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Highlights

- Old Calabar Architecture
- Traditonal Architectural Expression
- Air-Sea-Land Interaction
- Factors on Freshwater Eutrophication

Discovering Thoughts, Inventing Future

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Applied Physics of Air-Sea-Land Interaction During Hurricane Katrina

By Professor S. A. Hsu
Louisiana State University, United States

Abstract- A decade ago in August 2005 Hurricane Katrina devastated north-central Gulf of Mexico and southeastern Louisiana and Mississippi Gulf Coast. Although nearly all anemometers in the affected areas were destroyed by Katrina, few wind and wave measurement stations did survive the storm and provide some data to advance our understanding of the physics of air-sea-land interaction. Analyses of these measurements indicate that : 1. On the basis of upper-air measurements made at Key West, FL, and Slidell, LA, the power-law wind profile is verified in the atmospheric surface boundary layer (up to 300m) where the friction dominants; 2. The cyclostrophic equation, which is the balance between centrifugal force and pressure gradient force, is validated so that the wind speed at 10m over the water, U10 = 6.3(1013 - Pmin) ^ (1/2), where Pmin is the minimum sea-level pressure; 3.The significant wave height (Hs) and its dominant wave period (Tp) can be normalized by using U*, which is the friction velocity (= (τ/ρ) ^ (1/2), where τ is the wind stress and ρ is the air density).

Keywords: hurricane katrina, wind-wave interaction, friction velocity, storm surge, wave setup, cyclostrophic equation, power-law wind profile, and wind stress.

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Applied Physics of Air-Sea-Land Interaction during Hurricane Katrina

Professor S. A. Hsu

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Keywords: hurricane katrina, wind-wave interaction, friction velocity, storm surge, wave setup, cyclostrophic equation, power-law wind profile, and wind stress.

I. Introduction

About a decade ago in August 2005 Hurricane Katrina (see Figs.1 and 2) devastated north-central Gulf of Mexico and southeastern Louisiana and Mississippi Gulf Coast (see, e.g., Wang and Oey, 2008 and Hsu, 2014). Some examples of these destructions including one photo from Ivan in 2004 are illustrated in Figs. 3 thru 6. Although nearly all anemometers in the affected areas were destroyed by Katrina, few wind and wave measurement stations did survive the storm and provide some data for our reconstruction of the meteorological and oceanographic(met-ocean) conditions. To commemorate this infamous tropical cyclone in its 10th Anniversary this report is written to provide several applied physics of air-sea-land interaction.

Fig.1 shows that, when Katrina was in the central Gulf of Mexico, its minimum sea-level pressure (Pmin) was as low as 902hPa (or millibar, mb), which is 18mb lower than the commencement of the highest Saffir/Simspson Damage-potential Scale (i.e. category 5, for Pmin < 920mb). Also, as indicated in Table 1, even at its landfall in Louisiana, Pmin = 920mb. Furthermore, during its landfall, the radius of max wind was 65km (or 35 miles) and the tropical storm force winds (ranging from 34 to 63knots) extended out to 454km (245 miles). With this background information, we continue our analysis and discussions.

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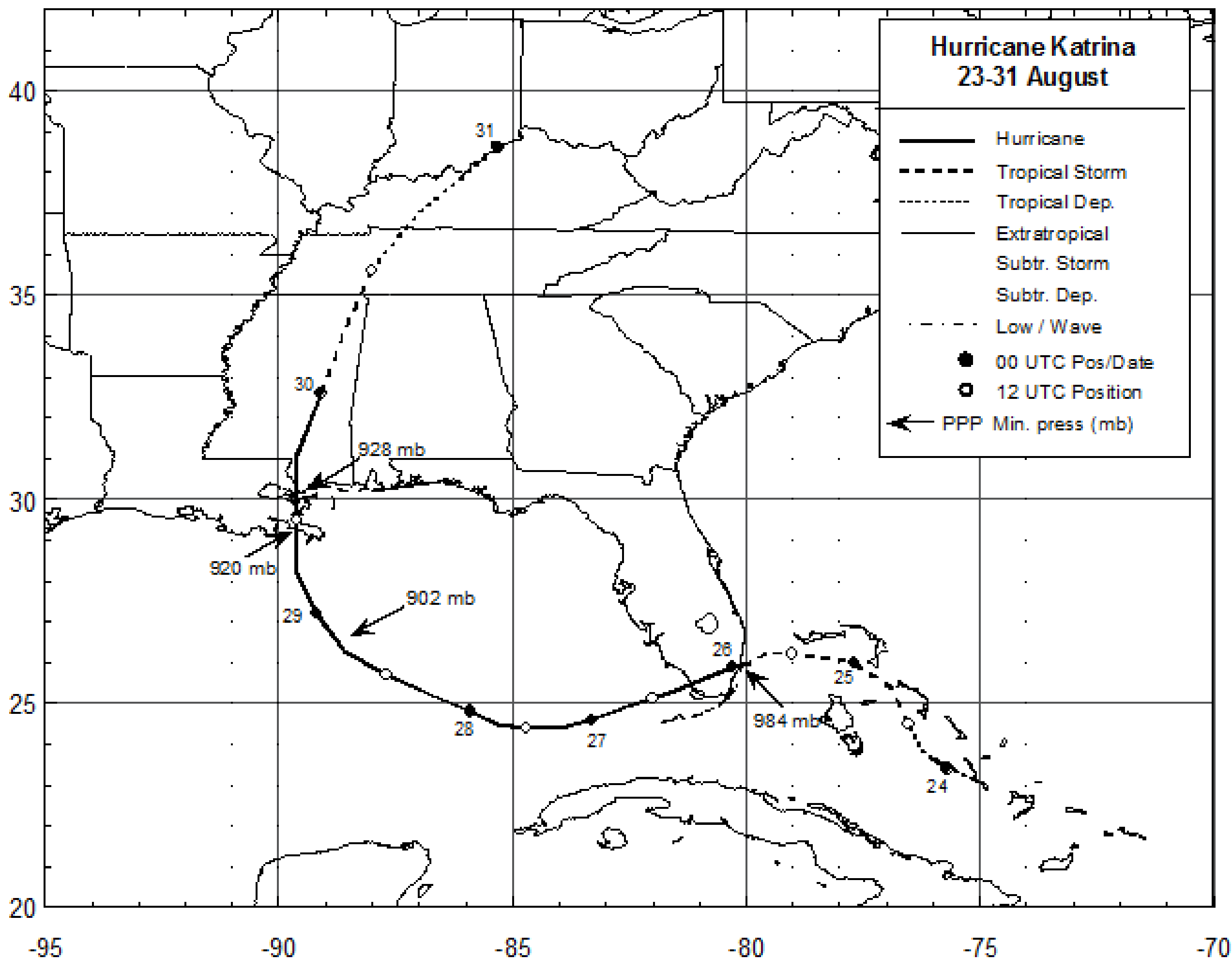

Fig. 1 : The track of Hurricane Katrina in August 2005 (see www.nhc.noaa.gov)

Fig. 2 : An image of Katrina over the central Gulf of Mexico near its peak wind conditions (see Table 1)

Table 1 : Radius of max wind (Rmax), minimum sea-level (central) pressure (Pmin), max wind speed at 10m (Vmax), and radius of tropical storm wind speed (R34kt) during Katrina in August 2005 (Data source: Powell and Reinhold, 2007)

Hurricane	Day	Time (UTC)	Rmax (km)	Pmin (hPa)	Vmax (m/s)	R34kt (km)
Katrina (FL)	25	2230	15	984	33	115
Katrina Peak wind	28	1200	26	909	71	349
Katrina (LA)	29	1200	65	920	52	454

Fig. 3 : Mars Tension-leg platform in the Gulf of Mexico (From http://en.wikipedia.org/wiki/Mars_(oil_platform))

Fig .4 : Mars platform showing damage from Hurricane Katrina in2005(http://en.wikipedia.org/wiki/Mars_(oil_platform)). According to Wang and Oey (2008), this billion-dollar platform was designed to withstand "140-mph winds and crashing waves up to 70ft high simultaneously"

Fig. 5 : Interstate I-10 over Mobile Bay damaged by Hurricane Ivan in 2004(From FHWA-NHI-07-096).According to FHWA, the wave setup on top of the storm surge was the cause

Fig. 6 : US 90 bridge over Biloxi Bay, Mississippi, was damaged by Katrina. Since the spans at higher elevations were not removed, the wave setup on top of the storm surge is more important than the wind loading (photo looking southwest from Ocean Springs 2/19/06, from FHWA-NHI-07-096)

II. A Verification of the Power-Law Wind Profile

During a tropical cyclone the atmosphere is well mixed or homogenized. This is represented by a skew T-log P thermodynamic diagram (see, e.g., Hsu, 1988) as shown in Fig. 7 at Key West, Florida, near the track of Katrina (Fig. 1). Since the dew-point measurements on the left is fairly close to that of dry-bulb temperature and since both curves also follow the saturation-adiabatic lapse rate, clouds could have been extended into the lower stratosphere. Therefore, deep convections ensue. However, because of the frictional effects near the ground or sea surface, mechanical turbulence over-powers the thermal convection so that the wind must decrease from cloud base to the surface. This is illustrated in Fig. 8. It is found that the height of the surface boundary layer extends to only 305m or approximately 1000 ft. This means that, based on the wind profile, we have a simple two-layer flow, i.e., above 300m the wind speed is nearly constant or changing slower than that in the sub-cloud layer, whereas blow this height, frictional effects prevail. Similar conditions over Slidell, Louisiana, during Katrina are demonstrated in Figs.9 and 10. The usefulness of this finding is further substantiated as follow:

According to Hsu (2003), under hurricane conditions, the power-law wind profile is valid so that

$$U2/U1 = (Z2/Z1) \wedge p \qquad (1)$$

$$p = (G - 1)/2 \qquad (2)$$

$$G = Ugust / U1 \qquad (3)$$

Where U2 and U1 are the wind speed at height Z2 and Z1, respectively, p is the exponent of the power-law for the wind profile, G is the gust factor, and Ugust is the gust measured at Z1. Note that both U1 and Ugust are measured routinely at Z1 by the National Data Buoy Center (NDBC) (see www.ndbc.noaa.gov).

At 12Z 26 Aug 2005 at NDBC station DRYF1 (see Fig. 11), which was located offshore but near the upper-air measurement station in Key West, U1 =14.7m/s, Ugust = 16.8m/s, and Z1 = 5.7m. Now, by substituting these values into above equations and setting Z2 = 305m, we get U2 = 19.5m/s at 305m. This result is in excellent agreement with the measured value of 20.1m/s or 39kts as shown in Fig.8, since the difference is only 3%. Therefore, the power-law wind profile is verified using the known surface boundary-layer height. This means that we can use routine measurements of U1and Ugust at Z1 to estimate U2 at given Z2.

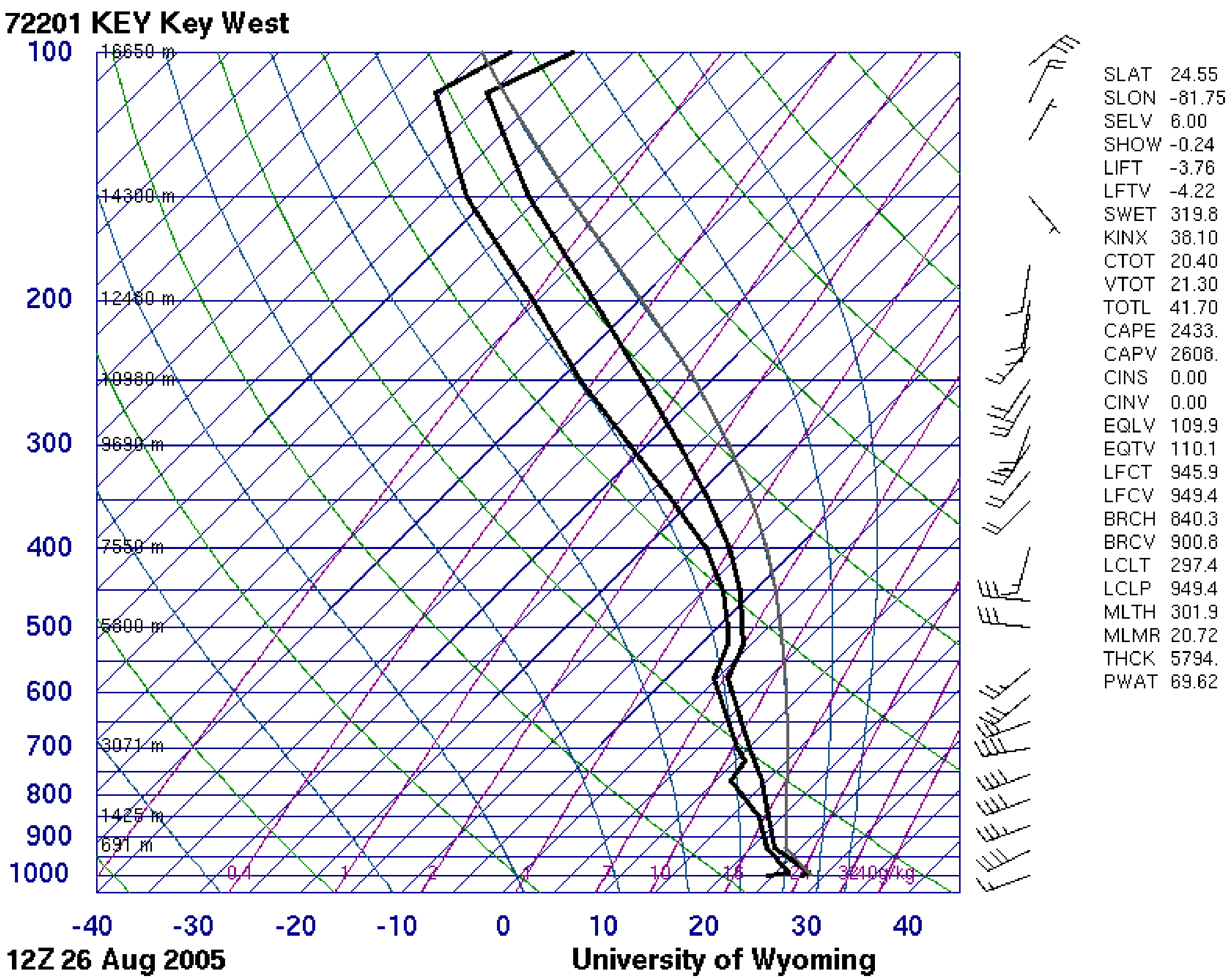

Fig. 7 : Upper-air sounding at Key West, FL, at 12Z 26 Aug 2005 (courtesy of the Department of Atmospheric Science, University of Wyoming, see http://weather.uwyo.edu/upperair/sounding.html)

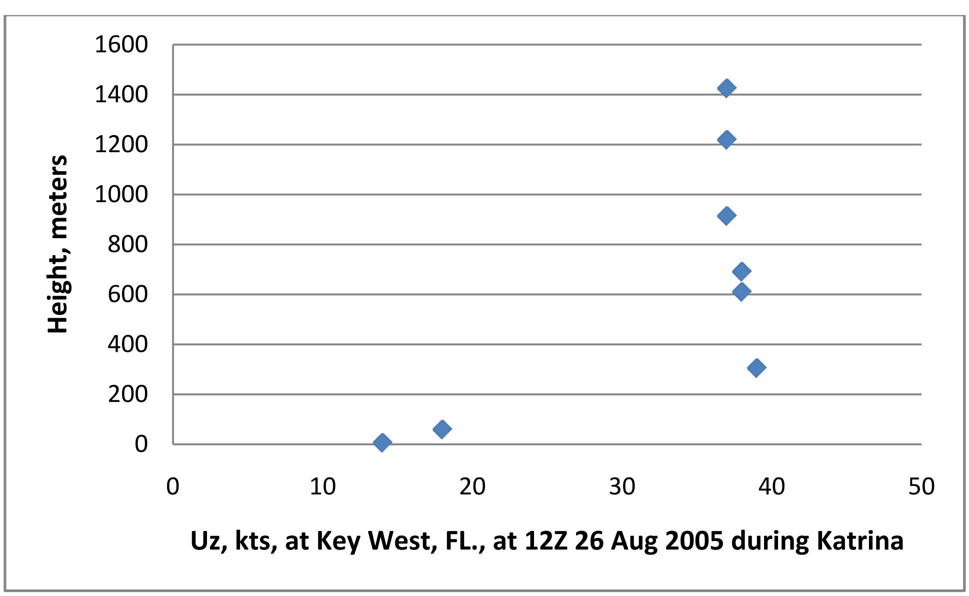

Fig. 8 : Wind profile at 12Z 26 Aug 2005 at Key West, FL, during Katrina

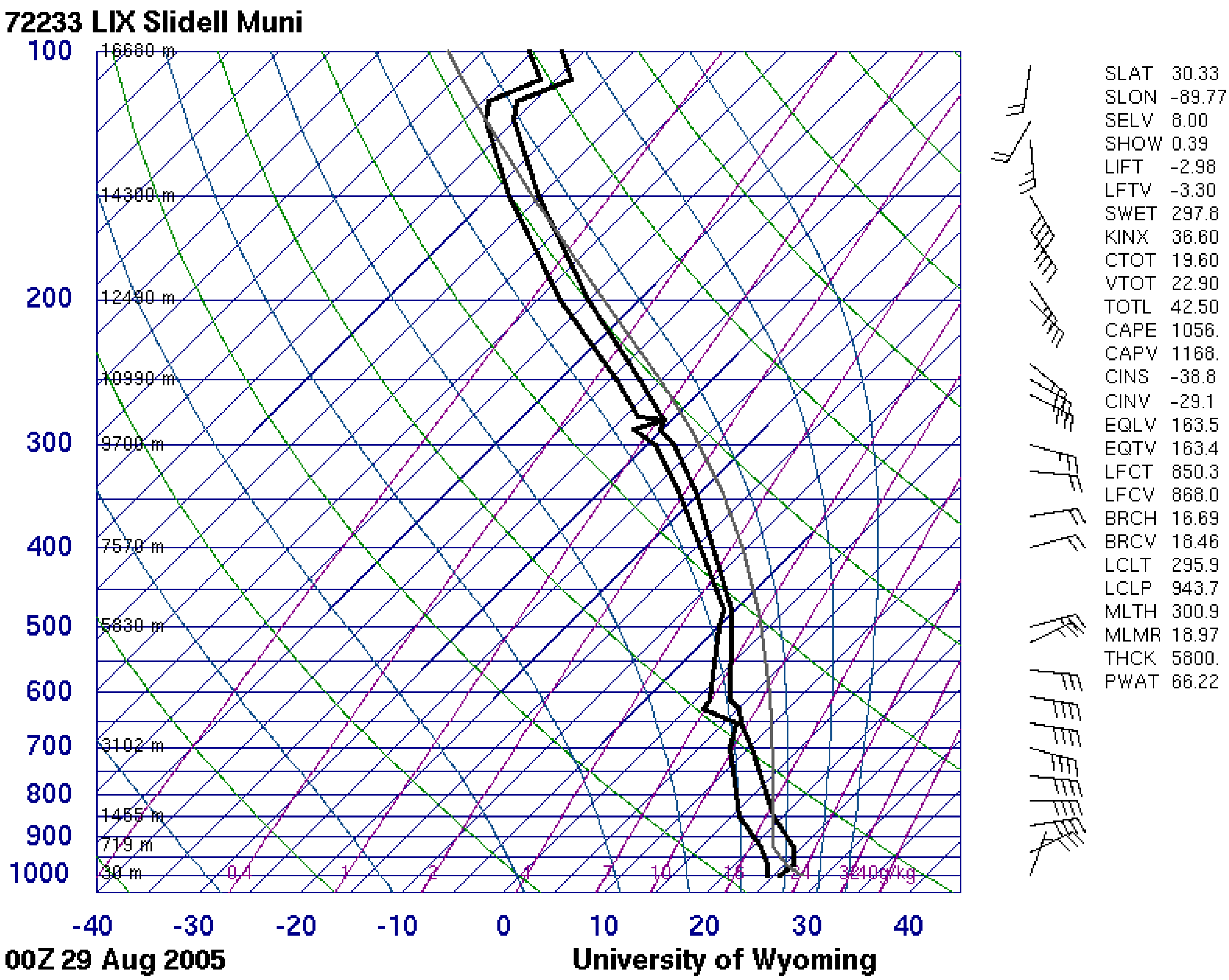

Fig. 9 : Upper-air sounding at 00Z 29 Aug 2005 at Slidell, LA, during Katrina (courtesy of the Department of Atmospheric Science, University of Wyoming, see http://weather.uwyo.edu/upperair/sounding.html)

