of inter-annual variabilities to hydrological properties from 1982-2000 for a small watershed (Pantabangan-Carranglan watershed) in the Philippines. The climate is tropical with seasonal changes (from wet to dry) usually marking the onset of monsoons and the start of the cropping calendar. The ENSO (El Niño Southern Oscillation) phenomenon is a type of inter-annual variability causing destruction to the affected areas at the environmental and socio-economic level. El Niño was originally applied to an annual weak warm ocean current that ran southward along the coast of Peru and Ecuador about Christmastime and only recently became associated with the unusually large warmings (El Niño) or coolings (La Niña) that occur every few years that change the local and regional ecology[2]. For this study, this definition of ENSO in relation to both the warming/cooling of ocean waters and the periodically unusual large warming/cooling affecting local and regional ecology is utilized.

There are several studies correlating ENSO to precipitation and discharge in different river basins around the world such as North[3),4)] and South[5)] America, Australia[6),7),8)], Asia[9)] and Africa[7),8),10)]. Several models to predict ENSO occurrence have been developed since the 1980s[11),12)] to determine its effects on water resources management.

In the Philippines, findings by Lyon et al.[13)] show that seasonal changes of the ENSO rainfall signal reverses sign between the boreal summer (July to September) and fall (October to December) due to ENSO transitions during boreal spring and changes in the large scale monsoon system during the life cycle of ENSO events. However, a study by Estoque and Balmori[14)] shows that rainfall prediction by extrapolation from previous events was difficult.

This study aims to supplement spatial/temporal data needed for water resources management for remote sites with only basic measuring capabilities during inter-annual variations. Reanalysis data is used to supplement unavailable meteorological inputs for the simulation runs. By using the distributed biosphere hydrological model WEB-DHM[15),16),17)], this study investigates the ENSO (1982-2000) influence on the hydrological properties in the Pantabangan-Carranglan Watershed. First, the model is evaluated with the 19-year monthly observed discharges. Second, time-series trends of the five hydrological properties (observed rainfall, observed discharge, simulated evapotranspiration, surface and root zone soil wetness) are studied, focusing on the influences of El Niño and La Niña phenomena on them.

2. METHOD

(1) The WEB-DHM Model

The WEB-DHM (Water and Energy Budget-based Distributed Hydrological Model) is a distributed biosphere hydrological model that enables consistent descriptions of water, energy and CO_2 fluxes in the basin scale[15),16),17)]. The model has shown reliable accuracies in the simulations of fluxes (including latent heat flux), discharge as well as surface soil moisture in river basins[17),18)].

(2) Anomaly and Linear Detrending

The effects of the time-series trend for the ENSO composite years are determined from the calculated anomalies using a modified method from Berri[19)].

$$Anomalies = \overline{X} - \overline{X}_{(Ttotal)} \qquad (1)$$

where: $\overline{X}$ is the mean monthly value of the parameter; $\overline{X}_{(Ttotal)}$ is the 19-year monthly mean value of the parameter, *Ttotal* is the total time duration of the study.

Linear detrending is calculated to standardize the monthly anomalies by removing the annual cycle. This process is done by fitting a straight line representing the linear trend obtained by the least squares regression and then subtracting this linear trend from the time series of monthly anomalies.

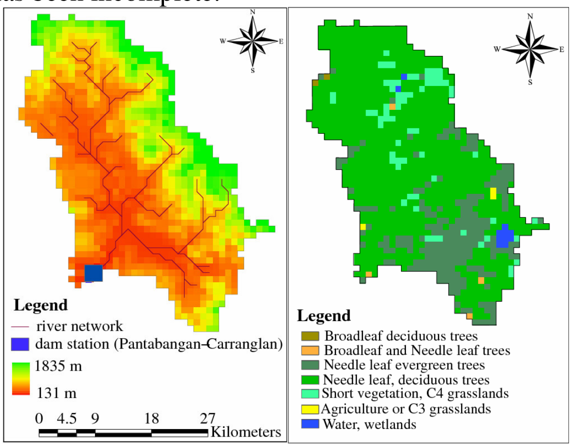
(3) Student t-test

The one-tailed t-test with unequal variance for $\alpha = 0.05$ is used to compare if there is a significant difference between the means of the hydrological properties for El Niño and La Niña composite years.

