5. Philippine Water Resource Systems and Water Related Disasters

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Ⅰ. INTRODUCTION

The Philippines by virtue of its geographical location and archipelagic structure is blessed with an abundance of water resources. The average annual rainfall from cyclonic, convective, frontal and other natural processes is on the average, 2,400 mm. Of this, the NWRB[1] estimates that 1,000 - 2,000 mm are collected as surface runoff by more than 4,000 principal rivers, 59 natural lakes and innumerable small streams. There are also extensive but yet unmapped groundwater aquifers with an estimated total area of about 50,000 sq. kms. The approximate storage and annual recharge of these saturated, rock-soil formations are in excess of 1.2 trillion cubic meters and 31.5 billion cubic meters per year respectively.

Alejandrino (1999) stated that while the estimated average annual availability (based on total renewable supply) of 4,000 cubic meters per capita in 1998 and 3,200 cubic meters per capita in the year 2025 exceeds the threshold per capita need of 1,000 cubic meters per year, the 'rise in population, urbanization and industrialization has put tremendous pressures on available water supply'. For instance, the intensive and extensive use of groundwater for agriculture, residential and industrial uses has already resulted to irreversible decline in water tables and piezometric levels in some of the most heavily populated, urbanized and industrialized areas of the country : Regions IV (Cavite and MetroManila), VI (Iloilo), and VII (Cebu). There have been reports that this resource depletion is responsible for salt water intrusion and/or land subsidence in the aforementioned areas.

The ongoing, unmitigated, regulated conversion of agricultural lands for human settlements, industrial and other uses is among the most significant landuse change affecting the country. In combination with recurring, atmospheric-oceanic aberrations associated with global climate like the El Niño phenomenon, increased demand and widespread pollution/degradation of surface water resources, landuse change has caused observable shifts in water utilization patterns with drastic effects on available water supply and natural balances.

This paper attempts to present the state of water resources development in the Philippines and the adverse effects of recurring natural events as floods and drought.

Ⅱ. OBJECTIVES OF THE PAPER

Specifically, the paper aims to collect/compile, and present general information on water resources systems development in the Philippines to meet various demands for irrigation, household use, power generation and flood control. In addition, the paper presents the factors why the country has had many disaster cases of flood and drought occurrences.

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III. INSTITUTIONAL FRAMEWORK FOR WATER RESOURCES DEVEL OPMENT IN THE PHILIPPINES

A. Overview of Land and Water Sector Policies and Strategies

Water resources development policies and strategies are formulated and approved at several levels of government (Alejandrino, 1999). At the national level, is the National Economic and Development Authority (NEDA) Board, with the President of the Philippines as Chairman. The NEDA Board on January 20, 1975, approved Resolution No. 20, Series 1975 adopting "the following policies regarding the control, conservation, development, and utilization of the water resources of the country :

1. The authority and responsibility for the control, conservation, development, and utilization of the water resources of the country belong to the State. These water resources include, among others, groundwater, surface water, and water in the atmosphere.
2. Priorities in the use of water and in the development of water resources shall reflect current usages of water and shall also be responsive to the changing demands for water which occur under developing conditions, taking into consideration the health and welfare of the people.
3. All water resources development projects shall be undertaken on a multi-purpose concept using the river basin, or closely related river basins approach. Single-purpose projects shall only be implemented when they are compatible with the multi-purpose concept and can be incorporated into the contemplated basin wide development program.
4. Identifiable beneficiaries of water resources development projects shall bear an equitable share of repayment costs commensurate with the beneficial use derived from the project.
5. Continuing program for basic data collection, manpower development and research shall be maintained since these are indispensable components of water resources development.

The National Water Resources Council (now the National Water Resources Board) shall formulate the guidelines, procedures, programs, rules, and regulations to implement the policies on water resources."

Alejandrino (1999) notes "water sector issues are considered at the Cabinet Cluster G (Water Management Cluster) which serves as the advisory committee of the President and the Cabinet on all matters relating to water resources management. Specialized committees and subcommittees are generally created to address specific sub-sector issues on water supply, irrigation, hydropower, flood control, etc."

B. Assessment of the Philippines Water Resources Sector

The National Water Resources Council (now the NWRB) conducted the first national assessment of the water and related resources of the country in 1975 under a UNDP grant. With presidential authority, the NWRC divided the country into 12 water resources regions based on the hydrological boundaries defined by topographic features and homogeneity in climate. These water resources regions generally correspond to the country's political regions with the exception of ARMM, CAR, and CARAGA.

The assessment reports contained in over 40 framework plans according to major river basins in the twelve water resources regions, indicated that the Philippines has more than adequate surface and groundwater water resources to meet projected aggregate demand for agriculture, industry and domestic use up to the year 2000. The estimated volume of renewable surface water alone is almost twice the projected withdrawal.

Alejandrino (1999) noted the following deficiencies of the assessments :

1) the estimates of surface water were based on gage data that were not corrected for upstream diversions and other artificial influences
2) groundwater recharge was based on 10 % of annual rainfall infiltrating and permeating into the aquifers. There is really no

research-based basis for the use of the proportionality factor..

