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Angkor Wat Meteorological Observation Station (AMOS): Installation of Monitoring System and Preliminary Results of Observation at Angkor Wat Temple, Cambodia

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The tropical climatic environment affects considerably the deterioration of building stone such as the sandstone and laterite blocks comprising the Angkor monuments. In particular, slaking of stones due to repeated wetting and drying, and the exposure of stones due to the clearing of vegetation, may accelerate their deterioration. However, there is little observational data at the Angkor monuments. Therefore, to accumulate meteorological data in the Angkor monuments, this study installed an automated meteorological observation station (AMOS: Angkor Wat Meteorological Observation Station) in the precincts of the Angkor Wat temple on December 2010.

The AMOS is composed of temperature and humidity probes, a rain gauge, an anemoscope and anemometers, a pyranometer, a solar panel, and a measurement and control module. The data is basically measured at ten second intervals, and this is arranged into three time intervals of 10-minute, 60-minute, and 24-hour duration. In observations in 2011, the absolute maximum and minimum temperatures observed were 36.1℃ (March 20) and 15.3℃ (December 12), respectively. Therefore, the absolute annual range was large, as much as 20.8℃. Precipitation was observed to have the characteristic that it often occurs over a short time (the heaviest rain of 19mm/10min was observed on April 18) in the rainy season. The instantaneous maximum wind speed was 10.8 m/sec (NNW), observed on May 14. The deterioration of pillars of the first gallery at Angkor Wat temple is considered to progress by the repetition of heavy rain and the desiccation of columns.

Keywords : Angkor Wat, Weathering environment, Conservation, Automatic weather station, Cambodia

1. Background

1.1 Stone deterioration and meteorological observation at the Angkor monuments

The Angkor monuments are in a tropical monsoonal climatic environment, and it is thought that the weathering of rocks forming the monument is caused by repeated wetting and drying, salt weathering, bio-chemical weathering, and insolation weathering (e.g., Uchida 1999; Waragai 2002, 2005b). Concerning the wetting and drying repetition, especially, the resistance of the sandstone and laterite blocks, the main construction material of the monument, is low. The sandstone and laterite blocks are gradually and damage of the monument is progressing. In addition, it is thought that exposure of building stone due to restoration involving clearing of vegetation has accelerated its deterioration (e.g., André et al. 2010).

Because the climatic environment affects the deterioration of building stones, specific climatic elements have been observed at monuments such as the Angkor Wat (e.g., Waragai 2006), Ta Prohm (e.g., André et al. 2009), Bayon, and Ta Nei temples, and the relationship between rock weathering and climatic environment has begun to be analyzed in recent years. However, these observation data are limited to data such as temperature and humidity. Moreover, there has been no detailed publication of data.

1.2 The meteorological network in Cambodia and significance of the study

The meteorological network in Cambodia may be useful for climatic environment analysis. It consists of 20 synoptic stations[1)], according to the Department of Meteorology, Cambodia (2009). There are nine automat-

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ed stations, 20 manual stations, and 200 manual rainfall stations. However, the automated stations are broken. The synoptic stations are equipped with manual observational equipment. Collection of rainfall data is also carried out at 200 rainfall stations by local observers.

According to the web site (www.worldweather.org/) of the WMO (World Meteorological Organization), there are two observation stations at Phnom Penh-Pochen Tong and Siem Reap which are listed under the Department of Meteorology of the Cambodian Ministry of Water Resources and Meteorology (http://www.dhrw-cam.org/). However, there are no observational data available for study.

Thus, the domestic observation stations of Cambodia do not function very well. Therefore, it is difficult to analyse the local climatic environment and effects on stone deterioration from the data at existing observatories. Automated observation stations should be installed to observe the local climatic environment at a specific location.

Climatic elements such as air temperature and relative humidity have already been measured in a structure of the Angkor Wat temple composed of a three-storied gallery (e.g., Waragai 2006). However, observation of major climatic elements such as rainfall, wind direction, wind speed, and insolation involved in stone degradation has never been carried out in and around the structure of the Angkor Wat temple. Therefore, to accumulate meteorological data in the Angkor Wat temple, this study installed an automated meteorological observation station in the precincts of the temple.

2. Location and methodology of the meteorological observation station

2.1 Location of the meteorological observation station

The system installed in the Angkor Wat temple is called AMOS (Angkor Wat Meteorological observation Station). The AMOS (N13° 24'48.1", E103° 51'44.7", altitude; 29m) is located at approximately 65m to the east and 98m to the north of the western gopura of the enclosure wall. It is approximately 375m from the northwest corner of the first gallery and 608m from the southeast corner of the first gallery (Fig.1).