3. DATASET

(1) Study Area

The climate types in different areas of the Philippines depend on the time period that the wet and dry seasons occur. The study site is located at the northern part of the Philippines. Majority of the watershed is type I climate (from the Coronas Climate Atlas {climate classification system}) with dry season (December-April) and wet season (May-November). A small portion near the sub-province of aurora is climatic type II (no pronounced dry season; very pronounced maximum rainfall from November to January). Average annual rainfall is 1,777-2,271mm. Average air temperature (from 1961-1999) ranges from 25.7-29.5°C. This watershed is surrounded by the Carraballo mountain ranges on the northwest and the Sierra Madre mountain ranges in the south and southeast.[20)] The land area of the watershed considered is about 845km^2. The Pantabangan-Carranglan watershed is part of the Pampangga river basin that supplies water to the surrounding areas for domestic, hydropower and agricultural use as well as part of the main water supply for Metro Manila so it is one of the more economically important watersheds in the country. Since dam construction, there have been several livelihood and watershed management and rehabilitation projects implemented in the area[20)] however, quantification of the water budget in the area has been incomplete.



(a) (b)

Fig. 1. The digital elevation map, river network and location of the dam station (Pantabangan Dam)(a) and the land use type (b).

(2) Input Data

This study on the Pantabangan watershed has data limitations. The meteorological forcing data used in the simulations are from 1982-2000 JRA25 fcst_phy2m dataset (air temperature, specific humidity, air pressure, wind speed, downward solar and longwave radiation). Precipitation and discharge are from the Pantabangan dam station data of the National Irrigation Authority (NIA), Philippines. Daily precipitation is downscaled to hourly precipitation using simplifications. The leaf area index (LAI) and the fraction of photosynthetically active radiation absorbed by the green vegetation canopy (FPAR) are from the Advanced Very High Resolution Radiometer (AVHRR)[21)] satellite dataset. Subgrid topography (**Fig.1a**) is described by 100m DEM resampled from the GTOPO 30[22)]. The land use type consists mostly of deciduous and needle leaf evergreen trees (forest areas) with grassland areas and agricultural areas. The land use type classification is from the USGS land use cover (**Fig.1b**). Soil hydraulic parameters[23)] are initially obtained from the FAO (Food and Agriculture Organization) global dataset (including saturated soil moisture content, residual soil moisture content, soil moisture content at field capacity, storage coefficient of ground water, saturated hydrologic conductivity of the first layer of unsaturated zone, saturated hydrologic conductivity of bottom layer for unsaturated zone, hydraulic conductivity of groundwater). Some of the parameters are optimized using the observed streamflow.

4. RESULTS AND DISCUSSION

(1) Model Evaluation

The model simulations are performed from 1982 to 2000 with an hourly time step and 1 km spatial resolution in the watershed, after calibrating with two-year (1997-1998) discharges. The parameters calibrated for this study are: saturated hydraulic conductivity at the soil surface, hydraulic conductivity decay factor, hydraulic conductivity for groundwater, Manning's roughness and anisotropy ratio for unsaturated soil (see **Table 1**). The Nash-Sutcliffe[24] coefficient (NS) and the bias error (BIAS) are used to evaluate the model performance.

Table 1. Basin-averaged parameters used in the study

Calibrated parameter	Value
Saturated hydraulic conductivity for soil surface (mm/h)	95.37
Hydraulic conductivity decay factor	0.57
Hydraulic conductivity of groundwater (mm/h)	1.78
Manning's roughness	0.05
Soil anisotropy ratio	10

Fig.2 shows the monthly hydrograph at the dam station from 1982 to 2000. In general, the simulated discharges agree well with the observed ones with BIAS=6.67% and NS=0.54. Underestimates (1982, 1991) and overestimates (1998-1999) were possibly due to data availability limitations and simplifications.