3) some of the river basin assessments are no longer valid as in the case of the Pampanga river basin which has been altered by the eruption of Mt. Pinatubo in 1991.
4) the estimates of safe yield from groundwater in the Pampanga river basin approximated the dependable surface water flow. This means that total extraction levels will be equivalent to groundwater 'mining' and progressively lower static water levels.
5) that average surface runoff (50% exceedance probability) is much larger than dependable flow (80% exceedance), suggests that most river discharge in the basin are due to flood flows.

A second water resources assessment is needed to update/refine the estimates made by the first assessment. The availability of new and powerful computer models and software as geographic information systems (GIS) and the opportunity offered by data at the turn of the century can validate the original NWRC projections of availability and demand. On the other hand, the default of concerned government institutions to invest in hydrologic data monitoring systems (streamflow gaging and groundwater observation networks) over the last 25 years will preserve the problem of data inadequacy and low reliability for forecasting purposes. The next water resources assessment should also include the a) the demarcation of the boundaries, at least of the major groundwater basins ; b) effects of water quality on availability and use.

A parallel effort should be undertaken by the PAGASA on the re-definition of the country's climatic zones based on recorded data over the past 20 years. The effects of global warming on local climates, the more frequent and intense oceanic-atmospheric phenomena as the El Niña and La Niñb should be inputted in the re-characterization of the Philippines climatic environments.

C. Major Water Resource Systems in the Philippines

1. Upper Pampanga River Multi-purpose System (UPRMS)

The UPRMS Pantabangan Dam is located in Pantabangan town in the province of Nueva Ecija some 120 kilometers north of Metro-Manila. The system which has a total reservoir capacity of about 3 BCM was designed by the American firm Engineering Consultants Inc. (ECI) and the Philippine consulting firm Engineering Development Corporation of the Philippines (EDCOP) to irrigate around 108,000 has. of lowland rice during the dry season. Over-estimation of the dry season flows of the Pantabangan and Carranglan rivers, which feed the reservoir, resulted to an over-designed dam. Conservation storage levels are consistently below expected elevations since the reservoir began filling up in 1977. The planning team which recommended the dam capacity and infrastructural design failed to take into account the relatively small dam watershed (84,000 has.) viz-a-vis the target service area. The source to point of use area ratio is less than unity when acceptable rule-of-thumb ratios is between 2 and 4. Consequently, the potential irrigated area and power generation output of 200 MW has never been serviced/attained.

A water augmentation scheme for the Pantabangan reservoir was also implemented during the period of main dam construction. The Canili and Diayo dams at the Aurora-Quirino watersheds upstream and adjacent to the Pantabangan reservoir watershed were built to provide supplemental dry season inflows for the Peñranda Irrigation System. A 5 to 6 meter wide transbasin channel was also constructed to divert water released from the twin reservoirs to the Digoliat River, which is a tributary of the Pantabangan R.

The multi-purpose system is jointly operated by the National Irrigation Administration (NIA) and the National Power Corporation (NPC).

2. Casecnan Multi-Purpose System (CMPS)

The CMPS is a private sector undertaking led by the American energy development company, MidAmerican Energy Holdings thru a local subsidiary, CalEnergy Casecnan Water and Energy Co. The firm invested US $ 700 M in constructing all project infrastructure. The Philippine government is a financing partner of the said company. The CMPS also aims to augment the water levels of the Pantabangan Dam for irrigation and hydrolectric power generation. The CMPS is already operational and transfers water impounded water from the Casecnan and Taan Rivers thru a 26 km tunnel to a power generation plant which can generate 150 MW and then to the Pantabangan Dam via a river tributary of the Pantabangan River. With the water augmentation, the UPRMS will be able to irrigate 108,000 has during the dry season and generate up to 200 MW of power.

3. Magat River Multi-purpose System (MRMS)

The MRMS is centered on the Magat Dam located in Ramon Isabela, some 350 kilometers north of Metro-Manila. The system reservoir which has a total storage capacity of 1.25 BCM and a lake area of 45 sq. kms at full supply level, was designed and constructed by the associated firms of ECI of Denver, Colorado, SECO of Montreal Canada, EDCOP and DCCD of Makati Philippines in the 1970's. The system has a potential irrigable area of 102,000 hectares of rice lands in Nueva Vizcaya and Isabela provinces. Furthermore, it has an installed hydroelectric capacity of 360 megawatts and an additional capacity of 180 MW that can be diverted to the Luzon Grid meet the energy demands of Central Luzon and Metro-Manila.

4. Angat River Multi-purpose System (ARMS)

The ARMS is located in Norzagaray, Bulacan province, about 60 kilometers north of MetroManila. The Angat Dam collects the flow of the Angat River, which drains the western flank of the Sierra Mountain Range. The reservoir water provides irrigation water to some 50,000 hectares of rice land in Bulacan. A main powerhouse generates 212 MW of electricity and is distributed thru the Luzon Grid. Moreover, the dam diverts water to the Ipo Dam which supplies water to the La Mesa Dam which supplies water to the Metro-Manila area.