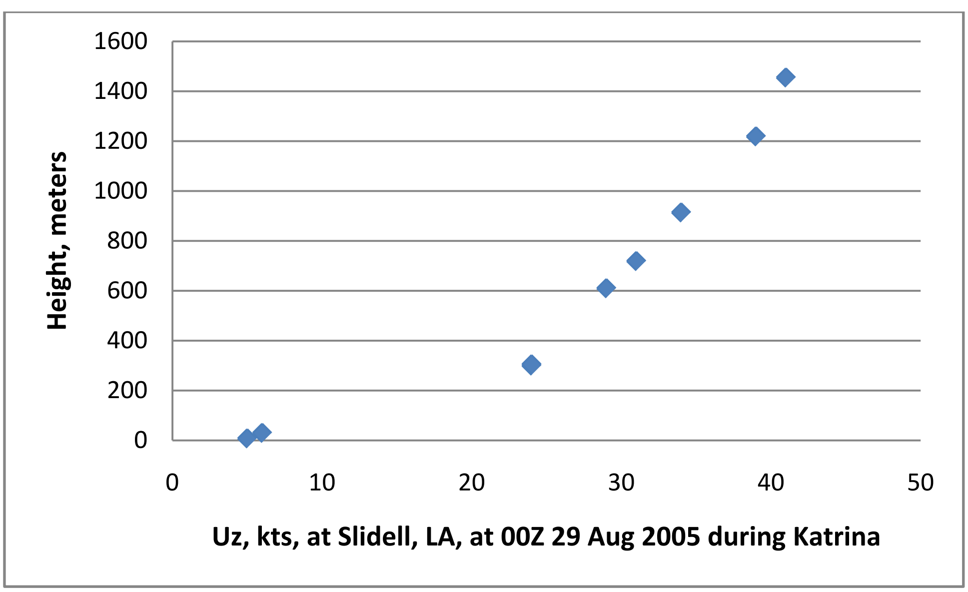

Fig. 10 : Wind profile at 00Z 29 Aug 2005 ay Slidell, FL, during Katrina

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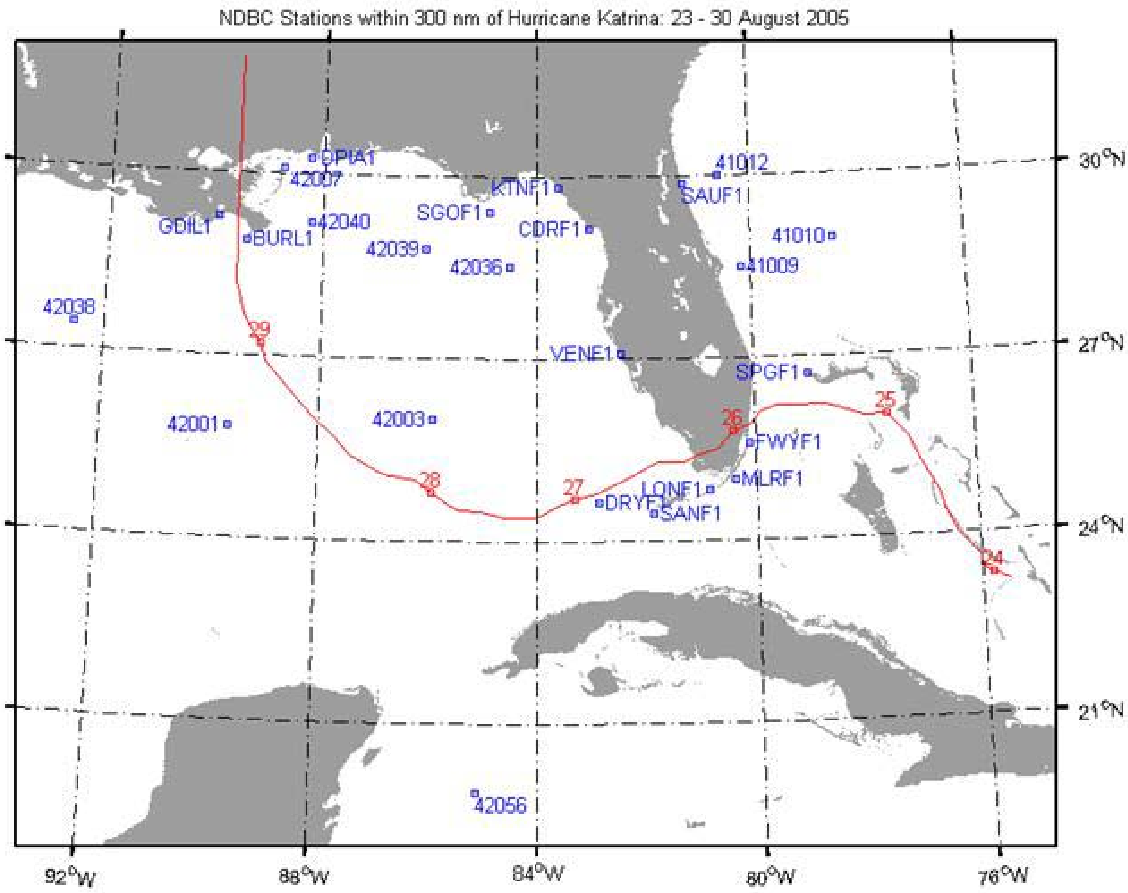

Fig. 11 : Hurricane Katrina's Track and NDBC Stations. Katrina's track (in red with the start of each day numbered) is from the current positions of the National Hurricane Center's Forecasts/Advisories (see http://www.ndbc.noaa.gov/hurricanes/2005/katrina/)

III. Relation Between Minimum Sea-Level Pressure and Wind Speed at 10m

On the basis of the balance between centrifugal force and pressure gradient force Hsu (2005) has formulated an operational cyclostrophic equation such that,

$$U10 = 6.3\,(1013\text{-}Pmin)\ \hat{}\ (1/2) \qquad (4)$$

Where U10 (in m/s) is the wind speed at 10m and Pmin is the minimum sea-level pressure (hPa or mb).

Further validations of Eq. (4) are presented in Fig.12 based on estimations from the National Hurricane Center (NHC) as listed in Table 2 during Katrina. Since Hurricane Lili had much higher U10 measurements than Katrina, we employ Lili data as measured at NDBC Buoy 42001 (see Fig.11) in 2002over the Gulf of Mexico (see Fig.13). These results indicate that Eq. (4) is very useful operationally.

Table 2 : Timeline and characteristics of Hurricane Katrina over the Gulf of Mexico in August 2005 (for data source, see www.nhc.noaa.gov)

Advisory number	Latitude degrees	Longitude degrees	Time UTC	Wind Speed, Kts	Minimum sea-level pressure mb	Saffir/Smpson Category
11	25.3	-81.5	08/26/09Z	65	987	HURRICANE-1
11A	25.3	-81.8	08/26/11Z	65	987	HURRICANE-1
11B	25.2	-82	08/26/13Z	65	987	HURRICANE-1
12	25.1	-82.2	08/26/15Z	70	981	HURRICANE-1
13	25.1	-82.2	08/26/15Z	85	971	HURRICANE-2
13A	24.9	-82.6	08/26/18Z	85	969	HURRICANE-2
14	24.8	-82.9	08/26/21Z	85	965	HURRICANE-2
14A	24.7	-83.3	08/27/00Z	85	965	HURRICANE-2
15	24.6	-83.6	08/27/03Z	90	965	HURRICANE-2
15A	24.4	-84	08/27/06Z	95	963	HURRICANE-2
16	24.4	-84.4	08/27/09Z	100	945	HURRICANE-3
16A	24.4	-84.6	08/27/12Z	100	940	HURRICANE-3
17	24.5	-85	08/27/15Z	100	940	HURRICANE-3
17A	24.5	-85.4	08/27/18Z	100	949	HURRICANE-3
18	24.6	-85.6	08/27/21Z	100	945	HURRICANE-3
18A	24.8	-85.9	08/28/00Z	100	944	HURRICANE-3
19	25	-86.2	08/28/03Z	100	939	HURRICANE-3
20	25.1	-86.8	08/28/06Z	125	935	HURRICANE-4
21	25.4	-87.4	08/28/09Z	125	935	HURRICANE-4
22	25.7	-87.7	08/28/12Z	140	908	HURRICANE-5
23	26	-88.1	08/28/15Z	150	907	HURRICANE-5
23A	26.5	-88.6	08/28/18Z	150	906	HURRICANE-5
24	26.9	-89	08/28/21Z	145	902	HURRICANE-5
24A	27.2	-89.1	08/29/00Z	140	904	HURRICANE-5
25	27.6	-89.4	08/29/03Z	140	904	HURRICANE-5
25A	27.9	-89.5	08/29/03Z	140	908	HURRICANE-5
25B	28.2	-89.6	08/29/07Z	135	910	HURRICANE-5
26	28.8	-89.6	08/29/09Z	130	915	HURRICANE-5
26A	29.1	-89.6	08/29/11Z	125	918	HURRICANE-5
26B	29.7	-89.6	08/29/13Z	115	923	HURRICANE-4

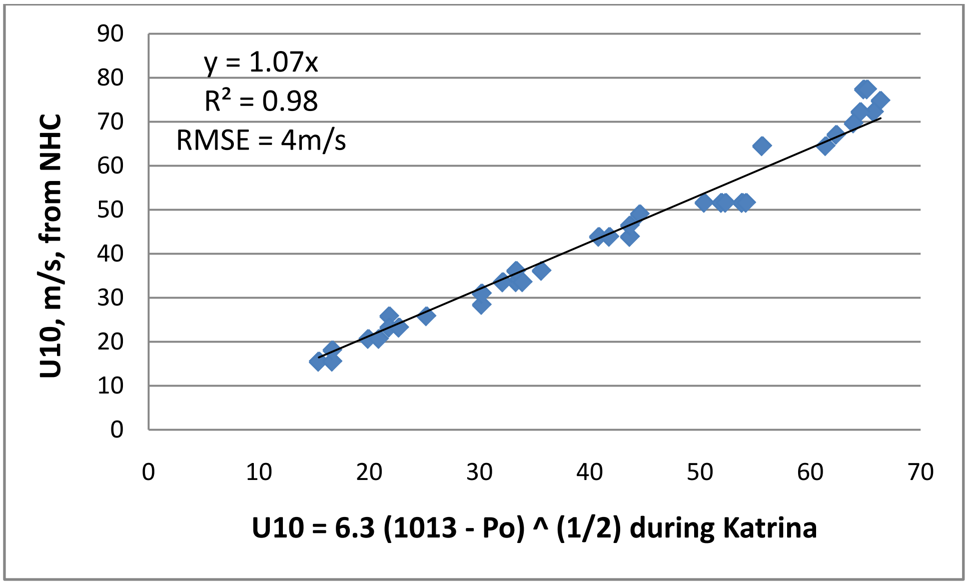

Fig. 12 : A verification of Eq. (4) based on data as listed in Table 2

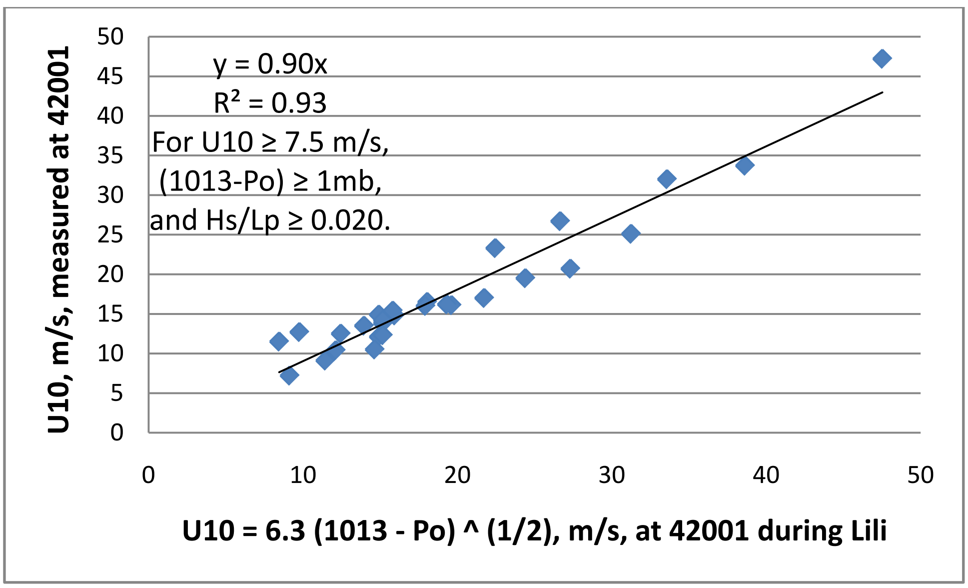

Fig. 13 : Further verification of Eq.(4) using the measurements made at Buoy 42001 during Lili in 2002

IV. Wind-Wave Interaction at NDBC Buoy 42003

As shown in Fig.11, NDBC Buoy 42003similar to that shown in Fig.14 was located on the right-hand side of the Katrina tack. Therefore, the wind and wave interaction should be intense. Unfortunately, the buoy was capsized during the storm (see, http://www.ndbc.noaa.gov/hurricanes/2005/katrina/). The data before its capsizing are listed in Table 3.

In order to investigate the wind-wave interaction, the effects of swell need to be minimized. According to Drennan et al (2005), the criterion to do so is to set that

$$Hs/Lp \geq 0.020 \tag{5}$$

$$Lp = (g/2\pi)\, Tp\ \hat{}\ 2 = 1.56\, Tp\ \hat{}\ 2 \tag{6}$$

Where Hs is the significant wave height, Lp is the dominant wave length, g (=9.8 m/s^2) is the gravitational acceleration, and Tp is the dominant wave period, and the parameter, Hs/Lp, is called wave steepness.

For wind-wave interaction, according to Csanady (2001, p.68),

$$g\, Hs/U^{*}\ \hat{}\ 2 = A\, (g\, Tp\, /U^{*})\ \hat{}\ (3/2) \tag{8}$$

$$U^{*} = (\tau/\rho)\ \hat{}\ (1/2) \tag{9}$$

Where U* is the friction velocity, τ is the wind stress, ρ is the air density, and coefficient, A, needs to be determined from the field measurements.

The problem now is to estimate U* independently from the wave parameters. This is accomplished by employing the sonic anemometer measurements made over the North Sea during storms (for details, see Geernaert et al.1987). The results are presented in Fig.14, so that

$$U^* = 0.0195 U10^{1.285} \qquad (10)$$

In order to extend Eq. (10) into hurricane conditions, Fig. 15 is presented. Because the vorticity method is based on atmospheric physics (Anthes, 1982), it is used here. Since the slope between this method and Eq. (10) is near one and that the R^2 value reaches to 94%, we are confident that Eq. (10) can be extended into hurricane conditions.

Now, with the data provided in Table 3, we can compute U* from U10 based on Eq. (10). Our results are shown in Fig.16. The coefficient "A" is determined to be 0.052 with $R^2 = 0.84$ so that Eq. (8) becomes

$$g\,Hs/U^{*2} = 0.052\,(g\,Tp/U^*)^{(3/2)} \qquad (11)$$

Or,

$$U^* = 38\,Hs^2/Tp^3 \qquad (12)$$

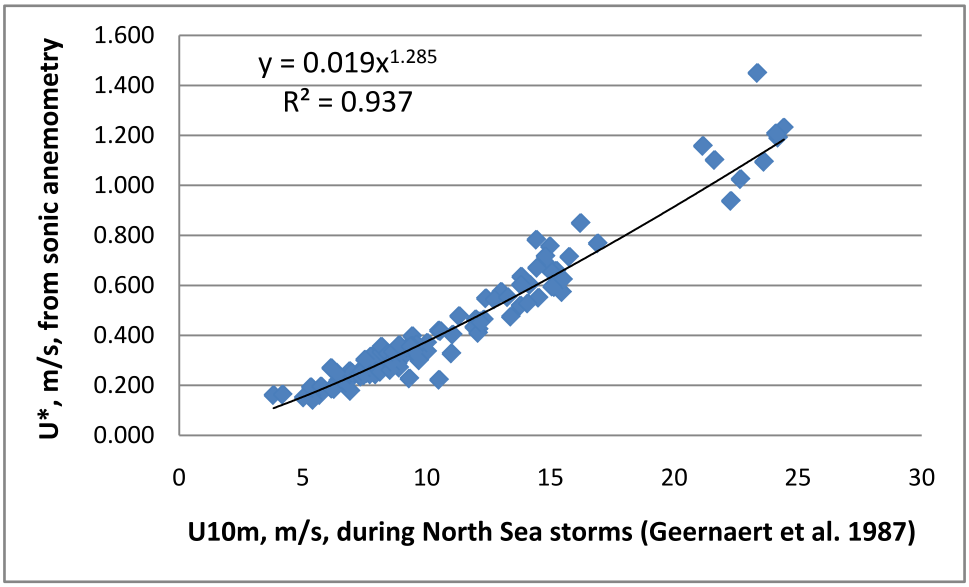

Fig. 14 : Relation between direct measurements of U* and U10m using sonic anemometers based on data provided in Geernaert et al. (1987)

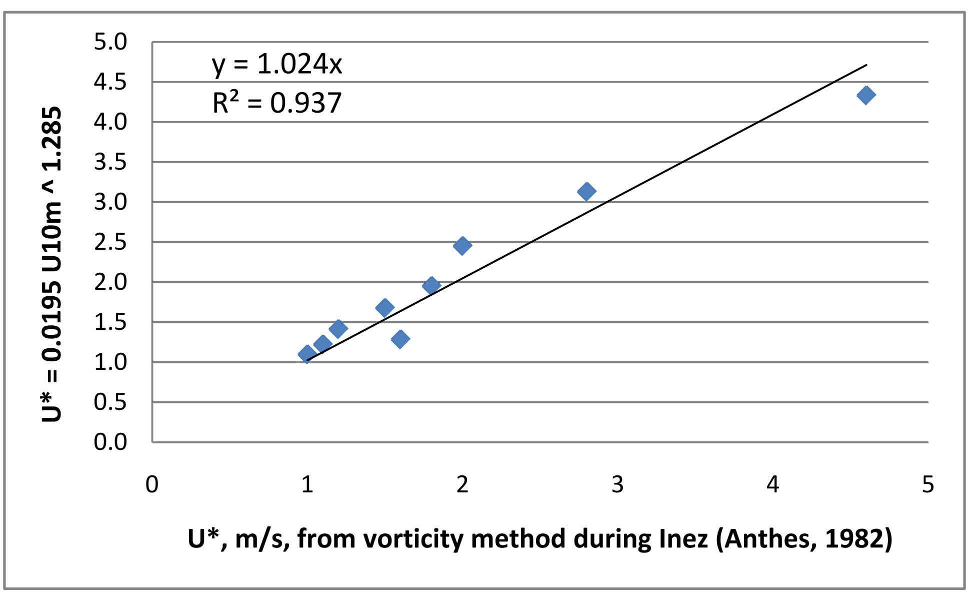

Fig. 15 : An extension of Equation (10) into hurricane conditions during Inez based on the dataset provided in Anthes (1982, p.71)

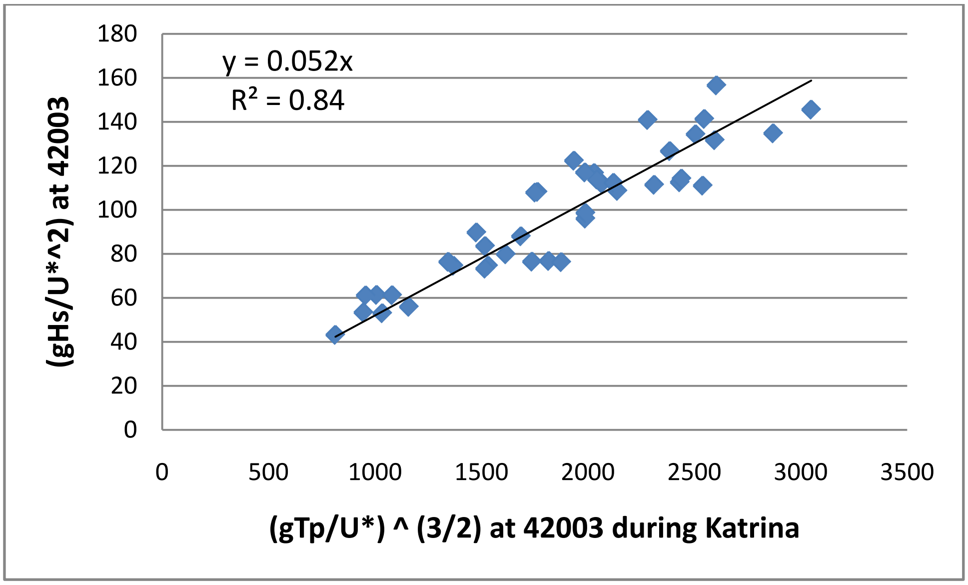

Fig. 16 : Verifying the 3/2 - power law between friction velocity, U*, and wave parameters (Hs, and Tp) at NDBC Buoy 42003 during Katrina

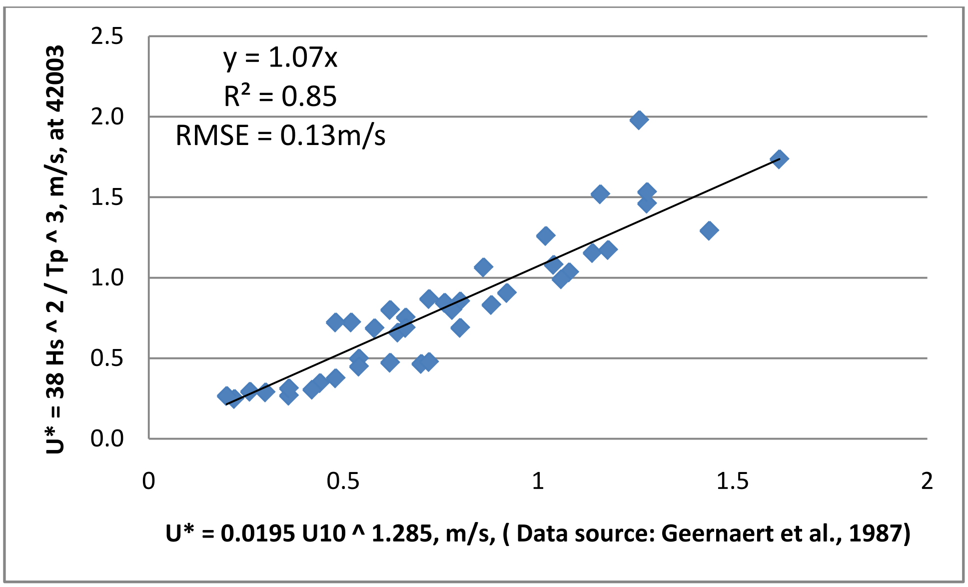

Fig. 17 : A comparison of Eqs. (10) and (12)

Table 3 : Wind and wave measurements at NDBC Buoy 42003 during Katrina in August 2005. U10 is for wind speed at 10m, Ugust for gust, Hs for significant wave height, Tp for dominant wave period, and Hs/Lp for wave steepness (for data source, see www.ndbc.noaa.gov)

Day	Hour UTC	Wind dir. degrees	U10 m/s	Ugust m/s	Hs m	Tp sec	Wave dir. degrees	Hs/Lp
26	12	12	8.2	9.3	1.26	6.25	36	0.021
26	13	15	8.5	9.8	1.25	5.88	23	0.023
26	14	19	8.9	9.9	1.44	6.67	33	0.021
26	15	12	9.7	11.2	1.5	6.67	31	0.022
26	16	9	10	11.8	1.6	7.14	28	0.020
26	17	16	11.9	13.7	1.73	7.14	28	0.022