(2) Impacts of the ENSO phenomenon

The Philippine Atmospheric Geophysical & Astronomical Services Administration (PAGASA) characterizes the ENSO phenomenon in the Philippines as occurring in the Pacific basin every 2 to 9 years, usually starting during December to February and usually lasts until the half of the following year (sometimes it stays longer). **Table 2** displays El Niño and La Niña occurrence from 1982-2000 using the Niño 3.4 Index categorized as weak, moderate or strong El Niño/La Niña classified using PAGASA's classification method. PAGASA monitors the occurrence of El Niño/ La Niña by category as follows: weak El Niño/La Niña having a magnitude of +0.5 to +1.0°C (or -0.5 to -1.0°C); moderate El Niño/La Niña having a magnitude of +1.0 to +1.5 °C (or -1.0 to -1.5 °C); and strong El Niño/La Niña having a magnitude of more than +1.5 °C (or less than -1.5 °C)[13),25)]. For this study, Niño 3.4 data from NCEP NOAA are averaged (using 3-month running average) and categorized using PAGASA's method.

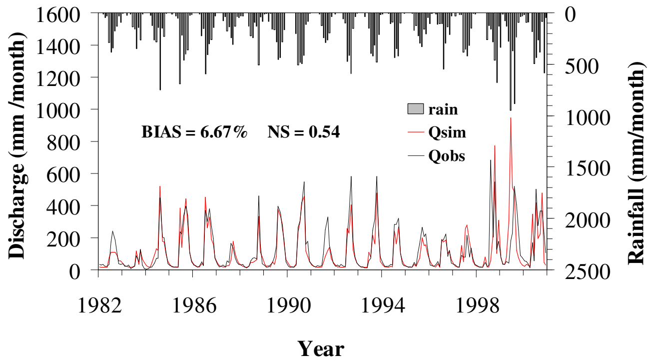


Fig. 2. Simulated and observed monthly discharge at the outlet of the Pantabangan-Carranglan Watershed from 1982 to 2000.

Table 2. El Niño and La Niña phenomenon from 1982-2000.

ENSO occurrence	JFM	AMJ	JAS	OND
1982		W	W+	W+
1983	W+	W+		C
1984	C-	C-	C-	C
1985	C	C-	C-	C-
1986	C-		W-	W+
1987	W+	W+	W+	W+
1988	W-	C-	C+	C+
1989	C+	C-		
1990		W-		W-
1991	W-	W-	W	W+
1992	W+	W+		
1993	W-	W	W-	
1994			W-	W+
1995	W	W-		C-
1996	C-			
1997		W	W+	W+
1998	W+	W-	C-	C+
1999	C+	C	C	C+
2000	C+	C-	C-	C-

Legend:
C- weak La Nina **C** moderate La Nina
C+ strong La Nina **W-** weak El Nino
W moderate El Nino **W+** Strong El Nino

Table 3. List of warm (El Niño) and cold (La Niña) ENSO events considered in the study for the years (1982-2000).

Warm ENSO events, or El Niño (6 cases)	1982/83, 1986/87, 1991/92, 1992/93, 1994/95, 1997/98
Cold ENSO events, or La Niña (4 cases)	1984/85, 1988/89, 1995/96, 1999/2000

Most of the effects of ENSO are on rainfall, temperature and tropical cyclone activities[26)]. Except for cyclone activities, abnormalities in rainfall greatly affect the outputs of simulations (discharge, evapotranspiration, surface soil wetness and root zone soil wetness) in WEB-DHM. The influence of the ENSO phenomenon on the hydrological variables are further analyzed by using the methodology introduced by Berri[19)] utilizing ENSO composite years to analyze mean monthly anomalies and identifying the effects of the time-series trend by removing the annual cycle. For this study, Nino 3.4 indices categorized based on the standard used by PAGASA is utilized to classify the occurrence of ENSO events. The 2-year composites are based on the occurrence of 5 or more consecutive months of warm or cold ENSO events per year occurring for 2 consecutive years. **Table 3** shows the list of warm and cold events considered in the study. These are consistent with the El Niño years (1982/83, 1986/87, 1991/92, 1992/93, 1994/95, 1997/98) and La Niña years (1984/85, 1988/89, 1995/96) considered by Berri[19].