5. Agus River Hydrolectric System (ARHS)

The Agus RMS is a series of hydroelectric plants along the Agus River complex located in the provinces of Lanao del Norte and Lanao del Sur in Mindanao. The Agus River which is the only outlet of Lake Lanao, the second largest lake in the Philippines flows north for a distance of some 37 kilometers before discharging into Iligan Bay. Along this river length are seven (7) hydroelectric plants (Agus I to Agus VII) generating a total of about 435 MW. The largest of these plants is Agus VI located near the Maria Cristina Falls. It has five turbine-generator units with a total output of 200 MW. The smallest hydroelectric plant is the Agus VII, located downstream of the Agus VI. It was constructed at the most downstream site of the Agus River, which discharges into Iligan Bay. The Agus VII generates 54 megawatts of electricity. The ARHS is under the direct control and management of the NPC.

6. San Roque River Hydroelectric Project (SRHP)

The SRHP is located at the Boundary of San Manuel and San Nicolas municipalities in Pangasinan Province and Itogon town in Benguet Province in Northern Luzon. When completed this year at a cost of US $ 1.2 B, it will be the largest private hydropower project in Asia and 11th highest in the world. It is 41 percent owned by the Japanese trading firm Marubeni ; 51 % by the American energy company Sithe Energies and the rest by the Japanese utility company Kansai Electric. The 200-meter high dam, which will store the inflow of the San Roque River, is capable of generating up to 345 megawatts of power that will be distributed to the Luzon grid.

IV. FLOOD AND DROUGHT OCCURRENCES

The geographical location of the Philippines in the tropics at approximately 14° N latitude and 121° E longitude (Figure 1) is the principal reason for its susceptibility to water related disasters. The archipelago of more than 7,100 islands are at the natural trajectory of tropical cyclones born in the Western Pacific and South China Sea. The problem is exacerbated by sweeping, population-driven land use change and unregulated logging

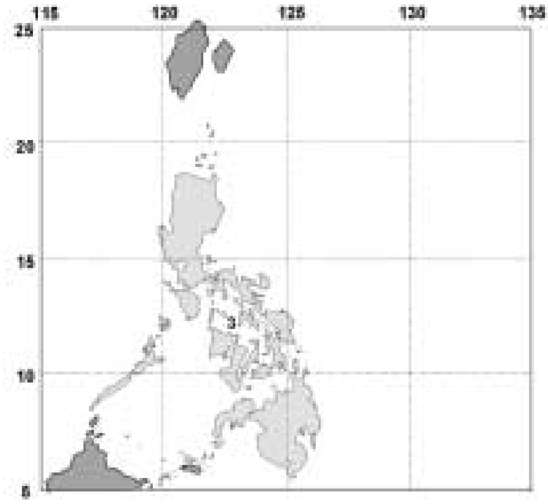

Figure 1 Map of the Philippines

that has a) reduced forest cover from as high as 15 M hectares in the 1950s to less than 1 M hectares today ; b) increased urbanization and industrialization which has significantly altered watersheds by infrastructure development on tributaries of large river systems that carry flood discharge and c) polluted river waters and /or induced seawater intrusion to groundwater aquifers.

A. Floods

On the average, twenty (20) tropical storms pass near or thru the country each year (Table 1 and Figures 2 to 4). Most of these weather disturbances, from tropical depressions (wind speeds up to 63 kph) to powerful typhoons (wind speed > 118 kph) occur from May to December. Figures 5 and 6 show some typical tropical storm tracks through the Philippines. The inter-tropical convergence zone (ICTZ) a migratory rainy band of cloudiness that oscillates north to south of the equator and the Southwest Monsoon a moisture-laden air mass that intensifies from May to November, combine with tropical storms to account for most of the 2,400 mm mean annual rainfall that the Philippines receives. La Niño episodes are associated with above average rainfall patterns in many places in the Philippines and sometimes follow El Niño episodes (The 1997-98 El Niño was followed by the 1998-99 La Niño). When such events take place during the rainy season, extensive floods in low-lying areas in Central Luzon, Mindanao and Metro-Manila destroy crops, homes, roads, bridges and takes its

Table 1 Monthly Frequency of Tropical Cyclones in the Philippine Area of Responsibility (PAR) from 1948 to 1988. Source : Climate of the Philippines, Philippine Atmospheric, Geophysical and Astronomical Services Administration, 1984