The AMOS was installed inside of the fence set up by APSARA Authority (Authority for the Protection and Management of Angkor and the Region of Siem Reap) using a tripod in 22 December 2010 (Figures 2 and 3A). Installed are a temperature and humidity probe, anemoscope and anemometers, pyranometer, solar panel and a measurement and control module for the AMOS. A tipping bucket rain gauge is set at the front of the tripod. Management

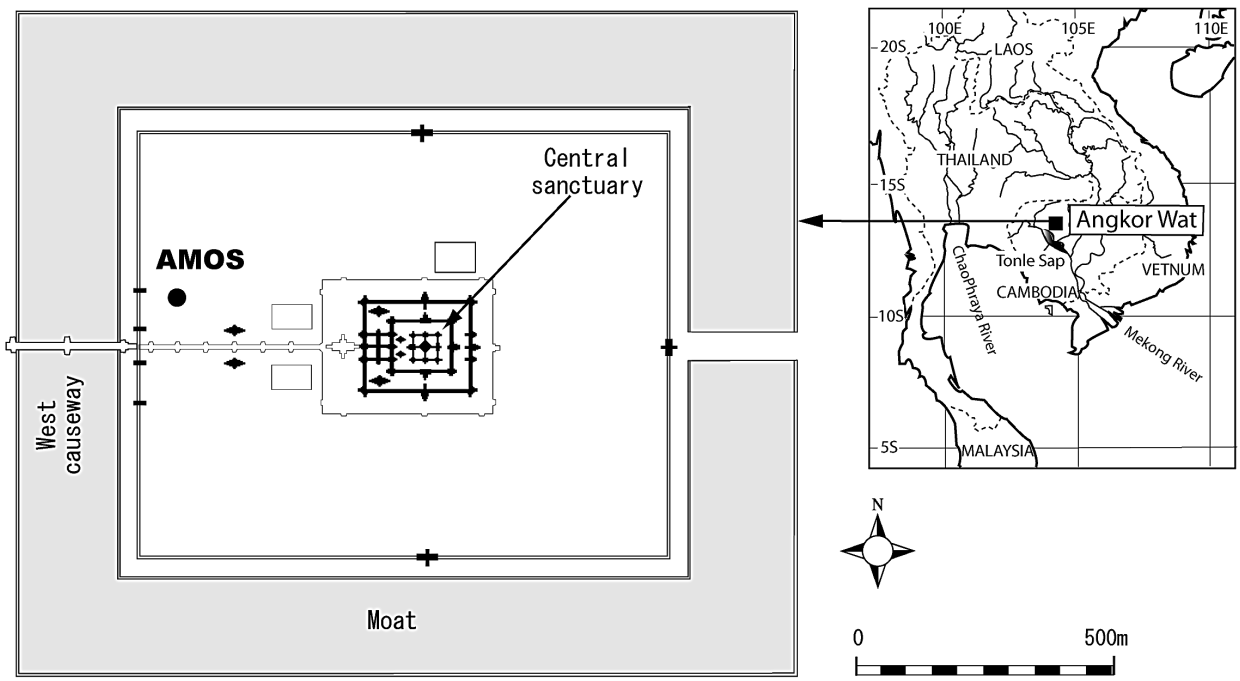

Figure 1 Location of the AMOS

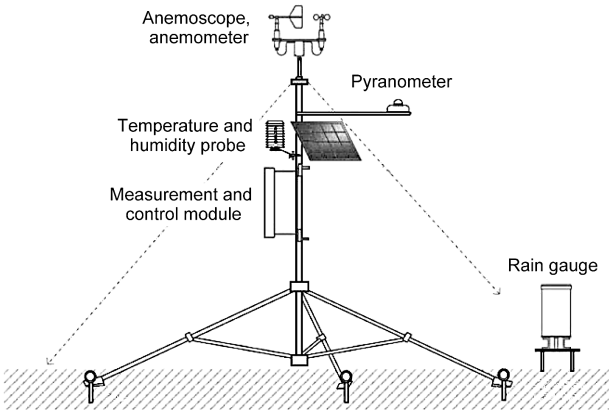

Figure 2 Schematic diagram of the AMOS

of the AMOS was requested of APSARA Authority and Sophia University Asia Center for Research and Human Development.