Anomalies for the ENSO 2-year composites are shown in **Fig.3**. For rainfall (**Fig.3a**), positive anomalies are observed during La Niña while negative anomalies occurred during El Niño. These anomalies are concurrent with the study[13] on seasonal reversal of the ENSO signals. Discharge (**Fig.3b**), surface soil wetness (**Fig.3c**) and root zone soil wetness (**Fig.3d**) show similar patterns with rainfall for the 2-year ENSO composites. Rainfall directly affects discharge and surface soil wetness. The root zone soil wetness is partially shaped by the inter-layer flow from the surface layer. Positive anomalies are observed during La Niña and negative anomalies are observed during El Niño. Other months not showing this pattern are due to the period of occurrence of the ENSO. These phenomena do not occur for the entire duration of the 2-year composites, so the results just approximate the general trend for the selected years. Soil wetness increases steadily until June and then decreases steadily for both year 1 and 2 of the composites. The anomalies in the root zone soil wetness changes slower on the second year as compared to the surface soil wetness. The evapotranspiration anomalies (**Fig.3e**) show very similar patterns with that of rainfall. The month of August (peak evapotranspiration month) have minimal anomalies for the ENSO composites. Subsequently, positive anomalies are observed for both El Niño and La Niña for the second year. Evapotranspiration is directly affected by rainfall as well as both root zone and surface soil wetness, hence the similar patterns.

Fig.4 shows monthly anomalies for the parameters from 1982-2000 without the annual cycle. Similar results are found for longer detrended anomaly data and the 2 year ENSO composites. Rainfall and discharge shows similar patterns (**Fig.4a** and **4b**) however, rainfall have greater intensity than discharge anomalies. For both variables, the highest anomalies occur in 1998-1999. The reversals in both the surface soil wetness and root zone soil wetness (**Fig.4c** and **4d**) are more apparent: negative anomalies (1982-1983), positive anomalies (1984-1990), negative anomalies (1991-1995), positive anomalies (1995-1997), negative anomalies in 1998, positive (highest) anomalies (1998-1999). For evapotranspiration (**Fig.4e**), fluctuations are similar to rainfall and discharge however, the highest anomaly occurred in 1992-1993 during a strong El Niño event that followed a strong La Niña event.

(3) Student t-test

A student t-test (see **Table 4**) to compare El Niño and La Niña composite years shows that for rainfall, the first year of ENSO had significantly higher rainfall for May and July but did not show significant differences for the other months because the seasonality masks the effects of ENSO. For the second year, May shows significantly higher amounts of rainfall as well. For discharge, only July (1 month after the peak of the rainy season), shows significantly higher discharge rates during La Niña years.

Soil surface wetness on the first year shows that only the month of June is significantly wetter during La Niña years. On the second year, the month of February and April is significantly drier while May and June are significantly wetter. For root zone soil wetness, the first year had similar results with the surface soil wetness, with only June showing significantly wetter soil during La Niña years. On the second year, April to August shows significantly wetter soil at the root zone..

Table 4. Monthly Student t-test p-values on the parameters during El Nino and La Nina for the two-year composites (p-value<0.05 significant). The index (0) indicates the year the event begins, and (1) is the year the event ends.

	Jan(0)	*Feb(0)*	*Mar(0)*	*Apr(0)*	*May(0)*	*Jun(0)*	*Jul(0)*	*Aug(0)*	*Sep(0)*	*Oct(0)*	*Nov(0)*	*Dec(0)*
Rainfall	0.18	0.27	0.15	0.13	0.01	0.18	0.02	0.26	0.06	0.21	0.28	0.26
Discharge	0.46	0.27	0.38	0.47	0.42	0.13	0.10	0.40	0.23	0.07	0.09	0.14
Surface Soil Wetness	0.15	0.16	0.11	0.12	0.1	0.02	0.16	0.35	0.12	0.28	0.25	0.38
Root zone Soil Wetness	0.17	0.17	0.15	0.14	0.12	0.03	0.22	0.30	0.13	0.32	0.23	0.39
Evapotranspiration	0.16	0.17	0.11	0.06	0.01	0.04	0.38	0.32	0.16	0.21	0.15	0.44
	Jan(1)	*Feb(1)*	*Mar(1)*	*Apr(1)*	*May(1)*	*Jun(1)*	*Jul(1)*	*Aug(1)*	*Sep(1)*	*Oct(1)*	*Nov(1)*	*Dec(1)*
Rainfall	0.15	0.13	0.11	0.36	0.04	0.12	0.46	0.08	0.24	0.27	0.38	0.22
Discharge	0.22	0.18	0.30	0.46	0.13	0.13	0.05	0.43	0.20	0.41	0.18	0.29
Surface Soil Wetness	0.13	0.04	0.06	0.04	0.007	0.01	0.15	0.06	0.34	0.17	0.17	0.28
Root zone Soil Wetness	0.16	0.07	0.06	0.04	0.01	0.002	0.01	0.04	0.20	0.17	0.21	0.13
Evapotranspiration	0.07	0.24	0.31	0.01	0.46	0.47	0.19	0.49	0.42	0.13	0.27	0.35