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1948	1	0	0	0	1	0	3	2	3	2	6	3	21
1949	1	0	0	0	0	2	5	2	4	3	3	2	22
1950	0	0	0	0	0	2	2	1	3	2	2	1	13
1951	0	0	0	1	0	1	1	4	2	1	1	2	13
1952	0	0	0	0	0	5	2	3	4	4	4	4	26
1953	1	1	0	0	1	2	0	5	2	2	3	2	19
1954	0	0	1	0	1	0	1	6	2	3	3	1	18
1955	1	1	0	1	0	0	2	3	1	4	1	1	15
1956	0	0	1	2	0	0	4	4	5	1	5	3	25
1957	2	0	0	1	0	2	1	2	3	3	1	0	15
1958	1	0	0	0	0	1	4	2	4	2	3	0	17
1959	0	1	1	0	0	0	1	4	2	4	3	2	18
1960	1	0	0	1	1	2	2	6	1	3	0	2	19
1961	1	1	1	0	1	3	4	4	4	1	1	2	23
1962	0	1	0	0	2	0	4	6	4	1	3	0	21
1963	0	0	0	0	1	3	4	2	3	1	0	2	16
1964	0	0	0	0	2	1	9	5	5	3	3	1	29
1965	2	1	1	0	2	2	6	2	3	1	1	0	21
1966	0	0	0	1	3	1	7	1	3	2	2	2	22
1967	0	1	1	1	1	2	4	5	0	2	3	1	21
1968	0	1	0	0	0	2	2	3	3	1	3	0	15
1969	0	0	0	1	1	0	4	2	4	1	2	0	15
1970	0	1	0	0	0	3	2	4	4	4	2	1	21
1971	1	0	1	3	3	2	5	2	3	5	2	0	27
1972	2	0	0	0	0	2	4	2	4	1	1	1	17
1973	0	0	0	0	0	1	2	3	2	3	1	0	12
1974	1	0	0	0	0	3	4	4	2	5	2	2	23
1975	1	0	0	0	0	0	1	3	3	3	2	1	14
1976	1	1	0	1	1	3	3	3	4	0	2	3	22
1977	1	0	0	0	1	1	4	2	4	2	2	2	19
1978	0	0	0	1	0	3	1	7	6	4	2	1	25
1979	0	0	1	1	2	1	3	3	3	4	2	2	22
1980	0	1	1	1	5	2	1	3	2	2	3	1	22
1981	0	1	0	0	0	3	5	4	3	2	3	2	23
1982	0	0	2	0	1	0	5	4	4	3	0	2	21
1983	0	0	0	0	0	0	3	3	4	6	4	3	23
1984	0	0	0	0	0	1	2	8	1	4	3	1	20
1985	1	0	0	0	1	2	2	3	4	3	0	1	17
1986	0	1	0	1	1	2	3	2	1	4	3	3	21
1987	1	0	0	0	0	1	4	3	2	2	2	1	16
1988	1	0	0	0	1	3	3	0	3	6	2	1	20
TOTAL	21	13	11	17	33	64	129	137	124	110	91	59	809
MEAN	0.5	0.3	0.3	0.4	0.8	1.6	3.1	3.3	3	2.7	2.2	1.4	**19.7**

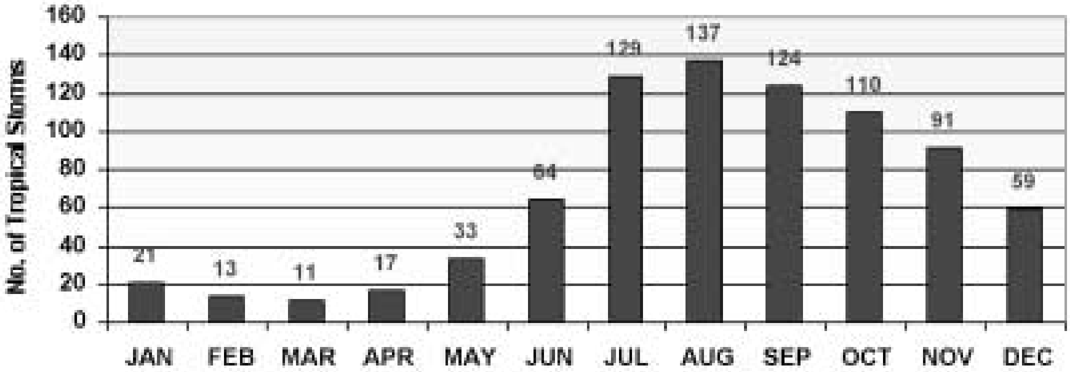

Figure 2 Total Monthly Number of Tropical Storms Passing Thru PAR, from 1948 to 1988 (Source : PAGASA)

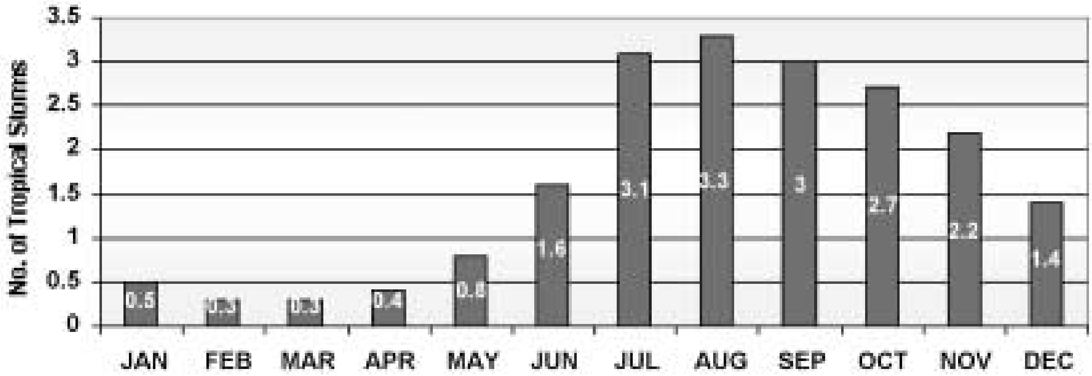

Figure 3 Mean Monthly Frequency of Tropical Storms in PAR, from 1948 to 1888 (Source : PAGASA)