26	18	15	10.5	12.7	1.82	7.14	29	0.023
26	19	13	12.4	14.5	1.91	7.69	30	0.021
26	20	9	12.9	15.3	2.12	7.69	25	0.023
26	21	15	13	16.5	2.11	7.14	37	0.027
26	22	26	13.4	16.1	2.44	7.69	31	0.026
26	23	36	12.8	15.5	2.61	8.33	41	0.024
27	0	50	12.8	15.4	2.94	7.69	43	0.032
27	1	42	12.2	14.6	2.94	7.69	41	0.032
27	2	41	12.8	15.9	2.68	8.33	49	0.025
27	4	44	14.1	17.7	3.98	10.81	90	0.022
27	5	44	14.6	17.9	4.45	10	91	0.029
27	6	49	14.9	18.1	5.09	11.43	96	0.025
27	7	47	14.4	17.7	5.2	11.43	100	0.026
27	8	51	14.6	18.2	5.37	10.81	92	0.029
27	9	53	15.2	19.2	5.68	12.12	100	0.025
27	10	50	14.9	18.7	6.29	12.12	97	0.027
27	11	69	16.5	19.4	5.67	12.12	99	0.025
27	12	51	16.8	19.9	6.12	12.12	99	0.027
27	13	49	16.9	20.9	6.32	12.12	100	0.028
27	14	52	17.4	21.3	6.72	12.9	104	0.026
27	15	55	18.3	24	7.35	12.12	105	0.032
27	16	63	18	23.4	7.64	12.9	106	0.029
27	17	62	19.6	24.2	7.15	12.9	111	0.028
27	18	65	20.8	25.1	7.06	12.12	104	0.031
27	19	66	20.7	25.9	7.81	12.9	113	0.030
27	20	68	20	25.1	7.68	12.12	114	0.034
27	21	64	20.7	25.1	6.85	12.9	116	0.026
27	22	64	21	26.9	7.41	12.12	111	0.032
27	23	68	23.8	29.1	7.48	12.9	116	0.029
28	0	65	25.2	31.6	8.27	12.12	120	0.036
28	1	68	28.6	34.4	9.26	12.9	116	0.036
28	2	77	25.6	33.7	9.9	12.9	119	0.038
28	3	89	26	32.4	10.28	13.79	127	0.035
28	4	96	26.6	33.8	9.44	13.79	118	0.032
28	5	105	26.3	32.6	10.57	12.9	121	0.041

V. Extreme Waves Measured at NDBC Buoy 42040

According to NDBC (http://www.ndbc.noaa.gov/hurricanes/2005/katrina/),Station 42040, located at 29°11'03"N 88°12'48"W approximately 64 nautical miles south of Dauphin Island Alabama (Fig.11), reported a significant wave height of 16.91 meters (55.5 feet) at 1100 UTC, August 29, 2005 (see Fig.18). Station 42040 is a 3-meter diameter discus hull buoy deployed and operated by National Oceanographic and Atmospheric Administration's National Data Buoy Center (NDBC). Although 42040 does not measure maximum wave heights, the maximum wave height may be statistically approximated by 1.9 times the significant wave height (World Meteorological Organization, 1998), which would be 32.1 meters (105 feet). At the time of the report, Hurricane Katrina was approximately 73 nautical miles to the west of 42040 with maximum sustained winds of 145 miles per hour (Public Advisory 26A issued by the

National Hurricane Center, see Table 2). In addition to the 55-foot report, 42040 reported seas 12 feet or greater for 47 consecutive hours.

The 55-foot report surpasses the previous highest significant wave height reported by an NDBC buoy in the Gulf of Mexico of 15.96 meters (52 feet), also reported by 42040 during Hurricane Ivan in September 2004, and matches the previous highest significant wave height reported by an NDBC buoy of 16.91 meters reported by station 46003 (in the Northeast Pacific Ocean south of the Aleutian Islands) in January 1991.

On the basis of Table 4, the relation between Tp and Hs is plotted in Fig. 19. Since this relation is very consistent with that of other tropical cyclones including Typhoon Man-Yi in 2007(Hsu, 2015), they are combined together as presented in Fig. 20. If one accepts these statistics as indicated in the figure, according to Hsu (2015), we have

$$U10 = (21/ (12.7 – 2.2 \, Ln \, (Hs))) \wedge 3.5 \quad (13)$$

Now, substituting this max Hs (=16.91m) into Eq. (13), U10 = 61m/s. If we substitute both Hs (=16.91m) and Tp (=14.29 second) (as listed in Table 4 during 11Z on Aug 29) into Eq. (12), we get U* =3.72m/s. Then, by substituting this U* value into Eq. (10), we obtain that U10 = 60m/s. Another independent measurement of atmospheric pressure was made at NDBC Buoy 42007 located farther north from 42040 (see Fig.11). The data are shown in Fig.21. Note that the minimum pressure, Pmin=927.4mb, occurred at 15Z 29 Aug. Now, if we substitute this value into Eq. (4), we have U10 = 58m/s. Since the extreme Hs (=16.91m) occurred 6 hour earlier than the Pmin measured at 42007, the wind speed must be at least 58m/s. Since the measured max wind speed at 42040 (see Table 4) was only 28.1m/s, which occurred at 10Z 29 August, caution must be exercised in using the wind data (e.g., to estimate the significant wave height) when a hurricane is making its landfall because of the effects of landmass on air flow. Apparently, local winds near the time of a hurricane's landfall are too low to generate the waves as measured. This problem needs to be investigated further.

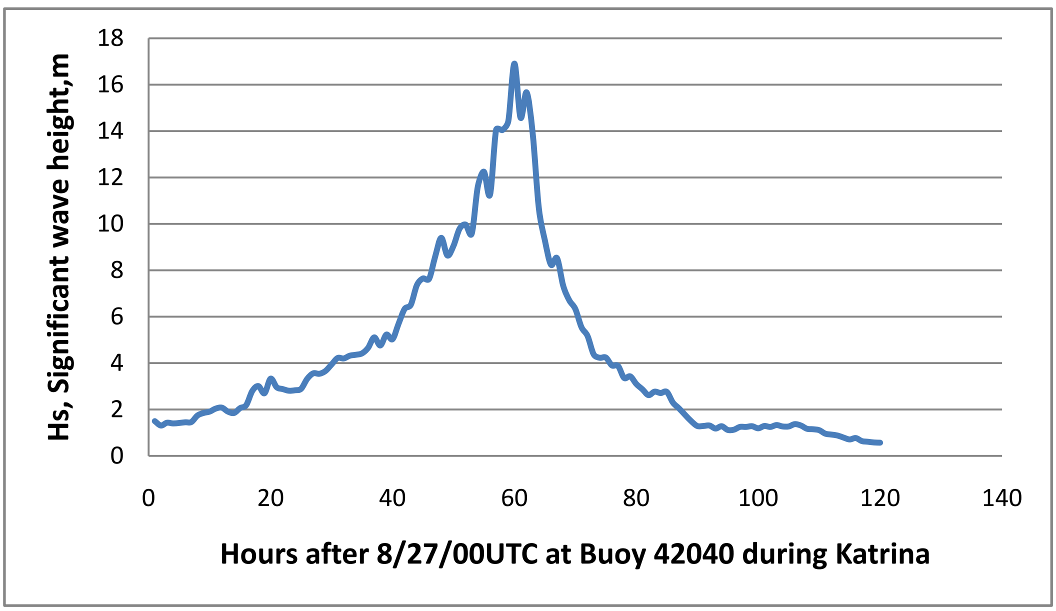

Fig. 18 : Measurements of extreme waves at NDBC Buoy 42040 during Katrina

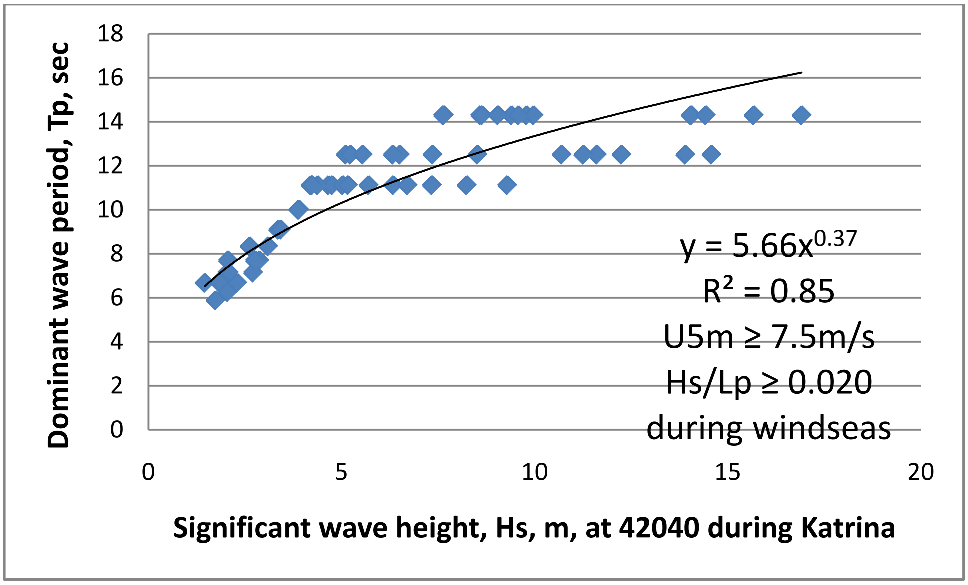

Fig. 19 : Relation between Hs and Tp at NDBC Buoy 42040 during Katrina based on Table 4 (for data source, see www.ndbc.noaa.gov)

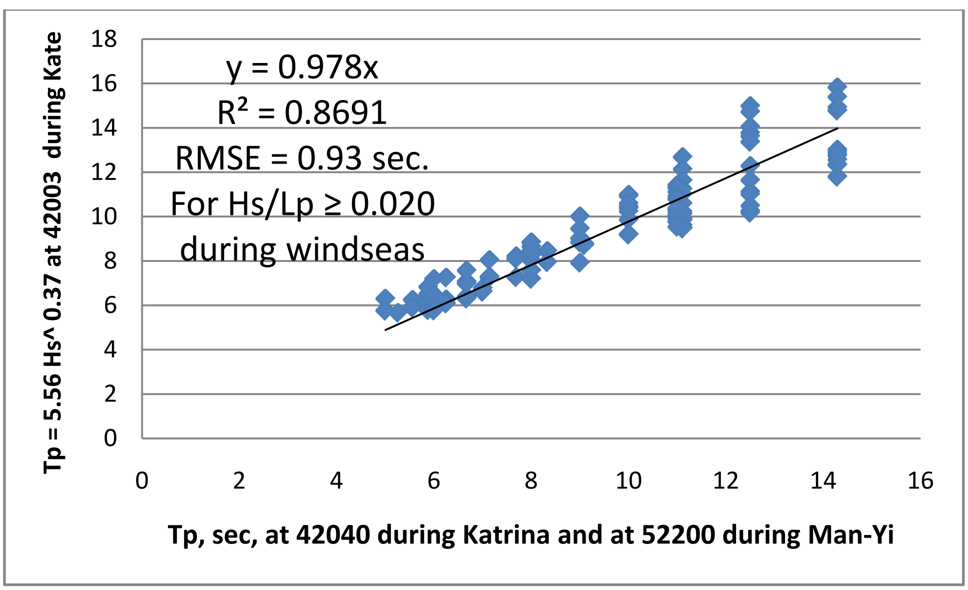

Fig. 20 : Measurements of Tp during Katrina and Typhoon Man-Yi (in 2007) and their comparison with that during hurricane Kate

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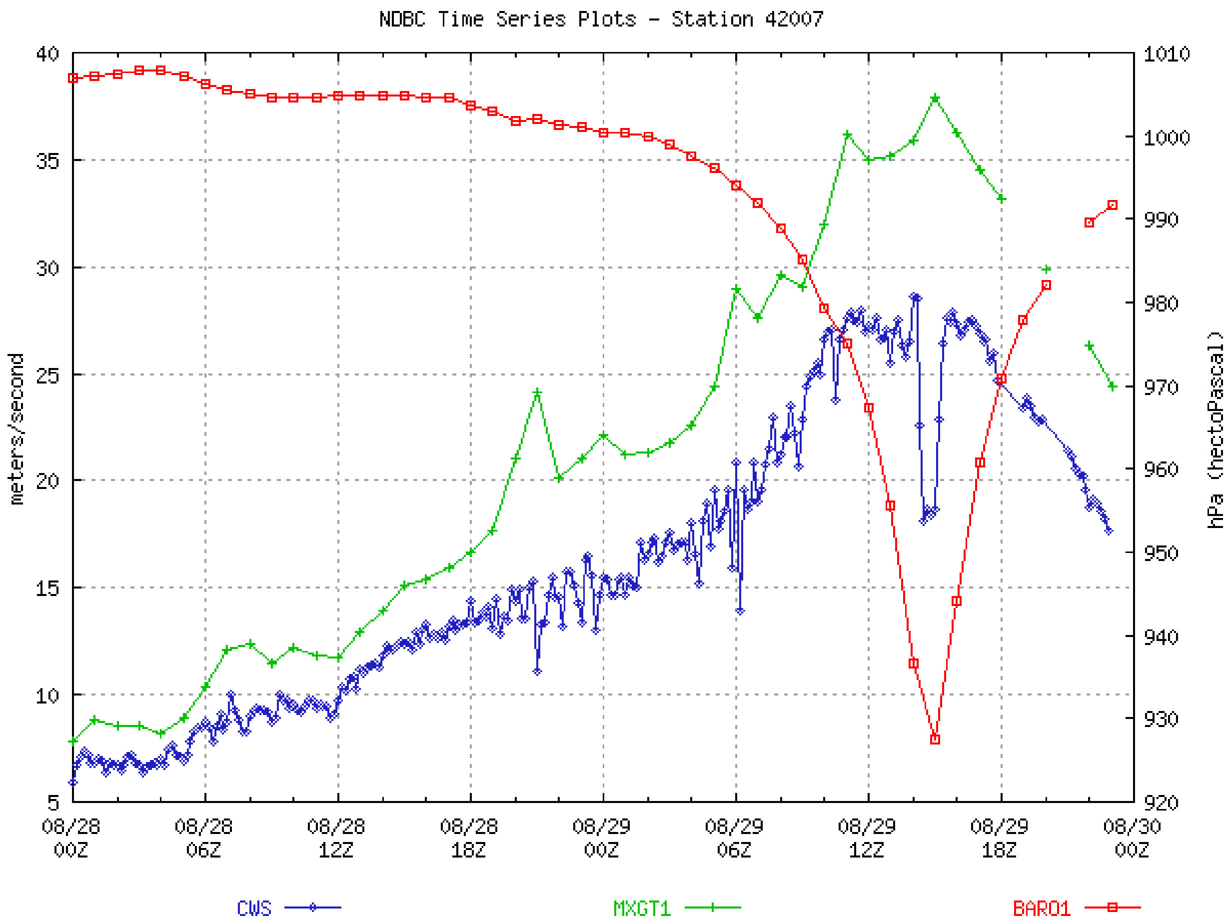

Fig. 21 : Station 42007: Winds (Anemometer Height 5m) and Sea-level Pressure (see http://www.ndbc.noaa.gov/hurricanes/2005/katrina/)

Table 4 : Wind and wave measurements at NDBC Buoy 42040 during Katrina in August 2005. U5 is for wind speed at 5m, Ugust for gust, Hs for significant wave height, Tp for dominant wave period, and Hs/Lp for wave steepness (for data source, see www.ndbc.noaa.gov).

Day	Hour	Wind dir.	U5m	Ugust	Hs	Tp	Wave dir.	Hs/Lp
	UTC	degrees	m/s	m/s	m	sec	degrees	
27	6	57	9.2	10.9	1.46	6.67	101	0.021
27	7	65	9.5	10.9	1.74	5.88	105	0.032
27	8	74	9.2	10.8	1.85	6.67	100	0.027
27	9	80	9.2	10.6	1.91	6.67	103	0.028
27	10	67	8.1	9.8	2.04	7.14	101	0.026
27	11	62	8.2	9.6	2.08	7.14	104	0.026
27	12	61	7.7	9.3	1.91	6.67	97	0.028
27	13	61	7.5	9	1.85	6.67	89	0.027
27	14	60	7.6	9.1	2.06	7.69	103	0.022
28	7	66	11.8	14.8	4.2	11.11	126	0.022
28	11	73	12.5	15.4	4.66	11.11	124	0.024
28	12	70	13.1	15.9	5.11	12.5	120	0.021
28	13	70	13.7	16.2	4.76	11.11	122	0.025

28	14	70	13.8	17.6	5.23	12.5	117	0.021
28	15	73	13.3	17.3	5.03	11.11	124	0.026
28	16	72	16	19.2	5.7	11.11	127	0.030
28	17	76	15.8	20.5	6.34	11.11	123	0.033
28	18	69	16.1	20	6.51	12.5	112	0.027
28	19	61	14	17.5	7.36	12.5	113	0.030
28	20	77	15.4	19.4	7.65	14.29	108	0.024
28	21	84	17	21.4	7.63	14.29	108	0.024
28	22	95	15.8	19.3	8.59	14.29	123	0.027
28	23	86	18.5	23.8	9.4	14.29	106	0.030
29	0	78	18	21.4	8.64	14.29	101	0.027
29	1	82	18.6	24.6	9.05	14.29	102	0.028
29	2	82	19.1	24.4	9.79	14.29	101	0.031
29	3	84	15.5	19.8	9.97	14.29	105	0.031
29	4	85	21	27.1	9.58	14.29	94	0.030
29	5	108	18.4	29.3	11.61	12.5	100	0.048
29	6	104	23.8	30.1	12.25	12.5	94	0.050
29	7	108	24	32.3	11.26	12.5	96	0.046
29	8	111	25.5	32.1	14.06	14.29	256	0.044
29	9	128	25.1	32.3	14.04	14.29	250	0.044
29	10	127	28.1	35	14.43	14.29	242	0.045
29	11	139	27.3	33.9	16.91	14.29	0	0.053
29	12	147	27.1	34.6	14.58	12.5	213	0.060
29	13	159	28	35.8	15.67	14.29	161	0.049
29	14	166	25.2	31.2	13.9	12.5	198	0.057
29	15	174	22.9	29.2	10.7	12.5	157	0.044
29	16	190	22.3	28.1	9.29	11.11	219	0.048
29	17	196	19.9	24.5	8.24	11.11	217	0.043
29	18	203	19	24.1	8.52	12.5	219	0.035
29	19	204	17.4	21	7.34	11.11	225	0.038
29	20	211	17.2	21.9	6.71	11.11	230	0.035
29	21	215	15.1	18	6.33	12.5	238	0.026
29	22	217	13.8	17.2	5.55	12.5	237	0.023
29	23	212	12.6	15.5	5.17	11.11	220	0.027
30	0	206	11.8	14.6	4.38	11.11	212	0.023
30	1	203	11.5	13.9	4.23	11.11	210	0.022
30	2	200	10.6	13.2	4.24	11.11	196	0.022
30	3	186	11.9	15.6	3.9	10	191	0.025
30	4	195	11.1	13.8	3.88	10	192	0.025
30	5	202	10	11.8	3.36	9.09	184	0.026
30	6	209	8.8	10.6	3.43	9.09	188	0.027
30	7	209	9.1	10.7	3.1	8.33	182	0.029
30	8	199	9.2	11	2.87	7.69	188	0.031
30	9	201	10.1	12.1	2.62	8.33	193	0.024
30	10	204	10.2	12.4	2.77	7.69	196	0.030

30	11	205	8.9	10.6	2.71	7.14	197	0.034
30	12	210	8.3	9.8	2.76	7.69	208	0.030
30	13	215	8.3	9.7	2.3	6.67	201	0.033
30	14	212	7.9	8.9	2.05	6.25	199	0.034

VI. Storm Surge and Wave Setup Near Biloxi, MS, during Katrina

In August 2005Hurricane Katrina induced widespread coastal flooding in southeastern Louisiana and Mississippi Gulf coast including the City of New Orleans. The most important cause for these extensive damages is the storm surge, which is the water-level rise above normal astronomical tide. According to the S*hore Protection Manual* (USACE,1977), the total water level rise at the coast is due to the wind-stress tide, the Coriolis tide, the barometric tide, wave set-up, and local conditions including water depth and fresh water run-off from land into rivers and bays. Further analyses of the relative contribution of these various factors indicate that during Hurricane Camille in 1969, approximately 80% of the total surge was due to the wind-stress tide (Hsu, 2004). In addition, as demonstrated in Hsu (2012), during Hurricane Irene in 2011, approximately 92% of the total storm surge affecting the New York Harbor could be explained by a wind-stress tide relation proposed by Hsu et al. (1997). Some physics of the wind stress tide during Hurricane Sandy in 2013 are given in Hsu (2013).

According to Dean and Dalrymple (2002), the wave setup is a phenomenon that occurs primarily within the wave breaking zone and results a super elevation of the water level. Some characteristics of wave setup during Hurricane Katrina and Tropical Cyclone Mahina have been presented in Hsu(2014). An illustration of storm surge and wave setup with reference to the normal water level is shown in Fig.22 (see FEMA, 2006). High water mark surveys of both storm surge and wave setup near Biloxi, MS, located just north of Buoy 42007, are presented in Fig.23, which indicates that the storm surge was 25ft and wave setup 8ft, a 33ft (10m) in total water level rise.They are explained as follows:

According to Hsu (2004),

$$\text{Storm surge} = 0.07*(1010 - P_{min})*F_s*F_m \qquad (14)$$

Where Fs is a shoaling factor and Fm is a correction factor for storm motion. According to Hsu (2004), in the Biloxi area, Fs =1.2, and Fm = 1.0 (based on Advisory #26A and #26B, the forward motion speed of the storm was near 15 miles per hour) (http://www.nhc.noaa.gov/archive/2005/pub/al122005.public_a.026.shtml?).