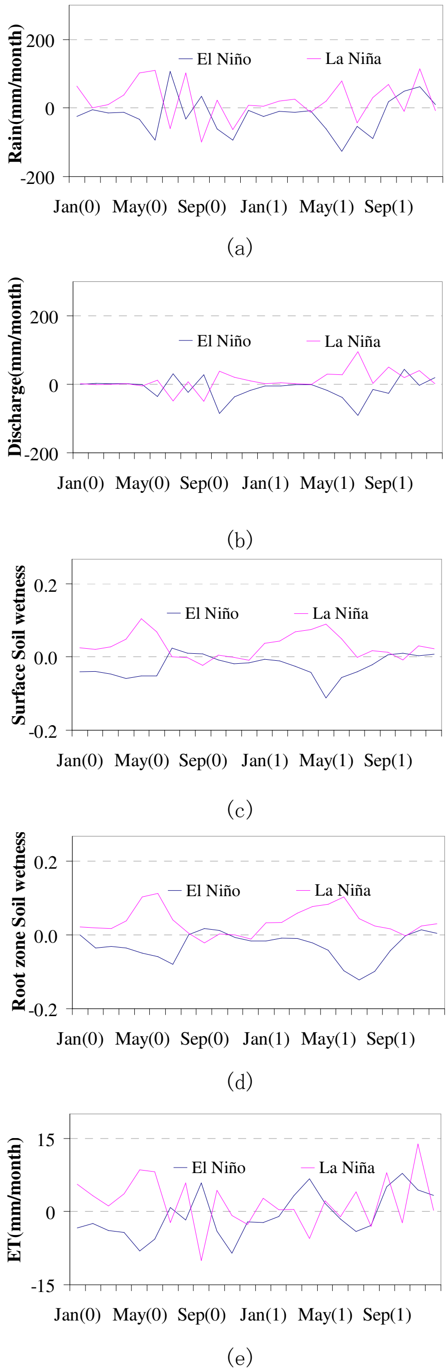


Fig.3. Standardized Anomalies of monthly observed rainfall and discharge (a and b), simulated surface and root zone soil wetness and evapotranspiration (c, d and e) in the Pantabangan-Carranglan watershed averaged for the composite of El Niño and La Niña years during 1982-2000. The index (0) indicates the year the event begins, and (1) is the year the event ends.