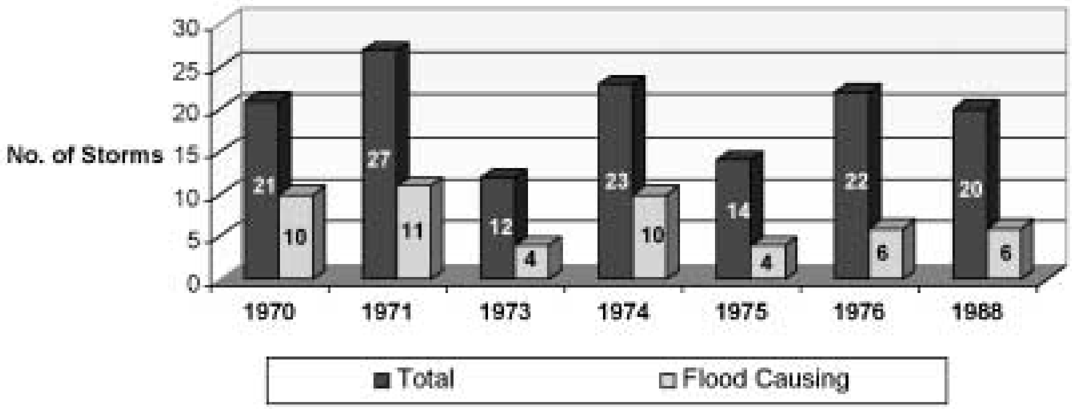

Figure 4 Total Number and Flood Causing Tropical Storms Passing Thru the Philippines in Selected Years

toll on human lives. High soil loss rates (from 50 to 100 tons per hectare per year) in denuded watersheds are deposited as siltation in river systems and flood plains and cause sedimentation in reservoir-based multi-purpose systems.

From July 6 to August 13, 2002, monsoon rains induced by Typhoon Gloria (International Code Name : Chataan), Tropical Storm Hambalos (ICN : Nakri), Typhoon Inday (ICN : Halong), Tropical Depression Juan (ICN : 13W) and Tropical Depression Milenyo (ICN : 18W) caused extensive flooding in Metro Manila, Central Luzon, Northern Luzon, Southern Luzon

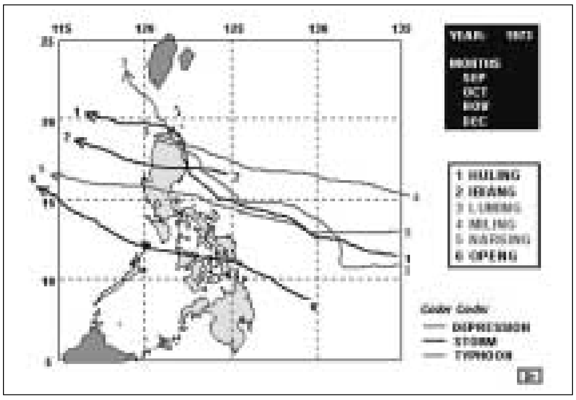

Figure 5 Tropical Storm Paths, January - August, 1973

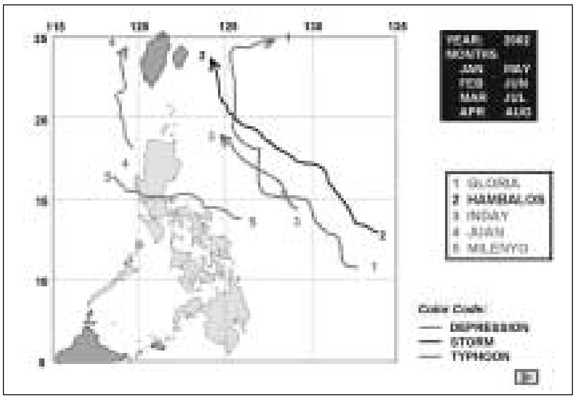

Figure 6 Tropical Storm Paths in the Philippines, July and August, 2002

and Western Visayas. The cyclones forced the suspension of classes at all levels, shut down nearly all government offices and stranded thousands of commuters. The floods left more than 85 people dead, destroyed asphalt roads and caused a lot of inconvenience in many cities and towns.. On the other hand the heavy rainfall was welcomed by farmers of agricultural lands parched by the long dry spell of the previous months. It may have also ended the El Niño - associated dry season in the country.

Official estimates of flood and wind-caused damage during tropical storm events in the Philippines are difficult to obtain. Unlike droughts, which primarily cause crop failures, floods also destroy various infrastructure, private property and take human lives. Conceivably, the economic losses could be much higher. For the tropical cyclones of July, 2002, estimates of agriculture damage by the Department of Agriculture as reported in the Philippine Star (July 10) totaled P94.2 M or US$ 1.8 M broken down as :

1. 19,481 tons of palay lost in 20,052 hectares worth P 40.6 M
2. 14,505 metric tons of corn lost in 4,540 hectares worth P34.7 M
3. Fisheries: P 9.8 M
4. Livestock: P4.0 M
5. Others (vegetables and coffee) : P5.1 M

Revised estimates made by the Philippine Daily Inquirer (July 15) put total damage at P400M (US $8M). Water levels at the Angat Dam, rose from the critical 179.0 m level before July 6, to 197.0 m on July 21. The Ipo Dam which receives water from the Angat Dam had to spill 4 MCM to avoid being overtopped. This aggravated the flooding in some same towns downstream (Philippine Star, July 22, 2002).