Now, substituting these values and Pmin = 927.4mb from Fig.21 as measured at Buoy 42007, the storm surge from Eq. (14) is 24ft, which is in excellent agreement with the 25ft as measured (see Fig.23).

According to Guza and Thornton (1981), the max wave setup is linearly related to the max Hs, H_{smax} , so that

$$\text{Wave setup} = 0.17\, H_{smax} \qquad (15)$$

Now, substituting Hsmax (=55ft, from Fig.18), wave setup is 9ft. Again, this is in good agreement with the 8ft wave setup as measured (see Fig.23).

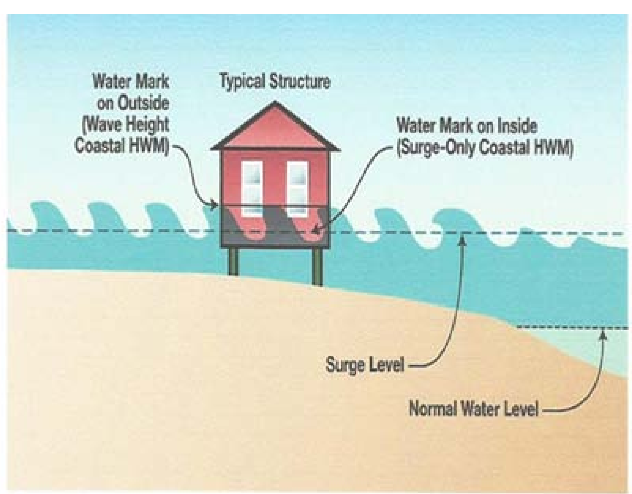

Fig. 22 : An illustration of wave setup = (high water mark outside – high water mark inside the structure) (See FEMA, 2006). Note that HWM stands for High Water Mark

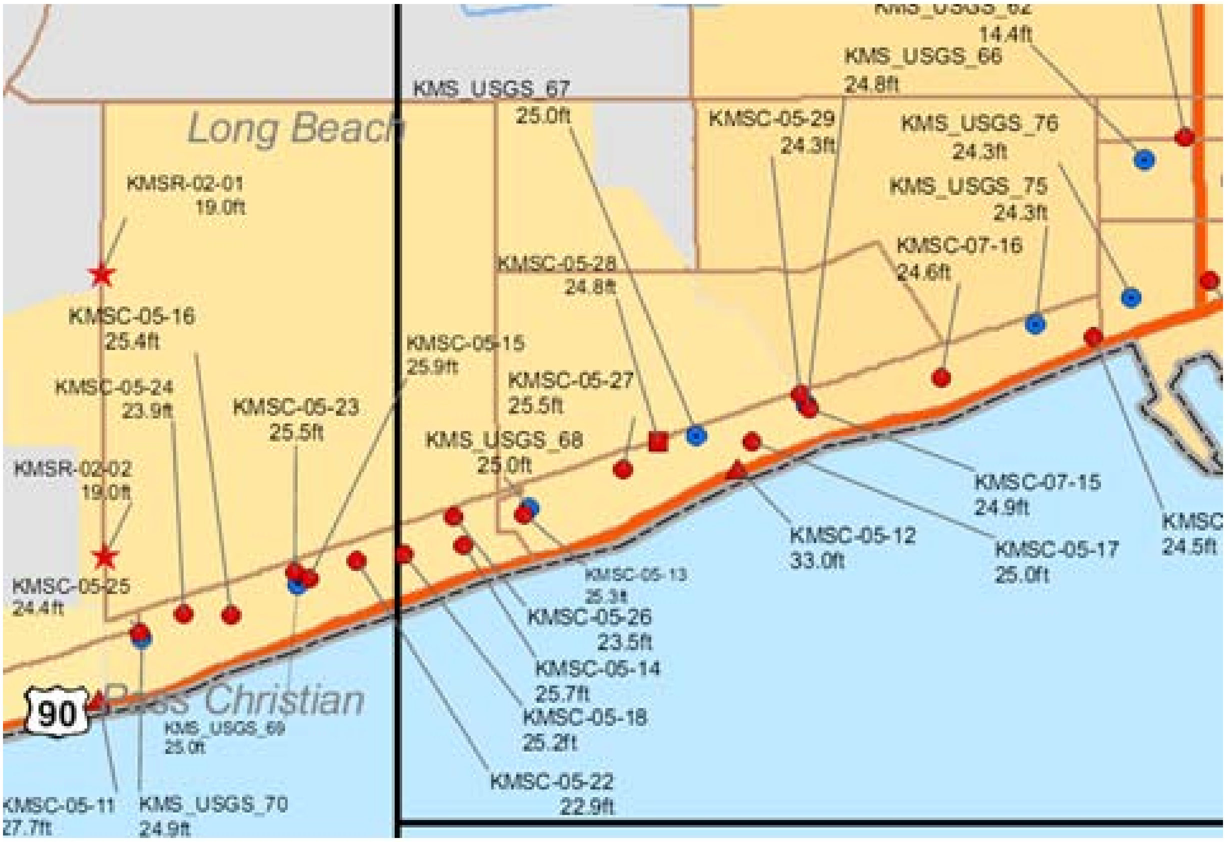

Fig. 23 : A section of HWM surveys along MS after Katrina (see FEMA, 2006). Note that an 8ft wave setup existed as a result of the difference between total inundation of 33ft at station KMSC-05-12 and the 25ft surge-only at nearby KMSC-05-17 (see FEMA, 2006)

VII. Conclusions

On the basis of aforementioned analyses and discussions, several conclusions can be drawn:

1) The power-law wind profile can be extended from the sea surface to 300m, which is approximately the top of the frictional boundary layer, see Equations (1) thru (3). This law is useful to estimate the wind loading on offshore structures during storms whether it is for design or forensic purpose;
2) The cyclostrophic equation, which is the balance between centrifugal force and pressure-gradient force, is valid so that the overwater wind speed at 10m, U10, can be estimated from the minimum sea-level pressure, Pmin, see Eq. (4);
3) Wind-wave interaction in the open sea as represented by NDBC Buoy 42003 indicates that the significant wave height, Hs, and its dominant wave period, Tp, can be normalized by the friction velocity, U*, resulting that U* can be estimated directly from Hs and Tp and that one can bypass the use of U10 and the drag coefficient; Extreme Hs (=17m or 55ft) measurement at Buoy 42040 could not be explained by the in-situ U10 data, but by Pmin (= 927mb) at 42007 in the vicinity as well as by the new U* and U10 formulations (see Equations (12) and (13), respectively);
4) Storm surge and wave setup near Biloxi, MS, can be explained physically by Equations (14) and (15), respectively; and
5) Because the wind data near Katrina's landfall is insufficient to explain the extreme wave, high storm surge and wave setup, caution must be exercised to use these wind data for the investigation of air-sea-land interaction when a tropical cyclone is near the coast.

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Architecture as Stimulus for Growth and Economic Development in Nigeria

By J. A. Olanusi, D. O. Akingbohungbe & Muhammed Adamu
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Abstract- Architecture and design constitute one of the major economic growth areas in any country. Nigeria increasingly needs to compete in knowledge, development and innovation. Such and all human activities are carried out within some form of shelter or organized open spaces which are contributions or products of architecture to the built environment and the economic growth of the nation. This phenomenon is of enormous and unquantifiable dimension in developing economies like Nigeria. This paper therefore examines succinctly the economic impact of architecture on corporate businesses and the contribution it has made to the social development of the nation. It recommends the way forward for exploring architectural potentials in the tourism industry for boosting the economic base of Nigeria as a means of attracting foreign revenue in support of emerging advocacy for diversification of oil revenue base of the nation.

Keywords: *architecture, design, development, environment, economy, tourism, culture, Nigeria.*

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ARCHITECTUREASSTIMULUSFORGROWTHANDECONOMICDEVELOPMENTINNIGERIA

Strictly as per the compliance and regulations of :

Architecture as Stimulus for Growth and Economic Development in Nigeria

J. A. Olanusi [α], D. O. Akingbohungbe [σ] & Muhammed Adamu [ρ]

Abstract- Architecture and design constitute one of the major economic growth areas in any country. Nigeria increasingly needs to compete in knowledge, development and innovation. Such and all human activities are carried out within some form of shelter or organized open spaces which are contributions or products of architecture to the built environment and the economic growth of the nation. This phenomenon is of enormous and unquantifiable dimension in developing economies like Nigeria. This paper therefore examines succinctly the economic impact of architecture on corporate businesses and the contribution it has made to the social development of the nation. It recommends the way forward for exploring architectural potentials in the tourism industry for boosting the economic base of Nigeria as a means of attracting foreign revenue in support of emerging advocacy for diversification of oil revenue base of the nation.

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I. Introduction

Architecture is a precursor to emotional attraction to goods and services from the exterior envelope of buildings to the interior that accommodate them, both tangible and intangible commodity. Architecture creates a friendly environment that attracts and appeals to the sensory emotional instinct in man to want to see, appreciate and belong. In the process, economic generating activities ensues which impact on the overall well being of man and society.

An interwoven relationship exists between man-made architectural icon and the beautiful spectre of a natural environment which can be visually attractive and inviting to patrons and tourists. Today tourism is one of the largest and highly dynamic sectors of external economic activities. Its high growth and development rates, considerable volumes of foreign currency inflows, infrastructure development, and introduction of new management and educational experience actively affect various sectors of economy. These positively and monumentally contribute to the social and economic development of nations across the world.

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Highly developed economies such as America, Switzerland, Austria, and France have accumulated a big deal of their social and economic welfare on profits from tourism. According to recent statistics (World Bank, 2011), tourism provides about 10% of the worlds Income and employs almost one tenth of the world's workforce. All considered, tourism's actual and potential economic impact is astounding.

The aim of this work is to identify and link economic and cultural demands regarding the Nigerian landscape and tourism architecture with a view to provide to provide a guide for stakeholders of the tourism subsector. It also seeks to underline the efficacy of architecture and design potentials as success tools in tourism and economic enhancement.

II. Architecture and Tourism

Platform of Architecture in Tourism (2007), observed that although architecture, culture of construction and design are attracting public attention, the innovative potential which lies within contemporary architecture is still hardly used in the tourism industry. Notwithstanding, it could greatly enhance the process of creating the corporate identity and market position of businesses, villages or destinations. Despite the close collaboration between the business areas of architecture and tourism, no goal setting or strategic development is directed towards relating tourism to architecture directly. This could have provided necessary interface with conceptual, theoretical and scientific approaches to drive the new product design paradigm as an emerging economic success tool. Historic buildings still remain important signatures as well as highly valued objects. The objective is to bring about sustainable tourism development as well as the international positioning of Nigerian tourism through contemporary architecture and design.

Architecture acts through its qualities.• High quality architecture stands for function and well-being Orientation, functionality and quality of space are hygienic factors indispensable for guest satisfaction. Short distances, good accessibility of all facilities and prevention of crossing points between front and backstage avoid conflicts and increase guest satisfaction. • High quality architecture stands for corporate identity; the very first impression of guest and potential customers is mostly enmeshed in architecture.

Sensual perception and impressive shapes, as well as their illustration create memories. Special design can easily be remembered and therefore positively influences the decision making process. • High quality architecture translates into competitive advantage; good architectural composition is something special and unforeseen. The involvement of history and environment gives it the potential to differentiate it from competitors.

III. Man Made Architectural Icons

a) Millennium Park: Impact on Chicago's Economy

Collins (2005) observed that the Millennium Park completely opened in the summer of 2004, but its impact on Chicago's economy was established years before since the park was opened incrementally. Real estate values and the property tax base were enhanced as early as the spring of 2000 when it was reported that a Michigan Avenue commercial building was sold for $90 a square foot, more than double what the seller purchased it for six years before. The seller maintained that Millennium Park stimulated the sales of condominium projects along central Michigan Avenue "with buyers standing in line for hours to put down deposits, and sales contracts being signed at a faster pace than any other downtown neighborhood."

A total of seven condominium projects are attributing their successful sales to Millennium Park. The most prominent is the 57-story tower Heritage at Millennium Park which is now totally sold out. The average price per square foot of the Heritage was $592 which puts it at a new top fee for the condo market. Millennium Park has created a very strong appeal for young professionals, retirees or "empty nesters" to move back downtown from the suburbs.

The central business district not only has Millennium Park with its largely free cultural attractions, but it also has many other cultural institutions, proximity to many business and corporate headquarters, and the potential of great views of the park, the lake and Chicago's incredible skyline. The Millennium Park, Economic Impact Study prepared by URS and the Goodman Williams Group and released in April of 2005, calculated that the impact over the next ten years on the adjacent real estate market that is directly attributable to Millennium Park totals $1.4 billion.

Similarly, According to the Voyages Photos website, tourism in Italy benefits the economy much more than its rich agricultural landscape. The tourism industry generates employment for locals and increases profit margins for the country. According to the Ministry of Foreign Affairs, 69 percent of Italy's GDP is the services sector, specifically tourism. The construction sector makes up 29 percent, which tourism greatly affects, and 2 percent of GDP comes from agriculture resources.

IV. Construction Industry as a Prime Motivator

The construction industry is generally responsible for the physical development or the transformation of the environment which makes the built environment very vital to social-economic development of a nation. It comprises of building, civil and heavy engineering works. Ajanlekoko (1990) affirms the industry to be a prime motivator of any economy while in Nigeria; it represents 60 percent of the capital investment. The World Bank attributes the industry to account for between 3 to 8 percent of the Gross Domestic Product (GDP) in developing countries, Nigeria inclusive.

Hillebrandt (2000) opines that the sector forms a crucial focus of any nation's economy. In the view of El-Rufai(1993), the sector was referred to in economic term as capital goods industry because its products and services do constitute the basis where other economic activities are built upon. Plessis (2007) views construction as a large sector of the economy responsible for millions of jobs and a significant proportion of GDP in most countries. When allied to other sectors and industries in materials production and distribution as well as services sectors such as transport, finance and the property market, its impact on society and the environment and its influence on the character of the world are tremendous.

Architecture is concerned with the planning, design, and production of buildings either existing or new (Amole, 2004) and its role in this struggle in which the Nigerian state seeks her rightful position in emerging 21st century global economy cannot be overemphasized. The demand on the practice of architecture is thus that research needs to match the level of everyday practice, if the profession is to retain its credibility or relevance. The diversity of clients, buildings and user groups suggest that new conditions hitherto unknown to the profession indicate that stock experience will not be sufficient to respond efficiently to the needs of these new environments and people.

Nigeria is classified as a mixed economy emerging market, and has already reached middle income status with its abundant supply of natural resources, well-developed financial, legal, communications, transport sectors and stock exchange (the Nigerian Stock Exchange), which is the second largest in Africa. Nigeria is ranked 31st in the world in terms of GDP (PPP) as of 2011. Nigeria is the United States' largest trading partner in sub-Saharan Africa and supplies a fifth of its oil (11% of oil imports). It has the seventh-largest trade surplus with the U.S. of any country worldwide. Nigeria is currently the 50th-largest export market for U.S. goods and the 14th-largest exporter of goods to the U.S. The United States is the country's largest foreign investor.(World Bank 2011).

Godwin (2008) stated that The International Monetary Fund (IMF) projected Nigeria's economic growth of 9% in 2008 and 8.3% in 2009. The IMF further projects an 8% growth in the Nigerian economy in 2011. According to Citigroup, Nigeria will get the highest average GDP growth in the world between 2010 –2050. Nigeria is one of two countries from Africa among 11 Global Growth Generators countries.

V. Creative Industries (Architecture and Design) as Economic Assets

Madaline (2005) observed that in today's economy Creative and new media industries are growing in number and playing increasingly prominent economic and social roles. The market value of products is increasingly determined by a product's uniqueness, performance, and aesthetic appeal, making creativity a critical competitive advantage to a wide array of industries; Also that most desirable high-wage jobs require employees with creativity and higher order problem solving and communications skills; while Business location decisions are influenced by factors such as the ready availability of a creative workforce and the quality of life available to employees.

Governors and their civil service staff are confronted by a global economy that is increasingly competitive and in which the Nigerian is no longer assured of a dominant position within the African sub region. Countries such as China, Korea, and Ireland are outpacing the United States in key indicators such as economic growth, new product innovation, broadband penetration, and educational attainment among younger generations. As this gap widens, states recognize that a competitive edge and a creative edge go hand-in-hand to support economic prosperity.

Further more in this environment, a state's arts and cultural resources can be economic assets. The arts and cultural industries provide jobs, attract investments, and stimulate local economies through tourism, consumer purchases, and tax revenue. Perhaps more significantly, they also prepare workers to participate in the contemporary workforce, create communities with high appeal to residents, businesses, and tourists, and contribute to the economic success of other sectors.

Emily (2005) explained that the creative economy may include human, organizational, and physical assets. It also includes many types of cultural institutions, artistic disciplines, and business pursuits. Industries that comprise the arts and culture sector may include advertising, architecture, the art and antiques market, crafts, design, fashion, film, digital media, television, radio, music, software and computer games, the performing arts, publishing, graphic arts, and cultural tourism. Though the creative industries are broadly defined, they are important to state economies. First and foremost, they contribute directly to jobs, tax generation, and wealth. For example, the creative economy in Arkansas in America employs nearly 27,000 individuals and generates $927 million in personal income for Arkansas citizens.(Regional Technology Strategies, 2007).

Creative enterprises are the third largest employer in Arkansas—after transport, logistics, Perishable and processed foods. Nigeria is yet to actually exploit the full potentials of the economic contributions of the arts using a range of measures, from the work of nonprofit arts agencies to the impact of cultural tourism.

Whether it is the $3.9 billion infused into North Carolina's economy in 2006 through the wages and income of workers employed by creative enterprises. (Regional Technology Strategies 2007), or the 17.6 percent yearly growth of the cultural sector in Massachusetts (and its $4.23 billion economic contribution), (Gregory, Wassall and Douglas 2002), it is clear that the creative sector is important to individual state and the Nigerian economy as a whole.

In addition to direct financial contributions, the arts and culture can offer states a wide array of other economic benefits, such as the following:

a) Helping Weak Economic Areas

The decentralized nature of the creative industries can benefit Residents of areas often thought to lack economic strength—such as rural areas. (Madeline 2005) and the urban core.(Jeremy 2007) At the heart of the creative industries are individual artists who are typically well-connected to the communities where they reside. Linking these artists with entrepreneurial opportunities both inside and beyond their regions offers many economic development possibilities.

According to Dun & Bradstreet data analyzed by Americans for the Arts, a national arts advocacy group, 2.98 million people across America work for 612,095 arts-centric businesses. This represents 2.2 percent and 4.3 percent, respectively, of all U.S. employment and businesses.(Jeremy 2007) Using Arts and Culture to Stimulate State Economic Development.

b) Recruiting and Developing a Skilled Workforce

Architecture is an important complement to community development. They provide an enhanced quality of life, enrich local amenities, and play an important role in attracting young professionals to an area. Richard Florida, a leading expert on economic competitiveness, innovation, and demographic trends, is credited with coining the term "Creative Class," which describes young and talented individuals who are mobile and more likely to locate where there is a vibrant and creative environment. Attracting and retaining talented young people and companies is becoming increasingly important to states. The arts and culture

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within an area play an important role in attracting these professionals.

c) Attracting Tourism Naira

The audiences drawn to arts venues and cultural events also bring economic benefits for other businesses. A thriving cultural scene helps attract visitors who not only spend their money on the events themselves, but also contribute to local economies by dining in restaurants, lodging in hotels, and purchasing gifts and services in the community. A recent study on the drivers of tourist spending found that tourist expenditures correlate directly with the number of arts and design workers employed in a region.(Regional Technology Strategies 2007)

VI. Architecture and Tourism Industry in Nigeria

In recognition of these benefits, numerous states have adopted a wide range of strategies designed to foster arts and culture and tap into the resulting economic benefits. Cross rivers state in Nigeria seem to have defined their creative economies in a variety of ways, depending on the composition and character of businesses, nonprofits, individuals, and venues that exist. The Tinapa Business and Leisure Resort in Cross River State has the potential to generate N100 billion (US$ 666 million) annually according to its managing director, Tinapa's major problem is that people are not aware of the opportunities at the resort. (Ndem.2010)

According to Ndem (2010), Tinapa will see an improvement in the quality of services and the number of tenants and businesses in the near future. physical structures at the resort have been completed, a number of shops have started to operate and that the water park has been completed.

Nigeria can take steps to incorporate arts and culture into state economic development plans and policies. Specific, approaches for better identification and analysis can be made for state's arts and cultural resources so that policymakers may better understand the existing creative enterprises in their state and the dynamic roles that these enterprises play in the state's economy. This often involves convening a strong leadership body comprising experts from public, private, and nonprofit sectors to develop a distinct vision for tying architecture and arts to economic growth strategies. Governors can develop the arts and culture sector through for-profit and nonprofit businesses, non-arts industries, individual entrepreneurs, and arts networks as well as through ensuring a skilled workforce for the sector to draw upon and education in the schools to cultivate understanding, appreciation, and demand for arts and cultural goods and services. In particular, states can incorporate arts and culture into community development plans through the use of grants, enterprise zones, and by supporting development of art space. States may include arts and culture as part of their tourism strategy, particularly through efforts that promote and market the state's unique cultural heritage or products.

This is intended to help governors' unlock the potential of arts and culture within their states to benefit state economies.

Inskeep (1991) gave a clear cut distinction of the components of the travel and tourism industry,. Preparatory to the components is the UNWTO (1999) definition of the travel industry which defined the industry as The composite of organizations both public and private that are involved in the development, Production, distribution, and marketing of products and services to serve the needs of the travelers.