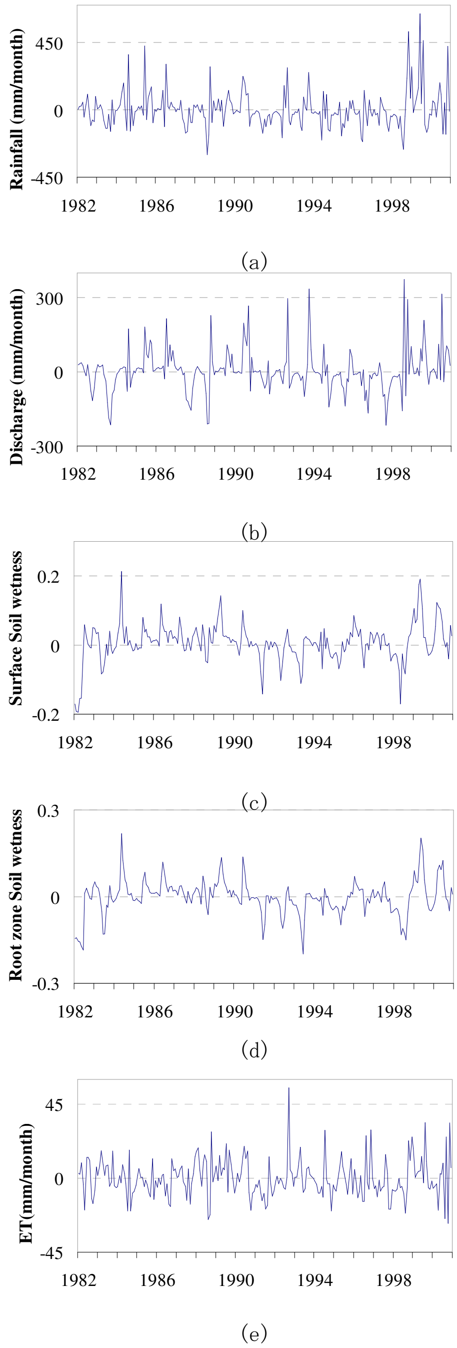


Fig.4. Monthly time series of the anomalies for observed rainfall and discharge (a and b), simulated surface and root zone soil wetness and evapotranspiration (c, d and e). The annual cycle and the long term trend have been removed by subtracting long term monthly trend and by linear adjustment.

This indicates that the delay and the larger anomalies in the root zone soil wetness occurrence on the second year of the ENSO composite are significant. For evapotranspiration, on the first year, May and June have significantly higher evapotranspiration during El Niño years than during La Niña Years.

5. CONCLUDING REMARKS

The impacts on hydrological properties in the watershed that were previously not readily measurable can now be simulated during inter-annual variations in ungauged or poorly gauged watersheds. With proper calibration, the information from the inputs (e.g. satellite data, global reanalysis data, gauge data) and outputs (e.g. evapotranspiration and discharge) of WEB-DHM can be very useful tools for determining the severity of the impacts of inter-annual variabilities like the ENSO phenomenon. Together with natural disasters, it is very important to quantify water availability/deficit in the soil (surface and root zone), in the reservoirs, the timeliness of water availability and the fluctuations from the average values of important hydrological variables. The impacts of these variations can be minimized if we are able to quantitatively predict the degree/intensity of their effects and thus provide proper and timely measures for water resources management.

ACKNOWLEDGEMENT: The study is supported by grants from the Ministry of Education, Culture, Sports, Science and Technology of Japan. The authors would like to acknowledge Dr. Rex Victor O. Cruz and Mr. Michael Joseph SM Pillas of the Environmental Forestry, College of Forestry and Natural Resources, University of the Philippines, for providing the observed rainfall and discharge data collected from NIA. I would also like to acknowledge Mr. Abdul Wahil Mohamed Rasmy for his help in data processing of JRA25.

REFERENCES:

1) Solomon, S., et al. : Technical Summary. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 2007.
2) Trenberth, K. : The Definition of El Niño, *Bull. Am. Met. Soc.*, Vol. 78(12), pp. 2771-2777, 1997.
3) Andrews, E.D, Antweiler, R.C., Neiman, P.J. and Martin Ralph,F. : Influence of ENSO on Flood Frequency along the California Coast, *J. Climate*, Vol. 17, pp.337-348, 2004.
4) Feng, X., and Houser, P. : An investigation of GSWP-2 Mississippi River basin surface water and energy budgets, *J. Geophys.Res.*,Vol.113, D15118, doi:10.1029/2007JD009144, 2008.
5) Leung, L.R., Hamlet, A.F., Lettenmaier, D.P. and Kumar, A. : Simulations of the ENSO Hydroclimate Signals of the Pacific Northwest Columbia River Basin, *Bull. Am. Met. Soc*. Vol 80(11), pp. 2313-2329, 1999.
6) McBride J.L., and Nicholls, N. : Seasonal relationship between Australian rainfall and the Southern Oscillation, *Mon. Weather Rev.*, Vol. 111, pp.1998-2004, 1983.
7)Ropelewski, C.F. and Halpert, M.S. : Global and regional scale precipitation patterns associated with the El Niño/Southern Oscillation, *Mon. Weather Rev.*, Vol. 115, pp.1606-1626, 1987.
8)Ropelewski C.F. and Halpert, M.S. : Precipitation patterns associated with the high-index phase of the Southern Oscillation, *J. Climate*, Vol. 2, pp.268-284, 1987.
9) Zubair, L.: Sensitivity of Kelani streamflow in Sri Lanka to ENSO, *Hydrol. Processes,* Vol. 17, pp.2439-2448, 2003.
10) Wang, G. and Eltahir, E. : Use of ENSO Information in Medium and Long-Range Forecasting of the Nile Floods, *J. Climate,* Vol.12. pp.1727-1737, 1999.
11)Cane, M.A., Zebiak, S.E., E. and Dolan, S.C. : Experimental forecasts of El Niño. *Nature*, Vol. 321, pp. 827-832, 1986.
12) Zebiak, S.E. and Cane, M.A. : A model El Niño-Southern Oscillation, *Mon. Weather Rev.*, Vol. 115, pp. 2262-2278, 1987.
13) Lyon, B., H. Cristi, E. R. Verceles, F. D. Hilario, and R. Abastillas: Seasonal reversal of the ENSO rainfall signal in the Philippines, *Geophys. Res. Lett.*, Vol. 33, L24710, doi:10.1029/2006GL028182, 2006.
14) Estoque, M.A., and Balmori, R.T.F. : Predictability of Droughts and Floods due to El Niño and La Niña episodes, *Report No.6 Climate Studies Division, Manila Observatory, Philippines*, 2002.
15) Wang, L.: Development of a Distributed Runoff Model coupled with a Land Surface Scheme, *PhD Thesis*. University of Tokyo. Tokyo, 2007.
16) Wang, L. and Koike, T. : Comparison of a Distributed Biosphere Hydrological Model with GBHM. *Ann. Jour. Hydraul. Eng.-JSCE,* pp.103-108, 2009.
17) Wang, L., T. Koike, K. Yang, T. J. Jackson, R. Bindlish, and Yang, D. : Development of a distributed biosphere hydrological model and its evaluation with the Southern Great Plains Experiments (SGP97 and SGP99), *J. Geophys. Res.*, Vol. 114, D08107, doi:10.1029/2008JD010800, 2009.
18) Wang, L., Koike, T., Yang, K., and Yeh, P.J. : Assessment of a distributed biosphere hydrological model against streamflows and MODIS land surface temperature in the upper Tone River Basin. *J. Hydrol.* Vol. 377, pp.21-34, 2009.
19) Berri, G.: The Influence of ENSO in the Flows of the Upper Parana River of South America over the Past 100 years. *J. Hydromet.*, Vol.3, pp. 57-65, 2002.
20) Cruz, R.V.O., Lasco, R.D., Pulhin, J.M., Pulhin, F.B., and Garcia, K.B. : Assessment of Climate Change Impacts, Vulnerability and Adaptation: Water Resources of Pantabangan-Carranglan Watershed, Working paper of AIACC-AS21: www.enfor.com.ph), 2006.
21) Myneni, R.B., Nemani,R.R. and Running, S.W. : Estimation of global leaf area index and absorbed par using radiative transfer models. *IEEE T. Geosci. Remote*, Vol. 35, pp.1380-1393, 1997.
22) USGS: HYDRO1k Elevation Derivative Database http://edc.usgs.gov/products/elevation/gtopo30/hydro/index.html, Accessed 2009.
23)FAO: Digital soil map of the world and derived soil properties, Land and Water Digital Media Series Rev. 1, United Nations Food and Agriculture Organization, CR-ROM, 2003.
24) Nash, J.E. and Sutcliffe, I.V. : River Flow Forecasting through Conceptual Models Part I – A discussion of Principles, *J. Hydrol,*. Vol. 10, pp.282-290,1970.
25) PIDS: Philippine Institute for Developmental Studies. Surian sa mga Pagaaral Pangkaunlaran ng Pilipinas. Economic Issue of the Day. El Niño/La Niña, *PIDS,* Vol.VII(1), 2007.
26) PAGASA database: General conditions during ENSO, http://wb.pagasa.dost.gov.ph/index.php?option=com_content&task=view&id=154&Itemid=126, Accessed 2009.

(Received September 30, 2009)