B. Droughts

Drought events in the Philippines has only recently been understood as associated and caused by the El Niño phenomenon which occurs on the average, every 4 to 5 years. Up to this year, Table 2 shows that the Philippines has had eleven (11) El Niño episodes, the worst being the 1982-83 and 1997-1998 events which caused massive crop failures and water shortages in the Metro-Manila area. Aggregate rice and corn production loss in more 450,000 has in 1983, were estimated at P 770M (US$100M at that time). Drought conditions affected 16 % of the country, notably, the Central Visayas provinces and Northern Mindanao.

The 1997-98 El Niño caused a dramatic decline in rice and corn production of 43% and 27% respectively, the lowest in last 20 years. Coconut production dropped by 10%. The largest losses of P7.24B (US 240M at the time) were incurred by the fisheries sector when freshwater fishponds dried up in Central Luzon and Western Visayas. Hydroelectric power production dropped by 9%. To compensate for the reduction, thermal power production used up an additional 300,000 - 400,000 barrels of fuel oil.

A total of 9,400 hectares of secondary and logged over forests burned during the drought

Table 2 COMPARATIVE ANALYSIS OF ANNUAL RAINFALL DURING EL NIÑO YEARS, LA NIÑA YEARS, YEARS AFTER EL NIÑO AND NORMAL YEARS

Water Year	Classification of Year	No. of Stations With Rainfall Increase	No. of Stations With Rainfall Decrease	No. of Stations With No Rainfall Change	Total Stations
Oct 98 - Sept 99	La Niña	N.A.	N.A.	N.A.	N.A.
Oct 97 - Sept 98	El Niño	N.A.	N.A.	N.A.	N.A.
Oct 96 - Sept 97	Normal	N.A.	N.A.	N.A.	N.A.
Oct 95 - Sept 96	Normal	27	12	3	42
Oct 94 - Sept 95	Year after El Niño	9	34	3	46
Oct 93 - Sept 94	El Niño	38	5	2	45
Oct 92 - Sept 93	Year after El Niño	5	43	0	48
Oct 91 - Sept 92	El Niño	6	42	0	48
Oct 90 - Sept 91	Normal	14	25	3	42
Oct 89 - Sept 90	Normal	12	32	1	45
Oct 88 - Sept 89	La Niña	46	3	0	49
Oct 87 - Sept 88	Year after El Niño	9	37	1	47
Oct 86 - Sept 87	El Niño	9	37	0	46
Oct 85 - Sept 86	Normal	31	13	0	44
Oct 84 - Sept 85	Normal	35	9	1	45
Oct 83 - Sept 84	Year after El Niño	26	21	1	48
Oct 82 - Sept 83	El Niño	3	44	0	47
Oct 81 - Sept 82	Normal	24	17	0	41
Oct 80 - Sept 81	Normal	15	23	1	39
Oct 79 - Sept 80	Normal	13	31	0	44
Oct 78 - Sept 79	Year after El Niño	15	24	1	40
Oct 77 - Sept 78	El Niño	5	36	1	42
Oct 76 - Sept 77	Normal	20	18	4	42
Oct 75 - Sept 76	La Niña	28	14	1	43
Oct 74 - Sept 75	Normal	27	11	0	38
Oct 73 - Sept 74	La Niña	34	10	0	44
Oct 72 - Sept 73	El Niño	4	39	2	45
Oct 71 - Sept 72	Normal	41	2	0	43
Oct 70 - Sept 71	La Niña	32	8	1	41
Oct 69 - Sept 70	El Niño	10	29	2	41
Oct 68 - Sept 69	Normal	6	36	1	43
Oct 67 - Sept 68	Normal	9	32	0	41
Oct 66 - Sept 67	Year after El Niño	27	14	0	41
Oct 65 - Sept 66	El Niño	13	29	0	42
Oct 64 - Sept 65	La Niña	32	8	1	41
Oct 63 - Sept 64	El Niño	10	28	3	41
Oct 62 - Sept 63	Normal	9	33	1	43
Oct 61 - Sept 62	Normal	33	7	1	41

causing an estimated damage of P150M (US $5M).

The drop to critical water levels in the Multi-purpose Angat Dam caused widespread water rationing in Metro Manila. With the lack of drinking water and the prevalence of unsanitary conditions there were outbreaks of diarrhea, cholera, dengue, H-fever and malaria in the poorer sectors of the densely populated metropolis.