From the above, it is obvious that the industry is all encompassing being multifaceted and multidimensional in nature as attested from the components of the industry and as identified by Inskeep (1991)to include;-

a) Accommodation

The sector which takes 20% - 30% of the tourist expenditure, is serviced by various components of the accommodation services to include; Bed and breakfast – budget; Pension Houses; Youth hostel; Camp ground; Recreational vehicle parks and Cruise; Hotel; and Motel Etc.

b) Infrastructure

Furthermore Inskeep explained that this refers to components found on or below the ground level that provide the basic framework for effective functioning of development systems such as urban areas, industry and tourism. The components further have those basic services to include supply of water, electricity power, sewage and solid waste disposal, drainage and telecommunications which are a few of the critical elements required for the industry to perform efficiently.

c) Transportation

As to whether the tourist travel by Air Sea or land with adequate facilities and services, these are in the areas as of airport terminals, harbors and road systems which involves architectural inputs.

d) Food and Beverage

This sector provides for restaurant, bar and other types of eating and drinking outlets of sizes and services. The business themselves form primary or secondary sources of tourist attractions for destinations such as Lyons, Paris, Rome, Hong Kong, new Orleans abroad and Obudu Ranch, Tinapa Disney World etc in Nigeria.

e) Support service

Is the last with shopping facilities and services at the destinations which help fulfill the basic as well as supplementary needs of visitors. The stores which meet the varying demands of the visitors include:- Souvenir shops;- Duty free stores;- Laundry facilities;- Grocery and department stores;- Tour guide services sport and Recreations retail and rental shops;- Entertainment facilities as Nite-club, opera etc.

VII. Nigeria's Policy on Tourism Development

The policy is a guide for action. The Nigeria tourism industry has been on the road map for development over time. This is evident in the provisions of a road map for the harmonization and diversification of the tourism resources. In 1990, a tourism developments policy was established and was partially implemented due to non implementation of the provisions. It was also seen to be a toothless bulldog for the fact that it was not been funded for action. Nonetheless, the policy made provisions upon which the 2005 reviewed policy was made more proactive to tourism development needs in Nigeria. The 2005 reviewed Tourism policy provided for a mandate; Policy Thrust, institutional framework; funding among others with the 2006 Nigeria Tourism Development Master Plan designed along the policy guide.

In the Nigeria Tourism Development Master Plan of 2006, tourism diversification strategies are stressed with interests covering all the tourism policy and development matters. The document produced in three volumes touched most aspects to do with sustainable tourism development in line with global best practices. A new set of reforms was introduced in the tourism industry with the assistance of the United Nations. This led to the creation of the "Nigeria Tourism Master Plan". The report identified amongst other things that the number of international visitors to Nigeria had been static over the last 15 years because of factors like stodgy entry visa processes, lack of information on Nigeria amongst tour operators in the west, bad road networks, and the dilapidated state of many of Nigeria's historic sites. Six years after the master plan had been drawn, the commentary on Nigeria's tourism industry will probably be worse. Though there has been a major influx of global hotel brands into Nigeria in the five years, especially in Lagos, the commercial capital of Nigeria, the average cost of these rooms puts it out of reach of the average holiday maker from Europe and America especially in these hard times. The tourism master plan advocated for partnership programs between the internationally operated hotels in Nigeria and tour operators in the west to use spare capacity in these hotels at favourable rates. Five years after, the tourism and hospitality industry still represents a meagre 0.5% of Nigeria's GDP.

VIII. Nigerian Economic Reforms and Tourism

The new thinking on tourism was actually spurred by the reforms embarked upon by the federal government, sensing the need to diversify the government's revenue base and correct the structural deficiencies of the economy. These macro-economic reforms of 2003 to 2007 led to strong growth in sectors like banking and telecoms. With oil revenue on the decline and distortions to crude supply owing to the troubles in the Niger Delta the Nigerian government looking for ways to breathe new life into the economy sought to develop the Nigerian tourism sector. Realising that tourism is a strong alternative to crude oil as a revenue earner, in view of declining global oil prices, government selected the industry as one of six priority areas central to the revival of the economy. Tourism became a cardinal stone for achieving Nigeria's 7-point agenda and its Vision 20:2020 programme and also attracting foreign direct investment.

The downstream economic impacts from the "export" revenues of international tourist spending was estimated to generate additional gross revenue of N29 billion. Unfortunately, tourism and solid minerals were some of the fragile non-oil sectors which suffered from a policy shift. The tourism industry has fallen off the radar once again and is still straddling for attention while more Nigerians are exporting jobs and revenues to less endowed destinations like The Gambia.

At the Tourism Conference held in Vancouver, Canada in 1988, it was estimated that the tourism arrivals for the year would be 400m while the projected revenue would rank third among all exports; accounting for 6% of total world export and representing 25% of international trade and services. The estimates also showed that international travel would contribute almost 10-12% of the world's gross product or US$2.0trillion in 1988. Moreover, a recent survey by the World Tourism Organization on receipts from international Tourism, 1977-1981, showed the contributions of Tourism to the economic well-being of some African States including Nigeria. In 1981, the revenue accruing to Kenya was US$240m, Morocco US$440m, Tunisia US$581m and Nigeria US$55m, representing 20.2%, 17.9%, 26.5% and 0.3% of total exports respectively. (Federal Republic of Nigeria 1998).

a) Capital flight due to patronage of foreign professionals

The Nigerian Institute of Architects has condemned the preference by government and corporate organizations for foreign professionals to handle building design and construction projects to the exclusion of their indigenous counterparts. This, the institute said, had shown insufficient recognition of the competence and capacity of the Nigerian registered architect, and inappropriately showing undue preference for foreign practitioners, contrary to mandatory provisions in the Architects Registration Council of Nigeria Act. This has implications on national security, economic growth, capacity development, transparency, national pride, job creation and sustainability of the profession. It no doubt runs contrary to the transformation agenda of the Federal Government in regards to the improvement of the quality of delivery of building construction in the country and a positive effect on the welfare of the millions of Nigerians, who are participants in this highly dynamic economic sector.

The global issues of sustainability, eco-architecture/green buildings and various rating systems and their relevance to the country, must undergo innovative adaptation and application for overall socio-economic transformation and cultural rejuvenation. Support is needed for the development and processing of local materials to complement contemporary design goals through constant integration of practice, education and research.

Daramola, (2005) opined that the level of bastardisation is gradually penetrating the rural set-up with alienating foreign design concept that has no bearing with the village architecture. This agrees with the earlier view of Awotona (1987) that the consequence of undue pre-occupation with visual order and the aesthetic of the spatial environment in the Western sense is gradual abandoning of the local ways of life, and of doing things. This has led to destruction of the positive features of the traditional patterns and weakening of the economic base of the architectural industry.

IX. Recommendations

The government should implement the already ratified 2006 tourism master plan and develop the tourism industry which is a viable alternative to a mono crude oil economy. An enabling commercial and business environment should be created to support the industry to thrive by encouraging private entrepreneurs willing to invest in architecture and tourism.

Physical infrastructure development like functional road networks, stable and reliable water and electricity supply will be required for the development and growth of the tourism industry.

Construction materials should be locally sourced and developed for use to reduce cost by the encouragement of Research Institutes and Universities through appropriate funding and patent manufacture of their research findings.

Security has to be ensured to create a feeling of safety to potential tourists and investors who directly or indirectly participate as stakeholders in the industry.

Indigenous architects and urban planners should be employed in all areas of the physical and other developmental plans by government or private entrepreneurs to stem capital flight for a positive reinjection and stabilization of funds for the nation.

Nigeria is lagging behind in the area of tourism and infrastructural development and is fast losing its commercial and industrial position to other neighbouring countries like Gambia and Ghana consequently losing accruable revenue and job creation activities. Government can generate jobs by creating a wholesome environment to enable business and commercial activities thrive, which will offer invaluable opportunities to the youths. This will further assist in ensuring peace, security and multiplied economic progress in the society.

X. Conclusion

This paper looked at architecture as the prime facilitator of the built environment in terms of design, planning and physical project execution be it buildings, landscape and the totality of urban design and the concomitant totality of human activities. Therefore the economic effects of the architectural stimulus is all encompassing since modern human endeavours are carried out in the planned space, be they open or enclosed.

Even though architecture has contributed to the economic development of Nigeria in terms of good quality designs for private, corporate and government clients while effectively stimulating other related economic activities carried out from design to construction and use of the facility, its other financial and economic benefits in the tourism sector is largely untapped and is comparatively low in Nigeria.

Architects as urban designers are involved in building designs as well as landscape designs primarily and are equally involved in other design related fields and so contribute immensely to the socio-economic development of a nation through the attraction of tourists and hence revenue to places of scenic beauty like TInapa in Cross Rivers State of Nigeria and the millennium park in Chicago in America. There is a lot of revenue accruable to tourism and man-made scenes of beauty besides existing natural features. There is always a good return on investments. There is an astounding cost benefit that nations of the world are keying into in order to reap the benefits and create job opportunities for their citizens.

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Peat Resources, Paleo-Environmental Interpretation as well as Their Utilization, Hakaluki Haor, Moulvibazar and Sylhet District, Bangladesh

By Mohammed Masum, Md. Mizanur Rahman, Mohammad Omer Faruk Khan, Nazwanul Haque, Faruk Hasan & Mohammd Anisur Rahman

Geological survey of Bangladesh, Bangladesh

Abstract- The study area is the Hakaluki Haor which is the second largest wet land of Bangladesh. It spans over the districts of Moulvibazar and Sylhet in northeast Bangladesh. The study was focused in the exploration of peat reserve, reconstruction of the paleo-environment as well as the utilization of the peat resources. Peat is found randomly from 0.5 m to 7 m below the surface and 1 m to 11 m thickness at over 40 beels as well as small plain lands of 90 km2 area of Hakaluki Haor. The total reserve of peat is 282 million ton in wet condition and 112 million ton in dry condition. The peat deposits of Hakaluki Haor area is the largest peat reserves of the Bangladesh. Peat bearing Hakaluki Haor is a low-lying wet land which geological term is synclinal depression. It may be a syncline between two anticlines which was filled with sediments as well as various plant materials derived from the hilly region (anticline) on both sides (west and east) of the Haor.

Keywords: *beel, deposition, haor, peat.*

GJSFR-H Classification : FOR Code: 960699

PEATRESOURCESPALEOENVIRONMENTALINTERPRETATIONASWELLASTHEIRUTILIZATIONHAKALUKIHAORMOULVIBAZARANDSYLHETDISTRICTBANGLADESH

Strictly as per the compliance and regulations of :

Peat Resources, Paleo-Environmental Interpretation as well as Their Utilization, Hakaluki Haor, Moulvibazar and Sylhet District, Bangladesh

Mohammed Masum [α], Md. Mizanur Rahman [σ], Mohammad Omer Faruk Khan [ρ], Nazwanul Haque [Ѡ], Faruk Hasan[¥] & Mohammd Anisur Rahman[§]

Abstract- The study area is the Hakaluki Haor which is the second largest wet land of Bangladesh. It spans over the districts of Moulvibazar and Sylhet in northeast Bangladesh. The study was focused in the exploration of peat reserve, reconstruction of the paleo-environment as well as the utilization of the peat resources. Peat is found randomly from 0.5 m to 7 m below the surface and 1 m to 11 m thickness at over 40 beels as well as small plain lands of 90 km2 area of Hakaluki Haor. The total reserve of peat is 282 million ton in wet condition and 112 million ton in dry condition. The peat deposits of Hakaluki Haor area is the largest peat reserves of the Bangladesh. Peat bearing Hakaluki Haor is a low-lying wet land which geological term is synclinal depression. It may be a syncline between two anticlines which was filled with sediments as well as various plant materials derived from the hilly region (anticline) on both sides (west and east) of the Haor. The transportation may be triggered by large natural disasters or any tectonic reason. On the other hand vegetation occurred in this depression as aquatic plants which might have been destroyed by large natural disasters or any tectonic reason. As environment dictates the characteristics and the source of sediments, various aspects of the sediment are indicators of the environment. Peat has mainly industrial importance as a fuel for power production, traditionally used for cooking, domestic heating and in brick fields, also used as insulator in many industries, agricultural purposes, retaining moisture in soil, raw material in horticulture and colour industries etc. Power plants of about 100 MW capacities may be established in this region based on peat of Hakaluki Haor which may be continued more than one hundred years.

Keywords: *beel, deposition, haor, peat.*

I. Introduction

Peat dominant Hakaluki Haor is one of the largest peat reserves of Bangladesh which is very important both economically and geologically. Peat is one of the most important mineral resources around the world. The peat dominant area is surrounded by Fenchuganj and Gopalganj upazila of Sylhet district; Baralekha, Juri and Kulaura upazila of Moulvibazar district (Fg. 1). The peat is characterized as thin to thick bedded (0.5 m to 8 m), brownish black to black colour, fibrous, mature as well as the chemical analysis of the peat reveals that the heating value is high, carbon content is high, ash content is low and sulfur content is low. The dominant type of peat in the study area is of mature class which is mature typeof peat. Most potential use is for small power plant which may help meet the current demandfor power which in turn may help the economy of the country.

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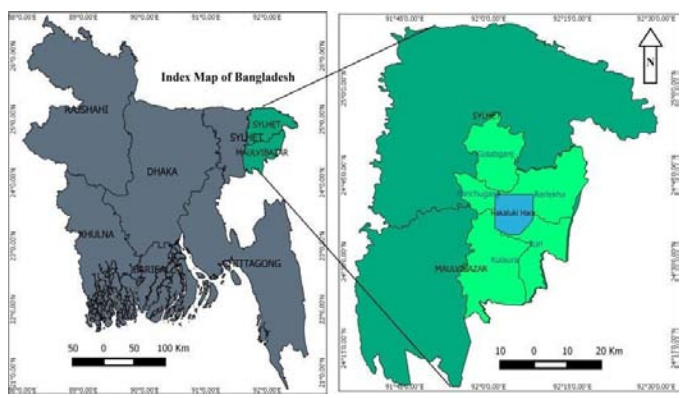

Figure 1 : Map showing the location of the Peat dominant Hakaluki Haor, Sylhet and Moulvibazar district, Bangladesh

II. Description of Peat Bearing Hakaluki Haor

The surveyed area of Hakaluki Haor comprises grass lands, plain lands, swamp forests, agricultural lands, river channels and more than 40 beels. The haor area is a low lying shallow depression which submerged for 3 to 5 months in a year. 1352 auger hole (Fig-2) have been drilled during the field investigation. The western part of Hakaluki is rich in dry peat which is about 56 km2 in areal extent. The eastern part of Hakaluki haor covers the eastern extreme part as well as north-eastern part of this haor which are mainly wet peat dominant. The minimum thickness of the peat encountered is 0.5 m in the peripheral zone and the maximum thickness is 12 m in the area near Chatal Beel. The peat is characterized by brownish black to black colour, fibrous texture and mature type. The peat is very fine grained at some places (westarn part) whereas contains large fragments of woody and leafy matters at other places (eastern part). The dryness of the peat deposit is of remarkable degree. There is only a very negligible amount of water within the peat while squeezed with bare hand. The organic matters of the peat have altered to a very high degree into dense, dark coloured and compact peat materials. The colour of the peat is a good indicator of its maturity and also indicator of a high degree of maturation in the coalification processes. At some places it is close to lignitic coal in nature which is observer during the field investigation. The thickness of peat decreases in dry upland areas may be due to vertical pressure of thick overburden whereas a reverse case is observed in the lowlying beel areas because of their thin overburden. The peat depostis of eastern part of this area is comperatively less mature in nature than that of the western part. Large fragments of wood (wooden logs/woody matters) and leafy matters are found in some places of easternpart where the water content of the peat is very high and is almost liquid to semiliquid when extracted above ground.

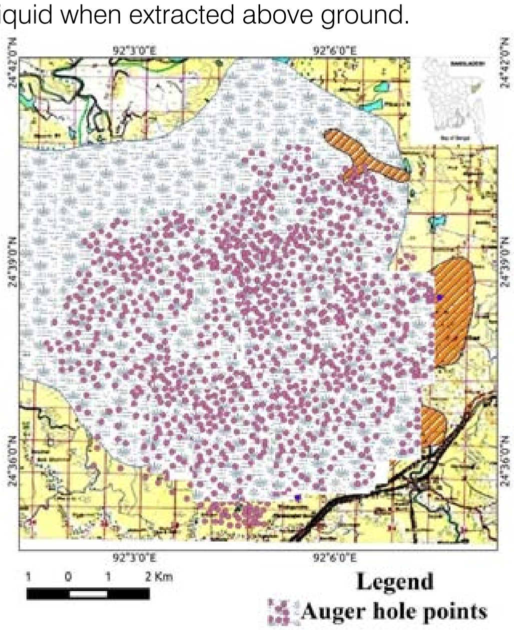

Figure 2 : Map showing the auger hole locations of Hakaluki Haor, Sylhet and Moulvibazar district, Bangladesh

III. Economic Aspacts of the Peat Deposits

Hakaluki Haor is a vast peat dominated region in Bangladesh. Peat is found at shallow depths (0.5 m to 7 m below the surface) which reserves is higher than others peat field in Bangladesh. The surveyed area of Hakaluki Haor is designated the largest peat field in Bangladesh. This peat of this Hakaluki Haor may be used at different purposes; most notable use is heating fuel for small power plant. The peat deposit of Hakaluki Haor is one of the most important mineral resources which may be used for power production as well as other home and industrial uses. If 50% of the deposits may extract, 100 MW power plant may be established in this region which would continue for a period 100 years. It should be mentioned here that annual fuel requirement for every 20 MW of capacity would be 200 thousand tons of dried peat (35% moisture level).

IV. General Geology of the Area

The study area of Hakaluki Haor occupies a syncline between two anticlines. The Patharia anticline on the east and Bhatera anticline in the west. The geology dictates the physiography of the area which is essentially a flat land with many small depressions termed as beels. The beels are wet lands that go under water for the whole of the year, while the whole area turns into a vast water body only in the wet season and is termed as haor.

V. Lithological Description of the Study Area

The Hakaluki Haor is a vast low lying area with many localized water bodies that persist throughout the year. Sediments derived from the nearby hills get deposited in the haor largely during wet seasons when the whole area goes under water. During winter when the haor dries up for the most part, the sediments are deposited only by small and narrow channels. The sediments settle over beel beds in calm and quiet condition. Thus coarser grained sediments are deposited on and near streams and finer grained sediments are deposited all over the haor. Thus, the surface lithology of the deposits is dominated by finer grained clay, silt, silty clay and clayey silt.

The lithological layers of surveyed area have been grouped in a generalized way into three units based on their dominant lithology as unit-I, unit-II and unit-III (Fig 04).

They reveal that under the surficial fine clastic deposits lies a thin to thick bedded carbonaceous layer. This is a peat bearing layer that from the main economic mineral resource of the area. The peat deposit is dominated by vegetal matter and is very fresh i.e. the sediment content of peat deposit is very low. Both dry and wet peat occurs in the area. In the southern part, the peat occurs in two or more layers whereas in the northern part, the peat is represented by only one layer.

The peat layer is underlain by a characteristic bluish gray, silty clay layer all over the area. At places, this layer is represented by sand or clayey silt which are localized in nature. The base of the layer could not be encountered due to limitation of the boring depth with a maximum depth of only 11 m. The content of vegetal matter in this layer is negligible and only some rootlets occur sparsely.

A fence-diagram (Fig 3) also using the Rockworks 16 software has been prepared which shows the overall distribution of the sedimentary layers. The fence-diagram shows that the thickness of peat is highest in the southern part and decreases towards north and northwest.

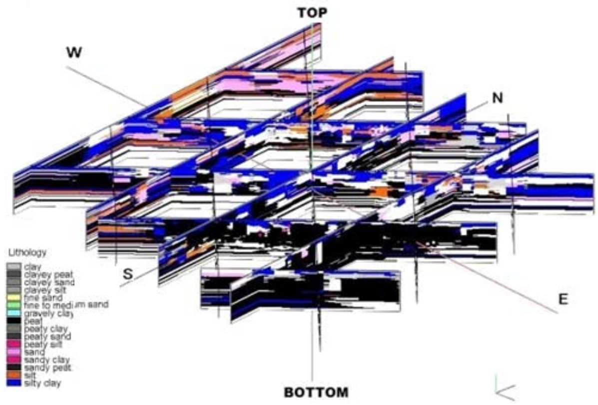

Figure 3 : Fence diagram of surveyed area Hakaluki haor, Sylhet and Moulvibazar district.

VI. Holocene and Pleistocene Boundary Condition

6 tube well boring have been done at different places (more than 1 km distance) in the eastern part of Hakaluki haor of the study area to identify the base of the Holocene deposits and the Holocene-Pleistocene boundary (Fig- 10). The bore hole litholog have been given in Appendix-2. The bore hole-1 is in the eastern most boundary at Nayabazar plain land, bore hole -2 is in the Chinaura beel, bore hole -3 is in the Chatal beel, bore hole-4 north-eastern boundary at Gorkori beel, bore hole -5 is in the middle-eastern extreme part of Hakaluki haor near Belagaon village and bore hole -6 is in the Sahpur village near Gobidhopur. The boundary occurs at different depths ranging from 15.7 m to 23.3 m. The maximum depth was attained in the bore hole of 1, 3, 4, 5 and 6 (21 m to 23 m) while the depth was minimum in the bore hole-2 which is eastern extreme peat dominant part of the study area. This signifies that the haor depression was deepest in the western part while shallowest in the eastern part. The nature of the boundary is not the same at every place. The upper layer is dominated by clay. At only two places it is dominated by sand. The lower sand bed is present everywhere but it is much thin in bore hole-3 and bore hole-5. The underlying sand is the Dupi Tila sand which is the main water bearing formation of the Bengal Basin. The average thickness of the upper layer is about 19 meter which indicates that the sedimentation rate was 0.162 cm per year (average thickness/age of Holocene, 11700 years).

VII. Pale Environmental Interpretation of Shallow Sediments of Hakaluki Haor

Geologically the haor is a synclinal depression located between two anticlines on eastern and western sides. The syncline has been filled up mostly by sediments derived from these anticlines. As environment dictate the characteristics along with the source of sediments, various aspects of the sediment is an indicator of the environment of that time.