2.2 Quantities Measured items

The quantities measured are air temperature, relative humidity, rainfall, wind direction, wind speed and insolation. These are measured by each sensor at ten minute intervals (Table 1). The following devices are used for measurements.

1) Temperature and humidity probe (Fig. 3B): VAISALA products (HMP-155D); Measurement range of air temperature, −80～+60℃; accuracy, 0.13℃ at 20℃. Measurement range of relative humidity, 0 ～100%RH; accuracy, ± 1%RH (0 ～90%), ± 1.7%RH (90 ～100%).

2) Tipping bucket rain gauge (Fig. 3C): OTA products (OT-34T) ; sensitivity, 0.5mm /tip; accuracy, ±0.5mm (20mm ≦), ± 3% (20mm>).

3) Anemoscope and anemometers (Fig. 3B): YOUNG products (YG-3302, 3102); wind direction; measurement range, 0 ～355deg; accuracy, ±5deg; starting wind speed, 0.5m/s; wind speed; measurement range, 0 ～ 40m/s; accuracy, 0.5m/s, threshold, 0.5m/s.

4) Pyranometer (Fig. 3B): HUKSEFLUX products (HF-LP02-c); measuring range, 0-2KW/m^2; accuracy: ±10%.

5) Power supply (Fig. 3D): CAMPBELL SCIENTIFIC

Figure 3 Some pictures of measurement devices of the AMOS
A. Angkor Wat Meteorological Observation Station (AMOS)
B. Anemoscope, anemometer, pyranometer, temperature and humidity probe
C. Rain gauge
D. Solar panel
E. Measurement and control module
F. Enclosures

Table 1 Measurement items and device specifications of AMOS

Measurement items	Sensors	Accuracy	Response speed / Resolution	Out put	Dimesions	Weight	Measurement range
Air temperature (℃)	HMP-155D	0.13℃ (20℃)	90 %, <35 s	Pt100	φ 40mm H279mm	86g	−80 ～ +60℃
Relative humidity (%)		±1%RH (0 ～ 90%) ±1.7%RH (90 ～ 100%)	20sec (63% at 20℃) 60sec (90% at 20℃)	0-1V			0 ～ 100%RH
Rainfall (mm)	OT-34T	±0.5mm (20mm ≦) ±3% (20mm>)	0.5mm/tip	pulse	φ 210mm H450mm	2.2kg	—
Wind direction (degree)	YG-3302	±5deg	Threshold; 0.5m/s	0-10k Ω	L220mm H280mm	170g	0-355deg
Wind speed (m/sec)	YG-3102	0.5m/s	Threshold; 0.5m/s	Hz	φ 12cm H280mm	113g/cup	40m/s
Insolation (W/m^2)	HF-LP02-c	±10%	18sec (95%)	0-50mV	φ 78mm H60mm	300g	0-2KW/m^2

products (PS100); DC12V; Solar panel 10W; lead-acid power supply; nominal rating of 7Ah capacity at 20℃.

6) Measurement and control module (Fig. 3E): CAMPBELL SCIENTIFIC products (CR10X); dimension, 243mm × 92mm × 66mm; 128KB for data storage; Flash ROM + 2MB for additional data storage. There are 12 differential analogue inputs, two pulse counters and eight digital I/O ports.

7) Enclosures (Fig. 3F): CAMPBELL SCIENTIFIC products (C-ENC-12/14); Fibreglass-reinforced polyester; inner dimension, 304mm × 356mm × 140mm; Weights, 5.4kg.

2.3 Data arrangement and data collection

The data got by these sensors is recorded in the measurement and control module. The data arrangements are shown in Table 2 with UTC (CLT, + 07:00). The data is basically measured at ten second intervals, however, the data is arranged into three time intervals of a 10-minute interval, a 60-minute interval, and a 24-hour interval.

The data arrangement of the 10-minute interval is average wind speed, average wind direction, temperature (instantaneous data), humidity (instantaneous data), average insolation, and integrated rainfall (Table 2).

The 60-minute interval data is arranged as follows: average wind speed, average wind direction, temperature (instantaneous data), humidity (instantaneous data), maximum wind speed, wind direction at the time of maximum wind speed, occurrence time (consecutive minutes) of maximum wind speed, average insolation, integrated insolation, and integrated rainfall (Table 2).