This year, 2002, El Niño warnings have already been issued thru the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) since January. The Department of Agriculture, requested and received from the national government an additional P1 B appropriation for drought mitigation activities such as the development / installation of more shallow tube wells in rice production areas, rain-making and water conservation measures. Newspapers (Philippine Star and Philippine Daily Inquirer, June 30 and July 1 issues) monitored the drop to critical water levels at the reservoirs of the Upper Pampanga River Multi-purpose System and the Angat River Multi-purpose System. The latter is the main source of domestic water supply for Metro-Manila. The loss in hydroelectric power generation at the two systems will again result to more fuel oil importation for thermal power plants to fill the baseload gap.

Table 2 shows the pattern of Normal, El Niño and La Niña years from 1962 to 1998.

V. Problems in Water Resources Development and Flood Control

A. Irrigation

1. The high cost of irrigation development

Large-scale gravity irrigation development is unavoidably expensive because of the need for headworks infrastructure and service area distribution systems. Storage reservoirs/diversion dams require detailed geo-technical and structural engineering and years of feasibility studies, bidding and construction work. Only the national government with funds sourced from the national treasury and/or international financing institutions can afford such development projects. Over time, the cost of national and communal irrigation projects, particularly those with large service areas, e.g., greater than 1000 hectares have escalated primarily due to economic inflation. The cost of such systems now range from P70,000 to P200,000 per hectare while rehabilitation costs may vary from P8,000 to P50,000 per ha.

In contrast, small system development based on shallow tube wells and low-lift pumps will cost one farmer anywhere from P7,000 to P45,000 per ha. Exclusive of (drilling costs) depending on the choice of pump set and credit scheme. (David, 2000). While the costs of STW and LLP irrigation are smaller than for reservoir or diversion dam irrigation, the relative costs to individual farmers may still be high given that their capacity to pay for irrigation equipment is limited by small disposable incomes and the considerable risks involved in farming due to climate and the likelihood of crop pests and diseases.

Shallow tube wells have been proven to be adequate sources of irrigation water during the dry season and during periods of drought caused by El Niño events. The P 1B (US $50 M) El Niño amelioration fund appropriated for the Department of Agriculture during the first half of 2002 was largely for shallow tube well development.

2. Private sector participation

The greater efficiency and effectively of the private sector in developmental activities relative to government agencies are desirable attributes that are potentially applicable in increasing the coverage of irrigated agriculture and improving the delivery of irrigation services. David (2000) reported that more than half a million hectares of land now irrigated by STWs and LLP’s comprise privately-owned irrigation systems. It is the now the fastest growing sector in irrigated agriculture. Crop yields and cropping intensities in private systems are also higher than in systems managed by the NIA and/or farmer water users associations. While informal suggestions to privatize the NIA as an equivalent utility agency as the NPC, and the MWSS, may still be a distant priority of government authorities, it deserves a serious consideration, given the long and continuing dismal record of the public sector in managing our national and communal systems.

3. Fragmentation of irrigation development activities

The empowerment of many government agencies - NIA, BSWM, DA-RFUs, DAR and LGU's for involvement in irrigation development, the quasi-independent status of the aforementioned agencies and the lack of an overall policy/framework for the country to achieve full irrigation by a certain target year, are contributory factors to the prevailing environment where there is a fragmentation of irrigation development efforts within the public sector. That there are specific agency turfs is for instance, verifiable in the assignment to the BSWM of the authority to develop small water impounding projects (SWIPs) and of small farm reservoirs (SFRs). The DA-RFUs have been entrusted with the development of STWs and SWIPs while the NIA is largely concerned with medium and large gravity irrigation systems (service areas > 1000 has.).

B. Power Generation

The development of water resource systems for power generation is the function of the National Power Corporation (NPC). The primary constraints to developing such systems are :

1) the huge development costs - it takes billions of pesos to design and construct hydro-electric power generation systems of the scale of those at Angat, Magat and Pantabangan dams. One such system could take more than ten years to build and will require enabling legislation to authorize. Also, foreign loans are needed to finance the actual design and construction/installation of all the needed infrastructure and equipment.
2) There are alternative, less expensive systems for power generation as oil or coal-fired thermal plants, and geothermal systems
3) There is a present oversupply of electricity in the country. Supply will exceed power demand even within the next 5 years.
4) There is a limited number of topographically and geologically favorable sites in the Philippines for large dams to store water for power generation (NWRC, 1977).

C. Flood Control

Flood control is always integrated into the design of large multi-purpose systems by way of dam provisions for flood storage. On the other hand, there is not always enough protection against rainfall events of large return periods. Recent experience in the case of the Angat Dam shows that rainfall from the combined effects of a tropical cyclone and induced Southwest monsoon in 1998 was only a about a 20-year event. Yet emergency spills from the dam was unavoidable and may have caused the death of a number of people along the Angat River downstream of the Dam.

Lahar deposits from the eruption of Mt. Pinatubo in 1991, has also permanently altered the topography of the watersheds along its eastern and western slopes. The watersheds of Abacan River and the Sacobia-Bamban Rivers on the southeastern slopes of the volcano have been overwhelmed by lahar deposits in such a way that the elevation of the channel beds of the many tributaries of the two river systems are now even higher than the old river banks. As a consequence, the natural flow of flood waters have been altered to spread and be directed to relatively, low-lying areas. Unfortunately these areas are many towns in Pampanga and Tarlac provinces. The reduction in the flood-carrying capacities of the affected rivers will cause perennial flooding in these municipalities for many years in the future. Fortunately, the dredging of rivers have began in the affected Central Luzon provinces. But because of the enormous volumes of the lahar deposits to remove, it will take many years before their flood carrying capacities are restored to pre-eruption levels.