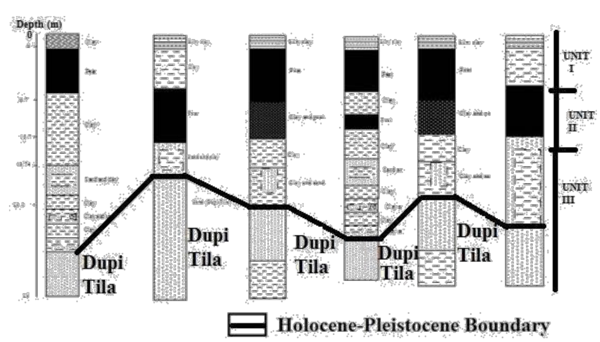

Figure 4 : Figure showing the Holocene-Pleistocene boundary condition and Three main lithological units, Hakaluki Haor, Sylhet and Moulvibazar district

The above characteristics may indicate a uniform environment of deposition in shallow to deep water lacustrine environment with little vegetal growth. This environment may be persisted as a deep to shallow lake allowing fine grained sediments to be deposited.

The sediments of this unit may indicate the upper part of the deposit which may represent the last stage of lake sedimentation. At the end of the sedimentation of the unit the water depth might have been less enough to allow vegetal growth on top of the unit. A hypothetical model has been constructed in the following figure indicating the paleo environment (Fig 5) during the deposition of Unit III. The Unit II is dominated by peat deposit and is situated on top of the Unit III. This

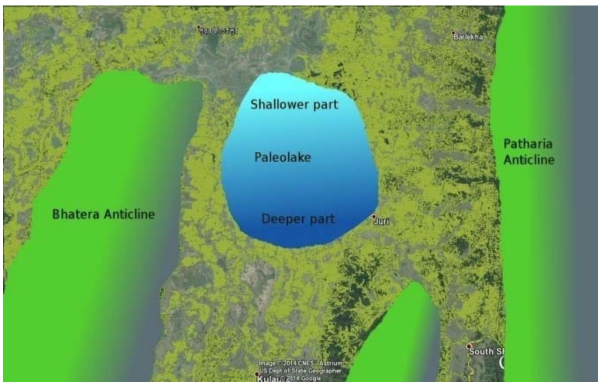

Figure 5 : A pale environmental reconstruction showing the lacustrine depositional environment. Sediments and water from the adjacent anticlines fed the lake. The water was deep enough to allow no vegetal growth

may indicate that at the last stage of the filling up of the lake the water of lake was reduced and the lake bed got exposed for the most part. The lacustrine environment gave way to swampy environment of shallow water and vegetal growth. However, the dry peat and woody to twiggy matter in the northwestern part may indicate that the lake was entirely disappeared in that part. But in the southeastern part the wet peat and filamental to fibrous vegetal matter may indicate that this portion was not entirely exposed. Rather this part was under water for long time. This part was dominated by aquatic plants whereas the northwestern part mentioned before may be dominated by small and medium trees of terrestrial forest environment. In this environmental setting occasional channel [Type a quote from the document or the summary of an interesting point. You can position the text box anywhere in the document. Use the Drawing Tools tab to change the formatting of the pull quote text box.]s might have persisted which allowed herbivorous plants. The environmental model (Fig 6) for Unit II shows a gradual change in vegetation pattern from northwest to southeast. Thus the area can broadly be subdivided into two parts. However, the presence of multiple peat layers intercalated with silty clay to clay layers may indicate disastrous events that transported huge amount of sediments. Nonetheless, the influx of sediments could not destroy the plant growth entirely but allowed vegetal growth on top of them.

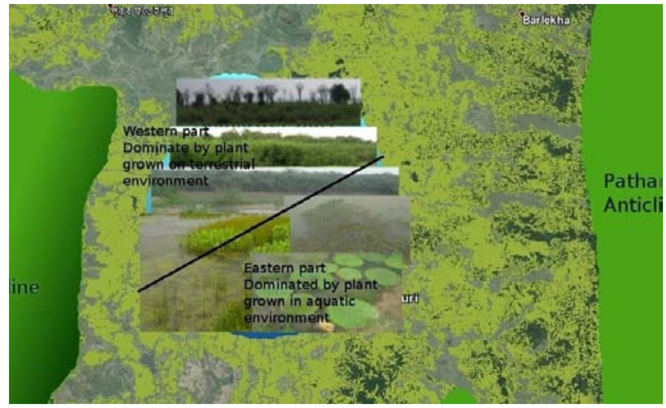

Figure 6 : A pale environmental model for peat deposition of Unit II. The northwestern part is dominated by land plants while the southeastern part is dominated by aquatic/lake plants

After the completion of peat deposition the swamp got totally destroyed by huge sediment influx which forms the Unit I of the stratigraphic succession (Fig 7). This may indicate a sudden subsidence of haor area and upliftment of adjacent hills from which the sediment came. May be this was the last event of upliftment of the hills. This upliftment turned the low lying areas a vast alluvial plain. The silty to sandy clay, suggests the same thing.

At present, however, the haor is slowly down wraping and the vegetation growth has been taking place since the completion of the deposition of Unit I. The current environmental situation has been hypothesized in the following model (Fig 08). This model shows that the current environment is a complex of swamps, lakes (beels), forests, small channels etc. In summary, today all the pale environments persist at smaller scales and are localized in nature. For example, the whole haor area goes under water during the wet season which represents the earliest stage of the pale environment. During dry period the area gets dry and vegetation only exists on channel banks which indicate the middle stage of pale environment. The present environment is a complex of the earlier ones which is well evidenced by its sediment content.

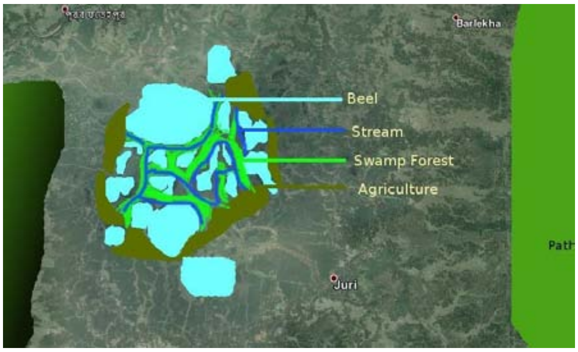

Figure 7 : A simplistic representation of present environmental condition at the Hakaluki Haor. This is the scenario of dry season. In wet season however the hoar turns into a vast sea of a single water body

Figure 8 : Pale environmental model for the development of Unit I. The peat dominating environment was destroyed by sediment from adjacent hills which formed a vast alluvial plain

VIII. Utilization of Peat

Peat is one of the most important mineral resources which is being extensively used around the world. Peat based power station established at different countries in the world like as Ireland, Scotland, Russia, Uganda, and Finland etc. The largest peat based power plant is in Russia named Shatura Power Station with production capacity of more than 1000 MW. The source of peat of that power station from different peat fields of Moscow oblast, Russia and their moisture level is 30%. Another peat based power station is Kirov oblast in Russia with a capacity of 300 MW. The Toppila, Kenjonlahti as well as Haapavesi peat based Power Stations in Finland and their installed capacities are 210 MW, 209 MW and 160 MW respectively. So, Finland is holding the leading position with respect to peat based power station. West Offaly (installed capacity 150 MW), Edenderry (installed capacity 120 MW) and Lough Ree (installed capacity 100 MW) peat based power stations in Ireland are mentionable. Vao peat based power station in Estonia which installed capacity is 25 MW. Peat has many other uses without the heating fuel for power generation which are describing below.

a) Use in agriculture

Peat is important for farmers and gardeners who improving the soil structures and acidity with the help of peat. In Sweden, farmers use dried peat to absorb excrement from cattle which are wintered indoors. The most important property of peat is retaining moisture in soil when it is dry and yet preventing the excess of water from killing roots when it is wet. Peat is an important raw material in horticulture. However, it is recommended to treat peat thermally, e.g. through soil steaming in order to kill inherent pest and reactivate nutrients.

It softens water by acting as an ion exchange; it also contains substances that are beneficial for plants, and for the reproductive health of fishes. It can even prevent algae growth and kill microorganisms. Peat often stains the water yellow or brown due to the leaching of tannins.

b) Use in water filtration

Peat is used in water filtration, such as for the treatment of septic tank effluent,as well as for urban runoff. Due to its purifying properties, peat also serves as a filter for septic tanks, as well, may be used as a water purifier.

c) Use in Balneotherapy

Peat is widely used in balneotherapy (the use of bathing to treat disease). Manytraditional spa treatments include peat as part of peloids. Such health treatments have a very long tradition in Europe, especially in Poland, the Czech Republic, Germany and Austria. Some of these old spas go back to the 18th century, and they are still active today. The most common types of peat application in balneotherapy are peat muds, poultices, and suspension baths.

d) Use in environmental and ecological issues

One of the characteristics for peat is that bioaccumulations of metals are often concentrated in the peat of significant environmental concern is accumulated mercury. The distinctive ecological conditions of peat wetlands, they provide habitat for a distinctive fauna and flora. Such habitats also have many species of wild orchids and carnivorus plants. It takes centuries for a peat bog to recover from disturbance.

e) Use in drainage

Large areas of organic wetland (peat) soils are currently drained for agriculture, forestry, and peat extraction. This process is taking place all over the world. This not only destroys the habitat of many species, but also heavily fuels climate change. As a result of peat drainage, the organic carbon which was built up over thousands of years and is normally under water is suddenly exposed to the air. It decomposes and turns into CO_2) which is released into the atmosphere. The global CO_2 emissions from drained peat lands have increased which particularly taken place in developing countries, as Indonesia, China, Malaysia, and Papua New Guinea, are the fastest growing top emitters.

f) Use in fires

Peat has a high carbon content and can burn under low moisture conditions whichs moldering fires can burn undetected for very long periods of time (months, years, and even centuries) propagating in a creeping fashion through the underground peat layer. Burning of peat bogs in Indonesia, with their large and deep growths containing more than 50 billion tons of carbon, has contributed to increases in world CO_2 levels.

g) Use in brickfields

Peat may be used in brickfields for heating fuel around the world which can reducethe destroying forest. Many of brickfields have been used wooden logs as heating fuel which is directly harmful for environment to decreasing the standard forest level. So the use of peat in brickfields increased to decreasing the environmental degradation.

h) Use in cooking

Peat can be used as domestic fuel for cooking purposes which may reducing the cutting forest and save the environment.

i) Use in paint industry

Peat is randomly used in several kinds of paint industries for making colouraround the world.

It should be mentioned here that the quality of peat is better than that of peat which is using in the above power plant as heating fuel. The moisture levels of peat at Hakaluki Haor as well as other constituents are very low which is good for heating purposes and reserve is sufficient for power production as heating fuel. So, the peat of Hakaluki Haor may be used also as a heating fuel for the production of powergeneration. This peat also used in agriculture, water filtration, brickfield, paint industry, fires, drainage and domestic purposes.

IX. Potential for Heating Fuel in Small Thermal Power Plant at the Study Area

The peat in investigated areas of Hakaluki Haor may be used to run peat fired power plant of 100 MW of capacity. Annual fuel requirement forevery 20 MW of capacity would be 1000 tons of dried peat (35% moisture level, Masum et. al, 2012). This could be obtained easily by mining of peat at Hakaluki Haor Moulvibazar andSylhet district. The total reserve of peat is about 112 million tons in the dry condition (35% moisture level). If 60% of the peat is mined and used in 100 MW power station, this could runfor about 100 years.

X. Conclusion & Recommendation

Based on the surveyed information of peat exploration of Hakaluki Haor of Moulvibazar and Sylhet Districts, the following conclusions and recommendations are made:

The peat of the investigated area is moderate to good quality according to the results on physical and chemical properties of peat.

The reserve of wet peat in the surveyed area is about 282 million tons whereas the dry peat is 112 million tons. The peat may be mined by using local dredgers in dry season and in wet season when the area remains under water, the peat may be mined by barge mounted dredgers. This peat may be used at different purposes of domestic and small industrial purposes after mining. Small power plant like 25 MW may be run using this peat. A proper planning for land use, environmental management and policy should be taken before extraction of peat. Mining of peat must be in such ways that prevents every kind of environmental hazards like landslide/subsidence of the peat dominant surrounding area. Before extraction of peat detailed feasibility study must be done in order to ensure sustainable and environmentally friendly operation.

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Effects of Flood on Infrastructural Development in Uyo Metropolis, Akwa Ibom State, Nigeria

By Anthony Adomi Mbina & Edem, Ephraim E
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Abstract- The increased intensity of infrastructural development in Uyo metropolis has given rise to land sites that have larger portions of non – permeable surfaces. A problem caused by little or no drainage and in some cases overloaded drainage infrastructure. This situation combined with the intense rainfall in the city gives rise to flooding in different locations. Flooding being one of the major ways water is introduced into building construction environment raises the cost of building since it impedes the construction and may eventually cause costly damage to the building. This study has identified flood-prone areas in Uyo municipality and has recommended measures to be taken in order to mitigate its effects on buildings.

Keywords: *overland flow; faulty sewers; peak flood; sediment load; uyo metropolis.*

GJSFR-H Classification : FOR Code: 960699

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Strictly as per the compliance and regulations of :

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Anthony Adomi Mbina [α] & Edem, Ephraim E [σ]

Abstract- The increased intensity of infrastructural development in Uyo metropolis has given rise to land sites that have larger portions of non – permeable surfaces. A problem caused by little or no drainage and in some cases overloaded drainage infrastructure. This situation combined with the intense rainfall in the city gives rise to flooding in different locations. Flooding being one of the major ways water is introduced into building construction environment raises the cost of building since it impedes the construction and may eventually cause costly damage to the building. This study has identified flood-prone areas in Uyo municipality and has recommended measures to be taken in order to mitigate its effects on buildings.

Keywords: overland flow; faulty sewers; peak flood; sediment load; uyo metropolis.

I. Introduction

Flood is the overflow of water into an environment that is normally dry thereby causing inundation and harm to plants and animals, including man. Its harm can be extended to man's buildings and infrastructures (Udosen, 2011). Most flood definitions include damage they cause and depend on their sources or types and magnitude. In the case of flood resulting from rivers, Ating (2003) defines it as a relatively high flow which overtakes the natural channels provided for run–off as well as a high stream which overtops its natural or artificial banks.

Wolf (1965) also describes flood as high rate of discharge in water sources and the inundation of normally dry lands. West (1991) further states that flood is a body of water which rises to overflow its banks or low- lying areas. All over the world, flood is known to cause great damage to people's lives, belongings and properties. Flood causes one third of deaths, one third of all injuries and one third of all damage from natural disasters (Askew, 1999 and Etuonovbe, 2011). This damage is normally felt by various "receptors" being people, buildings, infrastructure, agriculture, and open recreational spaces.

Even social and emotional costs from flooding are significant and are often widespread and indiscriminate in flooded areas. They include : displacement from homes, loss of personal valuables, fear and insecurity caused by such experience. The economy can be serially affected by flooding as businesses may lose patronage, stock, data and productivity. Tourism, farming and livestock can equally be affected.

Utilities and transport infrastructure can be rendered inefficient by flood. Portable water supplies may be contaminated in a flood which has immediate health effects upon human beings and animals. Other vital infrastructures may also be damaged just like the loss of electricity experienced in Britain in 2007 summer floods (RIBA, 2009).

Even in a developed country such as the United Kingdom, the Association of British Insurers has estimated the cost of the July, 2007 flooding, in insurance claims alone at over 3 billion pounds (RIBA, 2011). The pattern of flooding is similar in all parts of the world. In Nigeria for instance, flooding has forced millions of people out from their homes, destroyed businesses, polluted water sources, and increased the risk of diseases (Baiye, 1988, Akinyemi, 1990, Nwaubani, 1991 and Edward- Adebiyi, 1997).

a) Sources of flooding

Generally, there are six recognized sources of flooding namely: tidal flooding, fluvial flooding, ground water, pluvial flooding, flooding from sewers and flooding from man – made infrastructure.

- *Tidal Flooding*

  Sea and river defenses may be overtopped by a combination of low pressure weather systems and high tides. Its duration is limited by the cycle of the tides where drainage is available.

- *Fluvial Flooding*

  When rainfall or snow occurs in rivers, the capacity is exceeded and as a result, there is a rising water level which can in turn overflow into the floodplains close to the river.

- *Ground Water*

  As ground water levels rise, low lying area sitting over aquifers may flood. This type of flood is mainly seasonal and slow.

- *Pluvial Flood*

  This refers to surface water from rainwater – run-off mainly from urban or rural land that has low absorbency. As developments increase in urban areas, land surfaces increase in their areas of non-permeable surfaces and

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combines into intense rainfall which gives rise to localized flooding.

- *Flooding from Sewers*

  This occurs where there are faulty sewers or where sewage capacity is exceeded normally due to large surface water runoff over a short time.

- *Flooding from Man – made Infrastructure*

  This occurs when man-made structures like canals and reservoirs fail resulting in flooding areas downstream (RIBA 1999).

b) Causes of flood

The main thrust of this study has been to assess the immediate and remote causes of frequent flooding in Uyo metropolis. It was to determine which of these causes may be more responsible for the recent incidences of flooding in Uyo city. To be able to do this successfully, a number of physical flood characteristics were evaluated. These critical physical characteristics include:

a) depth of water
b) duration of inundation
c) area of inundation
d) velocity of flow
e) frequency – recurrence relations
f) flong time (Flood time lapse or flood-to-peak interval)
g) Seasonality
h) peak flood
i) rate of discharge increase and decline.
j) sediment load and
k) total flood run-off volume.

II. Research Methodology

The research design used for this study is descriptive. It is based on data already available in addition to responses from structured interviews from respondents who have experienced this malady. It was also based on current data that expose methods adopted by architects in solving flood problems in Uyo metropolis. It stems from the needs of a co-relational study of the effect of flood on architectural developments in Uyo metropolis.

a) The Study Area

The area of study is Uyo metropolis. This metropolis is situated in Uyo Local Government Area. It is highly urbanized, virtually all parts of Uyo lie within the Capital City Development Area (UCCDA) except Ikono clan. Uyo Local Government Area is bordered to the north by Itu, Ikono and Ibiono Ibom Local Government Areas, to the south, by Etinan, Nsit Ibom and Ibesikpo Asutan Local Government Areas, to the east by Uruan which stretches from north – east around Ibiaku Uruan to Ndon Uruan in south eastern corner. It is located between latitudes 4^0 53' and 5^0 04' north of the equator and longitudes 7^0 48' and 8^0 02' east of the Greenwich Meridian (Fig. 1). The total estimated population based on 2006 Population Census is 273,000 persons. While ecological problems cannot be directly linked to population pressure, steep marginal lands around Uyo metropolis which should otherwise be conserved, are developed due to increased need for sites for housing and other architectural developments apart from cultivation. The consequences of this practice are well known.

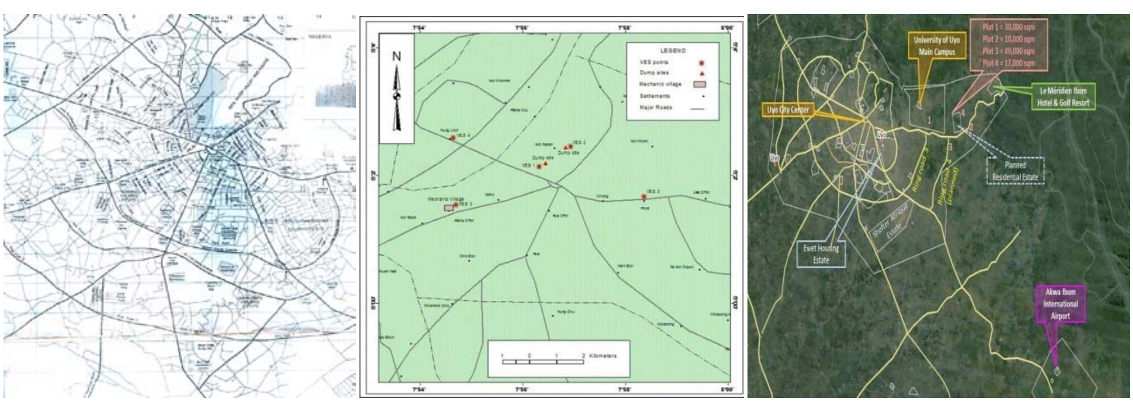

Fig. 1 : Uyo City

III. Flood in Uyo

Flood in Uyo is generally caused by rains. Other factors that cause flood include; the size of the land area from where rainfall is collected, the shape of this area, its average slope along the main channel through which the rain water is led to the site, the rate of urbanization, soil type, moisture content of soil, land use and similar factors, all contribute to the relative magnitude of floods in the metropolis.

The catchment areas or watersheds that collect rainwater to the drainage system are a great factor to be considered when assessing the effects of floods. Most flood problems in Uyo metropolis are associated with depressions in the undulating plains. For example, flood prone depressions include Abak road/Nkemba area, Udo Eduok Street, middle of Nsentip Street, Port Harcourt street, Ikot Ekpene road (near former AKTC) and Ewet/Uruan street. (Fig. 2).

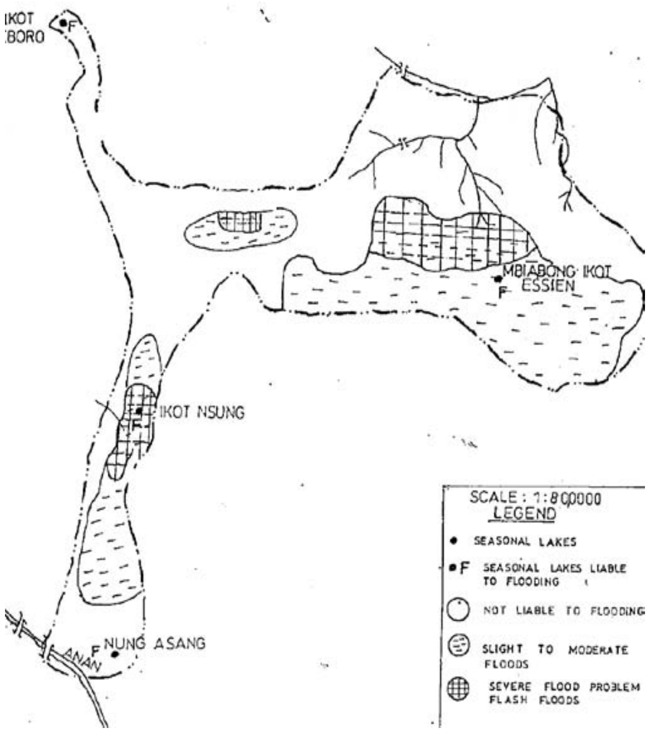

Fig. 2 : Flood Susceptibility Map of Uyo (Source: Field Study 2014)

According to (Udosen, 2011) eight critical flood prone areas are prevalent in Uyo metropolis. Six out of the eight areas were used as sample, that is, clusters of buildings around these flood prone areas are selected randomly for study. Five buildings from each of the six areas were duly selected from the sample. The sample size was thirty.

IV. Presentation and Analysis of Data

It was found out that the prevalent methods used in mitigating flood in these areas include: raised floor levels; the use of drainage to ward off flood water from buildings and the use of soft landscape features like shrubs. It was also observed, however, that most buildings were constructed before the actual resultant flood consequences were experienced. This led to the flood mitigation practices, being mainly rehabilitation and/or reconstruction work around these buildings as mentioned above. Apart from a general description of data collected in the field, an attempt was made to quantify the methods adopted in solving the problems of flood in Uyo metropolis. Among these methods are:

a) *Provision of Drains*

In all the six flood areas, the open v-shaped drains are used especially as street drains; covered drains are, however, used in some buildings at Ewet/Uruan street flood areas, which are also seen connected from compounds to the street drains (Plate 1).

Plate 1: New Drain channels under construction at Uruan Street

Source: Researchers' field work (2013)

Table 1 : Measurement of Street Drains (Gutters) In Uyo Metropolis

Flood area	Dimensions of drain (width x height)
Abak road/Nkemba street Udo Eduok flood area	750mm x 1200mm 600mm x 600mm
Ikot Ekpene Road (near former AKTC) flood area	75omm x 900mm
Ewet/Uruan Street flood area	600mm x 750mm
Middle of Nsentip street flood area	600mm x 600mm
Ibom Plaza	750mm x 900mm

Source : Researchers' field work (2013)

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The Ikot Ekpene road (near former AKTC) and Uruan street drains are channeled to a covered cesspool and soak away pit. These pools trap water in order to control its percolation into the earth after heavy of rain. Many of the drains need removal of sand from drain, to help the water flow quickly from these flood areas.

b) Use of Vegetation in Flood Mitigation:

Out of the flood areas under study, vegetation is notably used for erosion control purposes in the middle of Nsentip flood area. This vegetation (ornamental plants) is used to support the fence walls (Plate 2).

Plate 2 : Flood Control at Nsentip street flood area.z

Source: Researchers' field work (2013)

c) Raised Flood Levels and Half Walls in Building Verandahs

As illustrated in Plate 3, most buildings have 125mm ground floor levels above the natural and assumed ground level. This implies that the foundation foot is approximately 450mm from the natural ground level. It was discovered that dwarf walls of various heights were introduced to stop flood water that exceeded the ground floor levels of these buildings.

These dwarf walls were seen mainly on building entrances constructed to keep flood water from entering into the enclosures. The table 2 below shows the heights and description of dwarf walls in five (5) buildings in each of the identified flood areas. The buildings were chosen using simple random sampling method.

Plate 3: Sunken compound at Nsentip Street flood area

Source: Researchers' field work (2013)

Table 2 : Height of Fence in Abak Road/Nkemba Street Flood Area

S/no	Height of fence	Wall type	Building use
1	225mm	Concrete block wall with plastering	Shops (commercial)

2	225mm	Concrete block wall with plastering	Shops
3	450mm	Concrete Screed	Residential
4	675mm	Concrete block wall with plastering	Shops (commercial)
5	675mm	Concrete Screed	Residential

Source : Researchers' field work, 2013

The highest flood level in the area was seen at the Nkemba street/Abak road junction. Through flood, water is trapped in the junction and as a result, people are seen washing their vehicles using the flood water, the opposite buildings to the Nkemba Street at the junction are sunken below the road level, especially in the premises of the Church of Christ, Afaha Inang (Plate 4).

Plate 4 : Flooded Abak Road by Nkemba Junction

Source: Researchers' field work (2013)

Table 3 : Height of Fence in Udo Eduok Street Flood Area

S/no	Height of fence	Wall type	Building use
1	450mm	Concrete block wall	Shops (commercial)
2	450mm	Concrete block wall	Residential
3	675mm	Reinforced concrete	Commercial
4	450mm	Concrete block wall	Residential
5	150mm	Concrete block wall	Residential

Source : Researchers' field work, 2013

In Udo Eduok street flood area, residents have fence walls to keep water from entering their compounds. Vehicles were seen packed outside these compounds due to challenges of driving them above these fences into the compounds. (Plate 3).

In Nsentip Street flood area, tall fence walls replace the dwarf walls found in other flood areas. The fence walls are 450mm high above the road surface. As a result of this, the wall is 900mm higher than the ground floor of the building. Vehicles are also parked on the road. (Table 4).

Table 4 : Height of Fence in The Middle of Nsentip Street Flood Area

S/no	Height of fence	Wall type	Building use
1	450mm	Concrete block wall	Commercial
2	300mm	Concrete block wall	Commercial
3	900mm	Reinforced concrete wall	Residential
4	675mm	Reinforced concrete wall	Residential
5	450mm	Concrete block wall	Residential

Source : Researchers' field work, 2013

In Ikot Ekpene road (near former AKTC) flood area, few buildings make use of dwarf walls, most buildings make use of sloppy finished floor levels (ramps) as well as reinforced concrete fences. Fences are normally reinforced to act as retaining walls and also to prevent the flood water from seeping through the fence wall but with openings channeled to the cesspool(s).

Table 5 : Height of Fence In Ikot Ekpene Road (near former AKTC) Flood Area

S/no	Height of fence	Type of wall	Building use
1	150mm	Concrete block wall	Office
2	300mm	Concrete block wall	Commercial
3	225mm	Concrete block wall	Commercial
4	225mm	Concrete block wall	Residential
5	450mm	Concrete block wall	Residential

Source: Researchers' field work, 2013

Table 6 : Height of Fence in Ewet – Uruan Street Flood Area

S/no	Height of fence	Type of wall	Building use
1	No half wall	450mm ((raised floor level)	Residential
2	175mm	Concrete block wall	Commercial
3	450mm (raised floor level)	Concrete block wall	Commercial
4	250mm	Concrete block wall	Commercial
5	200mm	Concrete block wall	Commercial

Source: Researchers' field work, 2013

Apart from buildings in Ewet/Uruan Street flood area having dwarf walls and raised floor levels, it was noticed that most of the residential buildings were well-built and away from the flood area as well. The reason might have been to mitigate flood. Another reason might have been that these residential buildings needed to be away from the usually busy and noisy commercial Uruan street. In addition to these measures, the verandahs were tiled to prevent water from seeping into the interior, especially through the floor from the foundation. (see Table 6)

The Ibom Connection or Plaza is also listed as a flooded area (Udosen, 1999). Before 2003, it was normally flooded especially after heavy rainfall. The development in the plaza was, however, because of its historical significance, being the point of the former "Independence Square" or "Circus" where the British Union Flag was finally lowered after Nigeria gained her independence. But, the effect of flood on this development can be summarized in its coordinated flood control measures as seen in the underground flood drains and sloppy interlocking stone floors (See plates 5 and 6).

Plate 5 : Underground drains at Ibom Plaza

Source: Researchers' field work (2013)

Plate 6 : Landscaped Ibom Plaza including stone floors

Source: Researchers' field work (2013)

The sloppy nature of the finished floors aids in draining run-off water to the drains. The Ibom Plaza is a resort that hosts facilities such as shopping malls, business centres, parking lots, games centre, eateries and a gothic Greco-Roman model of a sitting area or amphitheatre with luminous fountains and a giant elevated screen beamed through satellite.

V. Discussion of Results

Two methods used in mitigating flood were identified in flood areas in Uyo metropolis namely:

- Raised floor levels or raised dwarf walls.
- Use of drains in the built environment.

Out of the afore mentioned, raised floor levels or raised dwarf walls is the most used since all the six flooded areas studied in the metropolis have raised flood/dwarf walls.

The purpose of a raised floor is to keep the flood water from moving into the building. It is however perceived that the dwarf walls used in place of the raised floor level are less expensive since it takes fewer materials to construct.

From the findings, it could be deduced also that the highest dwarf walls used in each flooded area are, 675mm, 900mm, 450mm, 150mm (highest dwarf wall used is in Ibom Plaza). This implies that the highest dwarf wall used is 900mm.

The average dwarf wall used in Uyo metropolis calculated from the research data gotten is as follows:

$$(225 + 225 + 450 + 675 + 675 + 450 + 450 + 675 + 450 + 150 + 450 + 300 + 900 + 675 + 450 + 150 + 300 + 225 + 225 + 450 + 450 + 175 + 450 + 250 + 200 +) \div 5 = 10{,}075 \div 25 = 403 \text{ mm.}$$

This implies that an average of 403 mm half wall or raised floor level is used to keep flood away from entering into building(s) in Uyo metropolis. However, a range of 175mm – 900mm high dwarf walls are used in these flood areas as deduced from the research data.

It can be said that the volume of water that would have wrecked havoc in a particular area can be calculated by the volume of water the street drains from that area. This means that the height of a dwarf wall or raised floor level is directly proportional to the volume of street drain found in an area.

VI. Conclusion and Recommendations

In flood prone areas in Nigeria, it is best to study the probable effects of flood in an area before designing and constructing any building. The havoc of flood that would be averted by doing this is immeasurable.

a) Conclusions drawn from findings

The nature of flooding in Uyo metropolis has transformed the building patterns in the metropolis. New buildings that took flood issues into consideration are clearly seen to be using these architectural characters. An average of 403mm half walls is used to keep away flood water. The materials used for construction is mainly sandcrete blocks walls. These are reinforced in some cases while some are constructed as retaining walls depending on how much flood water is present in the vicinity. A unique architectural composition of a public space with attention to flood control in Uyo is as seen in Ibom plaza, where all the methods mentioned above are used. This is a clear effect of flood on the architecture of Ibom Plaza flooded area.

b) Recommendations

From the foregoing therefore, the following recommendations are made to be able to alleviate the colossal damage caused by flood on infrastructural development in Uyo metropolis:

- flood mitigating strategies should be encouraged by both government and private developers.
- the Planning Authorities should establish and monitor effective integrated drain patterns in the entire metropolis.
- development control department should ensure that buildings are not erected on high risk flood areas.
- architects and other stakeholders should upgrade their designs strategies, especially if buildings are to be sited on flood pone areas.
- building construction should be properly supervised specifically if designed to tackle flood issues in an area.

It is therefore our belief that if the recommendations made in this study are adopted or adhered to, they will go a long way to militate against the damaging effects of flood on infrastructural development in Uyo metropolis.

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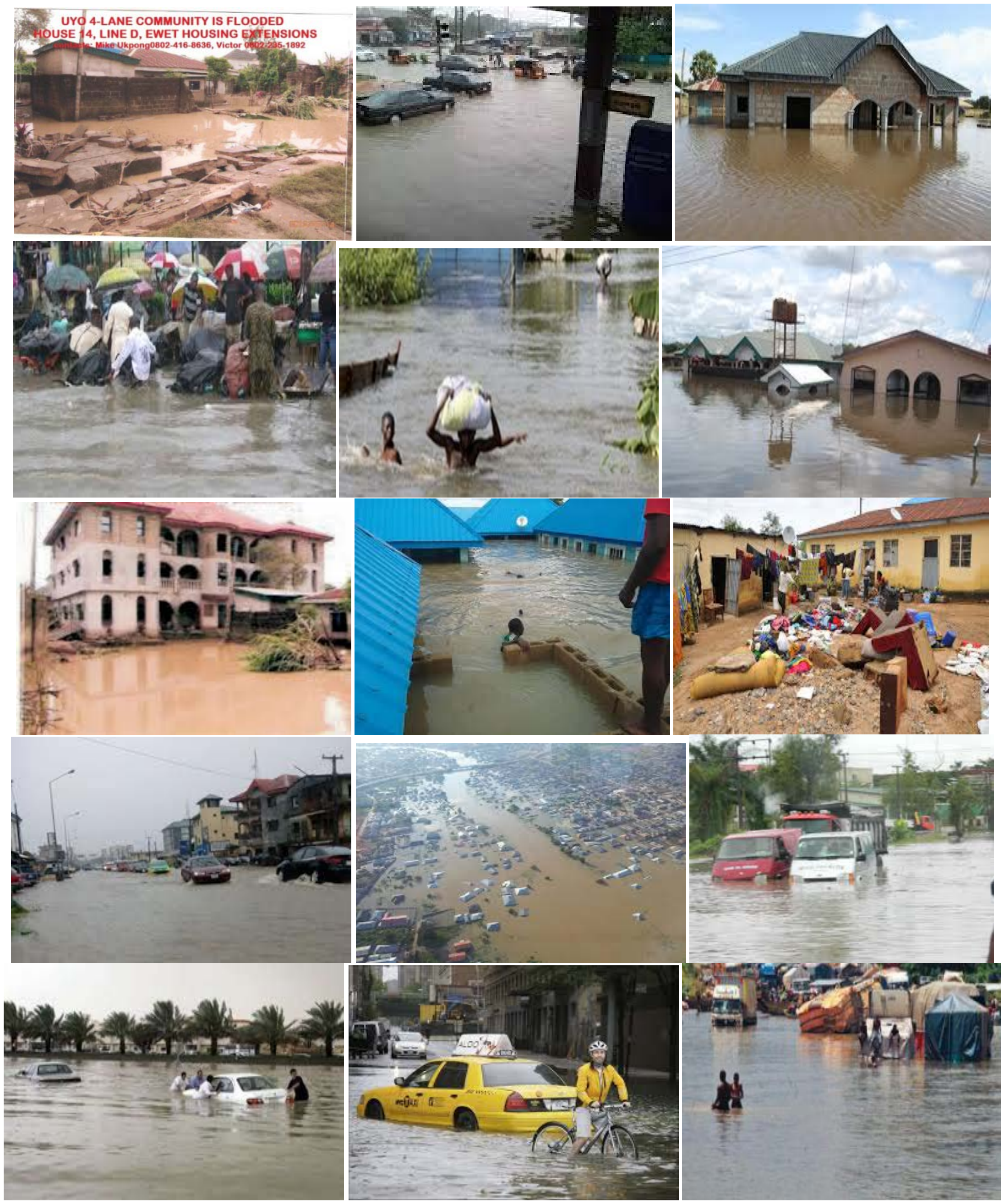

Plate 7 : Examples of Flooding in Uyo Metropolis

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The Effect of Modern Techonology on Traditonal Architectural Expression: Case of Old Calabar Architecture

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Abstract- Recently, there has been serious concern expressed over the fact that traditional architecture's language, its system of representation and indeed, its technology are excluded from the industrial future and hence from training, due to modern technology. Consequent upon this, the immense capital know – how held by building – related craft-trades, is disparaged as a pre- industrial and historical phenomenon and, as such banned from technical training and economic practice and retained merely as a subject for archaeology and arts and craft history courses. Thus, we are faced with a scandalous reduction in the productive capacities of society as a whole and with the radical impoverishment of basic democratic choices relating to vocations and trades and, generally, with the means of human self –expression. This study, therefore, seeks to establish the authenticity or otherwise of these allegations against modern technology. In doing this, a careful study was made of the developments in architecture with respect to its historical antecedents, specifically from the pre- World War 2 to the modern architectural era, 1945 till date.

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THEEFFECTOFMODERNTECHONOLOGYONTRADITONALARCHITECTURALEXPRESSIONCASEOFOLDCALABARARCHITECTURE

Strictly as per the compliance and regulations of :

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Keywords: modern technology; art; traditional architecture; architectural expression; old calabar.

I. Introduction

Traditional architecture is not something that can be acquired once and for all. It is transmitted from individual to individual and its quality varies greatly with each generation. It can disintegrate suddenly after attaining great heights or it can flourish extraordinarily in a few years after a period of general decadence. Like all living organisms, it finds itself in a permanent process of reconstruction (Krier, 1998).

Its present penury is not fatal and does not justify universal refection. Its very decadence creates the conditions necessary to clarify its causes and to prepare for an improvement. However, architecture found its highest expression in the Classical orders. A legion of geniuses could not improve them any more than they could improve the human body or its skeleton. Karl – Friedrich Schinkel drew the attention of his age to the fact that progress in architecture had been so great in the past that only the most trained eye could detect any improvement in the Classical orders.

Traditional architecture remains a living language, although many architects have lost the will to learn its grammar and use its vocabulary. Past and present crises have neither eroded nor polluted the traditional language; its rules, meanings, inventories and vocabularies are merely temporarily veiled in confusion. The transfer of its knowledge and its know – how has suffered a brutal interruption.

The resurgence of traditional architecture makes sense only in a broad context of planning and modernizing cities, villages and countryside. It has continued to serve in all ages and under different political regimes; there is no reason why this should not be the case in the future. Towns and buildings in this style can be adapted with imagination and elegance to the changing needs of advanced and democratic industrial societies – as was the case with nineteenth century railway stations.

There is no practical or philosophical reason for imposing modernist solutions when traditional methods have proved their superiority on a financial, technical, typological and aesthetic basis.

Traditional architecture produces objects of long-term use that differ from modernism's objects of immediate consumption. It is for this reason that traditional architecture's principles, its forms and techniques resist fashion for, to paraphrase Hannah Arendt, no public space or collective culture is possible without the potential immortality of our buildings and cities. There is no short – term wisdom. Without such material and moral immortality, architecture could not aspire to be a civic art, a tool of prime importance for civilization.

II. Concept of Modernity

Etymologically speaking, one can identify three basic levels of meaning accorded to the word "modern". In the first and oldest sense it means present, or current,

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implying as its opposite the notion of earlier, of what is past, The term modern was employed in this sense as far back as the Middle Ages. A second meaning of the word is the new, as opposed to the old. Here the term modern is used to describe a present time that is experienced as a period, and which possesses certain specific features that distinguish it from previous periods.

It was this sense of the term that began to prevail in the seventeenth century. During the course of the nineteenth century yet a third level of meaning became important. The notion of modern then acquired the connotation of what is momentary, of the transient, with its opposite notion no longer being a clearly defined past but rather an indeterminate eternity.

The current, the new and the transient all three of these levels of meaning refer to peculiar importance that is ascribed to the present in the concept of modernity. Modernity is what gives the present the specific quality that makes it different from the past and points the way toward the future. Modernity is also described as being a break with tradition and as typifying everything that rejects the inheritance of the past.

Modernity is constantly in conflict with tradition, elevating the struggle for change to the status of purveyor of meaning par excellence (Krier, 1998). Already in the eighteenth century modernity was thus a condition that could not be pinned down to a fixed set of attributes. It was in the nineteenth century that modernization also gained ground in the economic and political fields. With industrialization, political upheavals, and increasing urbanization, modernity becomes far more than just an intellectual concept. In the urban environment, in changing living conditions, and in everyday reality, the break with the established values and certainties of the tradition could be both seen and felt. The modern became visible on very many different levels. In this respect distinctions should be drawn among modernization, modernity and modernism.

The term modernization is used to describe the process of social development, the main features of which are technological advances and industrialization, urbanization and population explosions, the rise of bureaucracy and increasingly powerful national states, an enormous expansion of mass communication systems, democratization and an expanding (capitalist) world market.

Modernity refers to the typical features of modern times and to the way that these are experienced by the individual. Modernity stands for attitude toward life that is associated with a continuous process of evolution and transformation, with an orientation toward a future that will be different from the past and from the present. The experience of modernity provokes response in the form of cultural tendencies and artistic movements. Some of those that proclaim themselves as being in sympathy with the orientation towards the future and the desire for progress are specifically given the name modernism. In its broadest sense, according to Krier (1998), the word can be understood as the generic term for those theoretical and artistic ideas about modernity that aim to enable men and women to assume control over the changes that are taking place in a world by which they too are changed.

a) *Emergence of Modern Technology*

In the eighteenth century, modern technology, the practical incarnation of science, was born. First, in England and then across Europe, the Industrial Revolution took hold. The machine age began as man discovered his strength need no longer be that of his arm alone nor his speed that of feet. Factories and railways filled out the net of knowledge which science had cast over the landscape.

Rural areas became depopulated as the peasantry abandoned the land to become the urban proletariat. The idea of the machine, a mute, efficient man made realization of the external laws of science, became the dominant idea in the European mind. Machines promoted efficiency which created wealth in one vast impersonal mechanism known as technology, which became the ultimate, unarguable assertion of science's one big claim: "it works".

b) *Technology and Architectural Expressions*

The most important antagonism which exists in architecture today is not between tradition and modernism but between traditional culture and its caricature. The construction industry has almost universally replaced:

(a) load-bearing building techniques by the separation of the load-bearing structure from the external facing;

(b) natural building materials by artificial substitutes.

The reduction of external walls into simple screens, tiny but continuous differential movements between skeleton and skin, and the replacement of natural materials by materials of inferior quality have resulted not only in modernist – looking but also in traditional-looking buildings that are both fragile and vulnerable with limited lifespans and high maintenance costs. They often transform traditional-looking buildings into authentic fakes, resulting almost always in postmodernist or traditionalist kitsch (Krier, 1998).

There is therefore an ontological rupture between appearance and reality. The typological, morphological and tectonic depth of traditional architecture has been replaced by a surface depth. Traditional building techniques and natural materials are indispensible to ensure structural, architectural and aesthetic integrity. The slightly higher investment is generally vindicated by increased durability, reduced maintenance costs and a more pleasing and, overall, better building.

III. Theoretical Framework

This study is posited on the concept that modernism needs to co-exist with the traditional architectural language, its system of representation and its technology. About half a century age, modernist movements claimed to have the definitive solutions to all the problems of the built environment. Today, one truth is evident, without traditional landscapes, cities and values, our environment would be a nightmare on a global scale. Modernism represents the negation of all that makes architecture useful: no roofs, no load-bearing walls, no columns, no arches, no vertical windows, no streets, no squares, no privacy, no grandeur, no decoration, no craftsmen, no history and no tradition.