In Metro-Manila, flooding is exacerbated by an antiquated and inadequate sewer system. Since the 1950's, many of the small creeks/tributaries of the Pasig and Marikina Rivers - the principal drainage ways, have disappeared. Over the lengths of these small streams are now residential houses, buildings and other commercial establishments. Moreover, the embankments of the remaining streams/creeks are heavily populated with squatter houses and serve as solid waste (garbage) dumpsites of an undisciplined public. Thus, during the rainy season, the reduced capacity of the cities' rivers lead to flash floods. The underground sewers, often clogged with non-biodegradable debris and trash also are of little help despite the installation of flood discharge pumping stations at strategic points in the metropolitan areas.

VI. THE ROLE OF AGRICULTURAL EDUCATION IN INCREASING AWARENESS OF THE IMPORTANCE OF WATER RESOURCES DEVELOPMENT AND MANAGEMENT TO MITIGATE THE EFFECTS OF FLOODS AND DROUGHTS

Agricultural education has an important role to play in understanding the country's climatologic heritage, the interaction of hydrology and land-use change and the institutional framework which serves as the basis for water resources development and management for specific uses. In the Philippines, agricultural education as defined by the Commission for Higher Education (CHED), embraces the academic disciplines of agriculture, forestry, veterinary medicine, fisheries and agricultural engineering. It is under the undergraduate and graduate programs of agriculture, agricultural engineering and forestry that issues related to floods and droughts are discussed. In a way, this has increased public awareness of the impacts of floods and droughts on the country's economic well-being among professionals of the said discipline, particular those employed in state universities and colleges and government agencies as those in the Department of Agriculture, the Department of Science and Technology and the Department of Environment and Natural Resources.

At least as far as agricultural education is concerned, public sensitivity to floods and drought has resulted in the following :

A. Drought Alleviation
1. Better understanding of the El Niño Phenomenon
2. Water conservation measures during the dry season in agriculture and metropolitan areas
3. Installation of more shallow tubewells for irrigation
4. Crop insurance

B. Flood control
1. Improvement of municipal storm sewer systems
2. Dredging of principal rivers
3. Operational flood warning systems
4. Improved weather forecasting
5. Crop insurance

But being informed and being able to cope with such natural exigencies however, are two distinct matters. It is unfortunate that up to now, there are no pro-active public or private sector programs in place to address a potentially damaging flood or drought situation in the Philippines (as those which devastated Austria, Germany, Czechoslovakia this August, 2002). Government institutions only react to such events when they occur. There is not enough political will yet to develop long-term solutions because the economic and socio-political costs are prohibitive.

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PHILIPPINES : DISCUSSION

Question : Could you explain some programs of watershed management for flood and drought control, soil and water conservation? Are they successful?

Answer : There are reforestation projects in natural watersheds particularly in large reservoir-based water resource systems as the Upper Pampanga River System, Magat River System, Angat River System etc. Unfortunately, the reforestation projects are only 50% successful. There is more success against drought control measures as shallow tube wells from groundwater aquifers provide supplementary irrigation water to rice and corn production areas.

Question : What kinds of countermeasures are being done for drought problems in the Philippines?

Answer : a). We have developed an extensive network of shallow tube wells in irrigated areas for water augmentation. b). We have tried to develop field methods of rice production that will not require flooding during transplanting and early cultivation. c). There is now crop insurance available against possible drought that will enable farmers to recover production costs if drought occurs.

Question : Could you mention some of the non-structural measures for the flood damages in the Philippines?

Answer : Unfortunately, there are a few if not many structural measures in place. Flood zoning projects that remove people from flood prone areas are political and socially unacceptable at present.

Question : If we had the tools available to determine the economic value of ecosystem services provided by water resources and the costs associated with the long-term depletion of land and water resources (water disasters) do you think we would be able to influence government policies concerning exploitation and the need to spend money for the countermeasures?

Answer : Definitely. Such tools will generate timely, relevant data for policy making and project planning for land and water resources development. Many of our top-level decision makers in the government are unaware of the high cost or economic value of ecosystem services. More importantly, if people are made aware of the relative values of water for domestic use; water for irrigation; water for power generation, then perhaps they will appreciate the need for resource conservation and not be profligate users at present.

Question : On table 2 you indicated some rows as year after El Nino, and not always the case for every El Nino years. Could you explain more the conditions describing this identification?

Answer : The rows indicate years from the most recent (upper rows) to least recent (lower rows). Some years after El Niño years are La Niña years.

Question : What is the current rate of rice yields in the Philippines? Is there any improvement in this last decade or otherwise? What is the biggest potential productivity of rice production and at what land and water conditions?

Answer : The national average now is 3 to 4 tons/ha. Which is an improvement from the national average of 2 to 3 tons/ha about 10 years ago.

Question : Do you anticipate any food security problems for the country?

Answer : Yes, we will be a rice importer for the next 5 years.