Today, fifty years of modernism and thirty centuries of traditional architecture can be compared and judged. Infact, the public will accept any city plan and skyline provided that its architecture is traditional. The eradication of the teaching of traditional architecture has not succeeded in eliminating the demand and need for traditional architecture nor its worldwide practice. For three generations now modernist denunciations have merely succeeded in excluding traditional architecture from public commissions and have thereby brought it to its poorest level of expression in history.

IV. Study Area

'Old Calabar' refers to a region that lies in the South South part of Nigeria along the coastal region off the Gulf of Guinea. Presently, Calabar is the capital city of Cross River State of Nigeria and is located on latitude 04^{o} 57, North of Equator and 08^{o} 19, E of Greenwich meridian.The city of Calabar is located on a peninsula between the Calabar and the Great Kwa River some 50 km distance from the coastline. There are no records on the founding of the town, but it appears that there were several autonomous settlements (Fig. 1) populated by different ethnic groups (the Efuts, Quas and Akims) on the territory of the present Calabar municipality (Old, Duke and Henshaw towns), in present Calabar South Local Government Area. First documents report on regular trading activities in 1688, when two English traders were killed (NCMM 1986, Tesco 1972). In colonial times, Calabar became the site of the headquarters of the Oil River Protectorate.

By Nigerian standards Old Calabar can be considered an 'ancient city' that had served as a port, a Presbyterian missionary base, a cultural centre for the Efik people, an educational place, and temporally also as the capital of Nigeria (Ajato, 1970). The importance of the city is reflected in a popular saying: "Who is tired of Calabar is tired of life".

The ruling castes were the Efiks in Old Calabar with a legal system that was closely interwoven with the social and political structure. Unlike the Yoruba or certain tribes in Northern Nigeria, the Efiks were described as simple acephalous by anthropologists. That means that they don't have a clearly designated leader or central authority in their political organization. Even today the cultural traditions of the Efik is still alive in parts, and include certain burial rites, masquerades, secret cults, the seclusion of girls for training (ufoknkoho) and coronation ceremonies. The more wealthy and influential Efiks used to live in palace-like houses or in large compounds on prime sites, protected by special guards. The homesteads, including servants and slaves, could reach several hundred persons.

The climate of the area is hot and humid, having heavy rainfall all the year round. The mean monthly rainfall is about 300mm in some areas and more than 450mm in some other areas. The months of July and August usually have the heaviest rainfall though sometimes there may be a break in the middle of the month of August. The heavy rainfall has been attributed to the nearness of the area to the sea and Cameroon Mountains which gives it a micro-climate of its own different from some other areas in the same geographical zone.In order to be able to ventilate the rooms which were always many in a family compound, courtyards had to be introduced. An example of a typical family compounds is shown in figure 2.

The compound may have up to 8 small courtyards and one big courtyard serve the function of letting in cold air into the interior spaces.These courtyards were also able to light spaces which would otherwise have been totally dark. Although there were small courtyards, they were very effective for the purpose for which they were meant, namely lighting and ventilation.

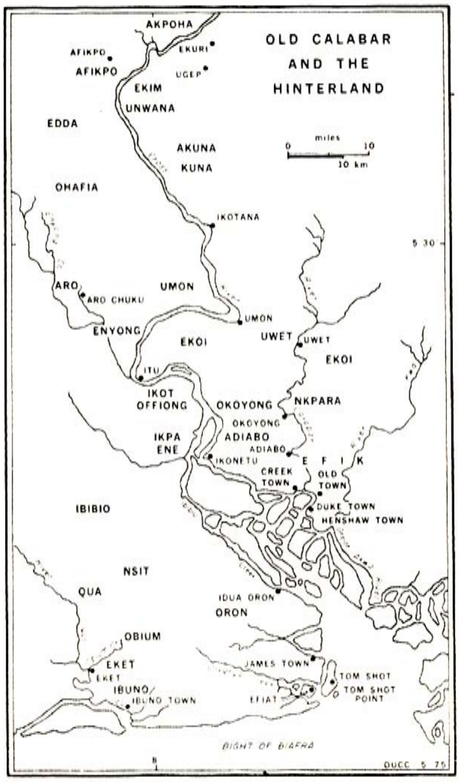


Figure 1 : Old Calabar

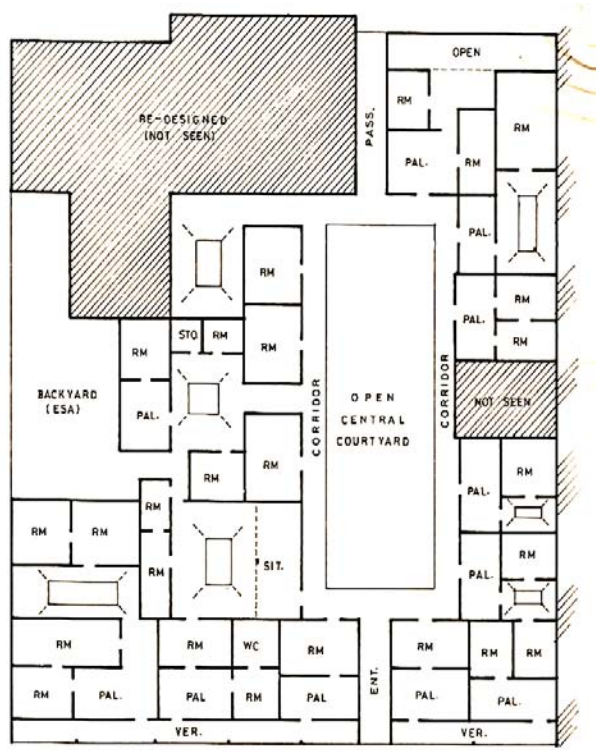


Figure 2 : Typical Family Compound

Thatch was used as the covering material for the roof because of its ability to absorb the tropical heat of the sun (fig. 3). The rooms were thus rendered cool and habitable. Few building materials used today as roof covering have the ability to absorb the heat of the sun as much as thatch.

Figure 3 : Thatch Roof

The nearness to the coast of the Gulf of Guinea gives it a sub-soil that is full of earth that can easily be prepared into mud suitable for building work. There are some deposits of fine white clay in some locations but this was not preferred to mud as a building material as it was not readily available in every area. This explains why the idea of using clay bricks as a substitute for mud was not poplar though clay was widely used in making earthen wares such as pots and plates.

Mud has the advantage of being available everywhere except around the swamps, in addition to being very cheap and affordable by all. This made it a more suitable material than any other for making the walls of buildings. In the swamps where mud was not available or not suitable for building work, timber got from mangrove trees and other trees were used instead. This gave the architecture of the riverine areas a slightly different kind of character different from that found in the hinterland.

It is believed that the idea of having courtyards originated from the concept of centre which has certain religious connotations (Aniakor, 1995). The concept of centre is believed to have been influenced by the religious beliefs of the people. According to this reasoning, the courtyard is the centre of the peoples' universe and is likened to the heart which is located at the centre of the most vital organs of the body. In much the same way the courtyard is placed at the centre of the compound. In a village set-up the most important activities of the people took place at the centre of the village: the market place, the ancestral grove ("akai") and the village square or dance square ("ufetmbre"). The centre always had religious connotations for the Africans in general. For this reason a courtyard was necessary at the centre of the compound to provide a place for keeping the ancestral shrine ("usanabasi"), which was an object of worship of ancestral spirits or deities.

V. Architecture of Old Calabar

The architectural history of Old Calabar can be divided in three periods: pre-colonial (period of unification); fragmentation (missionary period) and colonial (period of colonization), (Mbina, 1999).

a) The pre-colonial period

This time span, also identified as period of unification, lasted from the time of the first Efik settlements in the Calabar peninsula to the early 17^{th} century, when no permanent trade links existed with other continents. The architecture of this period was dictated by the locally available materials, basically earth, timber and thatch.

The settlement pattern in Old Calabar was made up of large, but compact compounds. The house of the chief stood in the centre of the compound, surrounded by those of his wives, dependent relatives, and servants. This house type usually had a central court (akwaesa) which was surrounded by deep verandas (peristyle) in front of the adjacent rooms. The shaded veranda served for sitting during family and house meetings and other social gatherings (Fig. 5). Also an altar used to be contained in the central courtyard area; it was dedicated to the 'true god' (usanabasi).

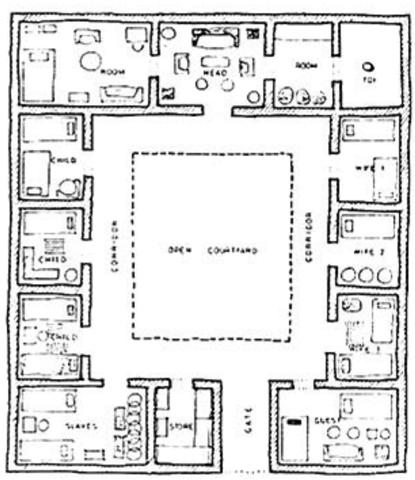


Figure 4 : Single Courtyard House

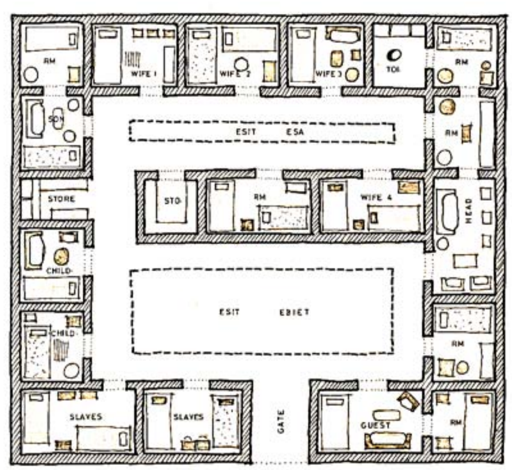


Figure 5 : Double Courtyard House

The number of rooms and the size of the dwelling varied according to the wealth of the family. In some cases, houses had more than one courtyard (Fig.6). In fact, the multi-courtyard house was an outstanding architectural feature of Old Calabar. It permitted that different kind of domestic activities such as cooking; bathing children, receiving visitors, family entertainment, etc. could take place simultaneously in different parts of the compound. Efik houses in Old Calabar generally had an unpretentious character when viewed from the street and apart from the main entrance normally no windows or other openings interrupted the external walls. The local customs foresaw that private activities were not to be seen in public.The building materials that were utilized in the making of the indigenous house were derived from the local environment. None was imported or transported from another region. Everything was obtained from the same locality and so have local names some of which are difficult to interpret correctly.

A detail of the structural framework of the roof and wall of the indigenous house for landed settlements shows that the local people had a technique of construction which agrees with the basic principles of construction in the modern times. A timber beam known as *ibatai* runs along the length of a typical verandah supporting bamboo rafters known as *ntong*. This beam itself is supported by a timber column known as *abai*. The beam and rafter in turn support the purlin-like members known as *ndumia* which carries the roof covering. The roof covering is made of thatch (*nkenya*) prepared from raffia palm leaves knitted together with special strips of raffia palm stem known as *ndubonga*s shown in fig. 3.

The ceiling was made of specially prepared thatch which was sometimes made to be very decorative. The supports for the ceiling were bamboo stems drilled into the wall at strategic locations.

As regards the wall structure, the main components were *ndumia*, *mboi* and *mkpana* earlier described in this discourse. *Ndumia* are connected to the *abai* by special sting known as *nyang* earlier described above while the horizontal members known as *ndumia* are connected to the vertical members known as *mboi* by tying them together using *idid* (string from raffia palm).

b) Period of Fragmentation

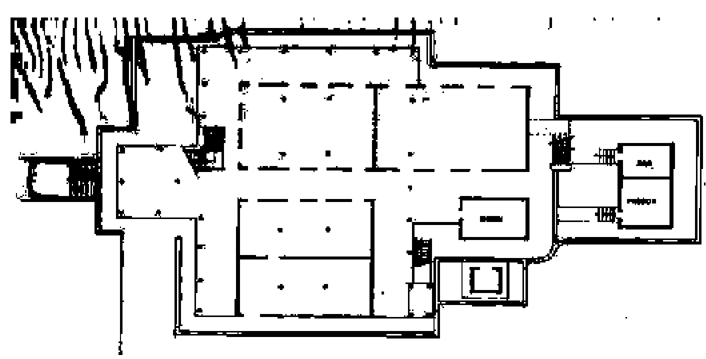
The first phase of this period was marked by the end of slave trading around 1650. At this time, the Efik people, traditionally farmers and fishermen began to engage in large scale and distant trading. A mercantile class emerged who broke with customary family formations and incorporated all kinds of people – sometimes even strangers – in their compounds in order to gather more labour force (i.e. for oil production) and to compete better with other traders (Nair, 1972). Eventually the term ekpuk (lineage) even disappeared from Efik vocabulary. It was replaced by ufok (house) since the members of the compound were not

Architecturally the new social composition of the compounds was reflected by the fragmentation of large building complexes into several independent smaller ones. The affinity to the compound head was often broken up with his death, particularly as a result of 'witch hunting' among family members.

Although no Europeans lived permanently in Old Calabar before the installation of the Presbyterian mission in 1846, several influential Efik chiefs had already acquired and erected prefabricated two-storey timber houses imported from Europe (Mbina, 1994). Rivalries among local politicians, trade barons and others caused violent fights which in the end led to the destruction of Old Calabar in the 1760s.

c) The colonial period

As a political strategy, the British refused to export their newly constructed industrial machinery to Africa until around 1891 (Nair, 1972). Only then appeared a number of dispersed factory buildings along the Calabar river; the first of them named South Sea, Matilda, Ivy, Millerio. Communication between the factories was by ship since there was no adequate road network. However, further communication between the factories and the individual customers on the compounds had to rely on narrow, steep and muddy footpaths. The first permanent houses of Europeans were built near the beach between 1884 and 1909 (Tesco, 1972). Many of them were prefabricated and had been shipped from Britain. Typical examples of them include the Old Residence, and the Saint Margaret Hospital (fig.7 and fig.8).



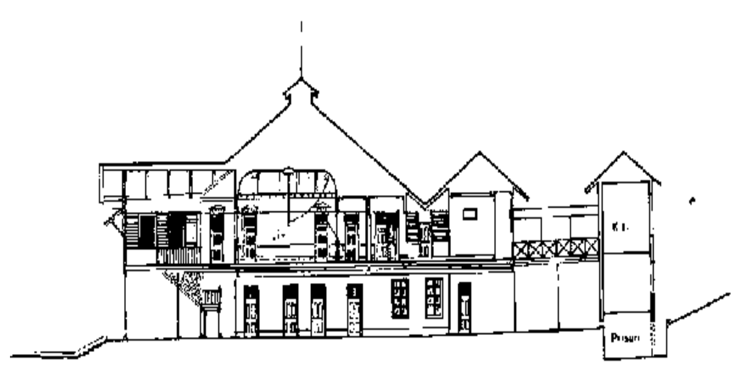


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Figure 6 : Old Residency (Ground Floor Plan, section & Elevation)

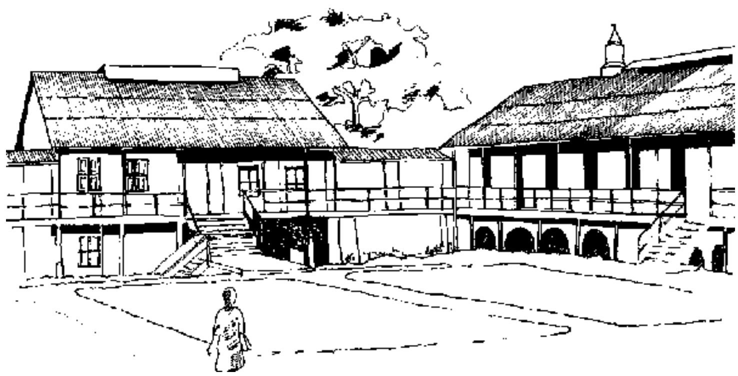

Figure 7 : Saint Margaret Hospital

VI. Research Method

This research was aimed at determining the extent to which modern technology has affected the art of traditional architectural expression with particular reference to Old Calabar traditional architecture. Visits were made particularly to local communities, parks, public and private buildings with questionnaires to see and acquire firsthand knowledge of the situation.

Questionnaires, interview schedule and field surveys were used as data collection instruments. Twenty five questionnaires were distributed and only eighteen persons responded. The data collected from the respondents were presented in tabular format. The data were analyzed by comparing responses with the actual situation on ground. Questions and the responses were grouped and presented according to the specific objectives they were set to achieve, and the questions were structured in open and closed ended format but were basically centred on the influences of modern technology on the traditional architectural concept, materials used, technological skill in the construction methods, etc.

Field surveys of specific buildings were made. These included pre-colonial buildings whose designs, construction methods and materials used were mainly indigenous. Others included buildings of post-colonial era where the design concepts, construction methods and materials used were foreign to the communities under study.

VII. Findings

While modern technology may be flawed, either from a nationalistic or socio-cultural or whatever point of view, it nonetheless served the purpose of the modern times admirably. It suitably adapts environmentally and meets the requirements of firmness, commodity and delight, especially within the limits of material resources.

The construction materials have moved from walls made of earth (cob or adobe construction) to more sophisticated materials like sandcrete blocks, bricks and even reinforced concrete and from roofs of vegetable matter to those with metals. Though windows are still of wooden panels, it is not strange to come across glass panes. However, the most significant evidence of such change, vis-à-vis door and windows, relates to their size. Unlike what obtained in traditional models, it is no longer necessary to stoop to access a vernacular building and windows are no longer slits (Edem, 2010).

In its architectural transformations, not only the overall character of buildings has been affected, the expected gradual change has also impinged on space – use, for example, the absorption of outdoor activities (traditionally associated with either the courtyard or ancillary structures) into the main building. As such, it is commonplace to see people cook in the spacious corridor of a typical vernacular model. This shift from outdoor to indoor might perhaps be connected to the corresponding arrangements in the western archetypes where buildings have kitchen, laundry and general service quarters either semi – detached from, or only tenuously linked to the main building. In both cases the service spaces were always relegated to the back of the house and were always less pretentious in architectural articulation.

With the advent of the functionalist – rationalist approach to design of the 'Modern Movement' and modern technology, these spaces gradually became integrated into the general living quarters. Not only did they came under the same roof, they have been given an appreciated status, by appropriately spatially relating them to other spaces within the main building, whose functions they complement.

From the point of view of enduring Nigerian folk building practices, modern technology has played a signal role; the legacies of the phenomenon have served as stylistic inspiration over the years, successfully generating popular archetypes the local people are at home with, physically and socio-culturally. Transformation of the original model (traditional) has resulted, in a large measure, in widely accepted vernacular architecture of the Nigerian masses, particularly the Efiks.

Another significant area of transformation was the general configuration of the house. A typical Old Calabar compound was a sprawling, rectangular mass, with the centre perforated by a sizeable courtyard. With visible examples of more 'rational' house layouts (in line with modern architecture), a more compact house type (with discrete units) evolved, predicated on vernacular practices. The courtyard style was progressively eliminated, giving rise instead to an exaggerated central (double – loaded) corridor. Whereas the Old Calabar indigenous house was inward – looking (with activities focused on the centralized courtyard), today's vernacular model provides a general interaction space at two levels:

i. At the semi – public levels that is, the front verandah (that abutts a public thoroughfare) and
ii. At the semi – private level, that is, the corridor and verandah behind the house, that lead to the outhouses.

VIII. Recommendation

Economic considerations, as well as cultural and climatic factors, underscore the need to develop indigenous building technology to meet modern needs. The courtyard compound and subsequent open plan houses surrounding the courtyard make movement and ventilation in the house easier than does the modern plan which is very rigid. The choice of materials and thermal functions such as cooling also play a role. The traditional adobe structure and pliable roofing materials keep the house cool, but nothing can be more miserable than the heat of the day in aluminum – roofed house without air conditioning. On the other hand, poor energy supply and lack of resources make the cost of cooling by air conditioning very expensive. So, it is important to seek building materials other than brick and aluminum. This raises the question of how indigenous traditional architecture can cope with the construction of houses that use expensive imported materials.

However, in most advanced industrial countries such as Germany and Italy it is no longer conceivable to promote industrial development to the detriment of craft. The co-existence of these two production methods and ways of thinking is now largely recognized as an absolute necessity for a modern economy.

On the architectural level, however, strong ideologically motivated resistance to this co-existence persists. Balanced development requires a profound change in mentality and the abandonment of outdated creeds that remain anchored in an industrial and collectivist teleology. It must be remembered that in the genesis of artistic and architectural modernism, the founding myths were established in a complex break with the past. The rest were pronounced pre-history. Some events and some works were elevated to the rank of paradigms for a new humanity, for a necessarily all – industrial modernity. Anything that does not go with the mainstream of this sectarian vision of modernity is disqualified as historic, late and superseded.

IX. Conclusion

No doubt, many Nigerians, informed by nationalistic sentiments, would want the curtain permanently drawn on the nation's colonial part – regardless of the legacies of this past. This paper views that as throwing away the baby with the bath water. It is an unchangeable fact of human existence that the history of a people directly affects their present, and informs their preparations for tomorrow. At the very worst, modern technological heritage deserves commendation, at least, for its varied built cape. Above all, it has been established that in a subtle way, modern technology impacts positively on the people every day. It has informed and will continue to inform the local interpretation of space and use of materials and techniques. This alone should be reason enough for appreciating modern technology and conceding some recognition to it.

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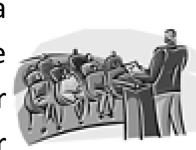

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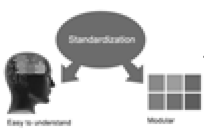

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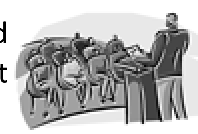

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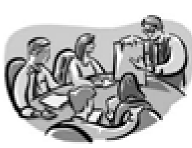

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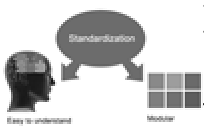

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21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

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27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

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30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

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33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

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- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

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In every sections of your document

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· Present your points in sound order

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- Reason of the study - theory, overall issue, purpose
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- To the point depiction of the research
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- Significant conclusions or questions that track from the research(es)

Approach:

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- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

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- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
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Approach:

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The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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