The 24-hour interval data is arranged as follows; average wind speed, average wind direction, maximum wind speed, wind direction at the time of maximum wind speed, occurrence time (consecutive minutes) of maximum wind speed, average temperature, maximum temperature, occurrence time (hh:mm) of maximum temperature, minimum temperature, occurrence time (hh:mm) of minimum temperature, average humidity, maximum humidity, occurrence time (hh:mm) of maximum humidity, minimum humidity, occurrence time of minimum humidity, integrated insolation, and integrated rainfall (Table 2).

From capacity of the data storage and measurement intervals of the data, data collection is carried out every six months using a laptop PC with the Microsoft Windows operating system. The application software PC208W is used for the data collection.

3. Preliminary results

Results of the observations between 23 December 2010 and 17 March 2012 are shown in Figures 4-7. In addition, some statistics of the meteorological data between 1 January 2011 and 31 December 2011 and in 2011 at the AMOS are concluded as shown in Tables 3 and 4, respectively.

Fluctuations of daily air temperature (℃) and relative humidity (%) are illustrated in Figure 4 with a 20-day moving average. The daily average air temperature has a minimum of about 22 ℃ from late December to early January, and then rises to nearly 28 ℃ by early March. Then, the air temperature repeats small fluctuations until November. The average air temperature in 2011 was 26.5 ℃ (Table 4), and the absolute maximum and

Table 2 Data arrangement of the AMOS

ID and Number	item	explanation
200		time of starting up
	1 200	ID
	2 Year_RTM	year
	3 Day_RTM	Julian day
	4 Hour_Minute_RTM	hour/min
	5 IntTemp	temperature of the inside of logger (℃)
	6 BattVolt	voltage of power source (V)
	7 ProgVer	Program version
210		data of the 10-minute interval
	1 210	ID
	2 Year_RTM	year
	3 Day_RTM	Julian day
	4 Hour_Minute_RTM	hour/min
	5 WindSpeed_S_WVT	average wind speed (m/sec)
	6 Wind_Dir_D1_WVT	average wind direction (degree)
	7 Air_Temp	temperature (instantaneous data) (℃)
	8 Humidity	humidity (instantaneous data) (%)
	9 Solar_Wm2_AVG	average insolation (W/m^2)
	10 RAIN_TOT	integrate rainfall (mm)
260		data of the 1-hour interval
	1 260	ID
	2 Year_RTM	year
	3 Day_RTM	Julian day
	4 Hour_Minute_RTM	hour/min
	5 Ws10	average wind speed (m/sec)
	6 Wd10	average wind direction (degree)
	7 Air_Temp	temperature (instantaneous data) (℃)
	8 Humidity	humidity (instantaneous data) (%)
	9 MaxWs60	maximum wind speed (m/sec)
	10 MaxWsdr60	wind direction at the time of maximum wind speed (degree)
	11 MaxWstm60	occurrence time (consecutive minutes) of maximum wind speed
	12 Solar_Wm2_AVG	average insolation (W/m^2)
	13 Sun_MJ60_AVG	integrate insolation (MJ/m^2)
	14 RAIN_TOT	integrate rainfall (mm)
	15 IntTemp	temperature of the inside of logger (℃)
	16 BattVolt	voltage of power source (V)
224		data of the 24-hours interval
	1 224	ID
	2 Year_RTM	year
	3 Day_RTM	Julian day
	4 Hour_Minute_RTM	hour/min
	5 WindSpeed_S_WVT	average wind speed (m/sec)
	6 Wind_Dir_D1_WVT	average wind direction (degree)
	7 MaxWs24	maximum wind speed (m/sec)
	8 MaxWsdr24	wind direction at the time of maximum wind speed (degree)
	9 MaxWstm24	occurrence time (consecutive minutes) of maximum wind speed
	10 Air_Temp_AVG	average temperature (℃)
	11 Air_Temp_MAX	maximum temperature (℃)
	12 Air_Temp_Hr_Min_MAX	occurrence time (hhmm) of maximum temperature
	13 Air_Temp_MIN	minimum temperature (℃)
	14 Air_Temp_Hr_Min_MIN	occurrence time (hhmm) of mimimum temperature
	15 Humidity_AVG	average humidity (%)
	16 Humidity_MAX	maximum humidity (%)
	17 Humidity_Hr_Min_MAX	occurrence time (hhmm) of maximum humidity
	18 Humidity_MIN	mimimum humidity (%)
	19 Humidity_Hr_Min_MIN	occurrence time of minimum humidity
	20 Sun_MJ24_AVG	integrate insolation (MJ/m^2)
	21 RAIN_TOT	integrate rainfall (mm)

*: Recorded date is Universal Time(UT). Local time of Cambodia is +7 hours to UT.

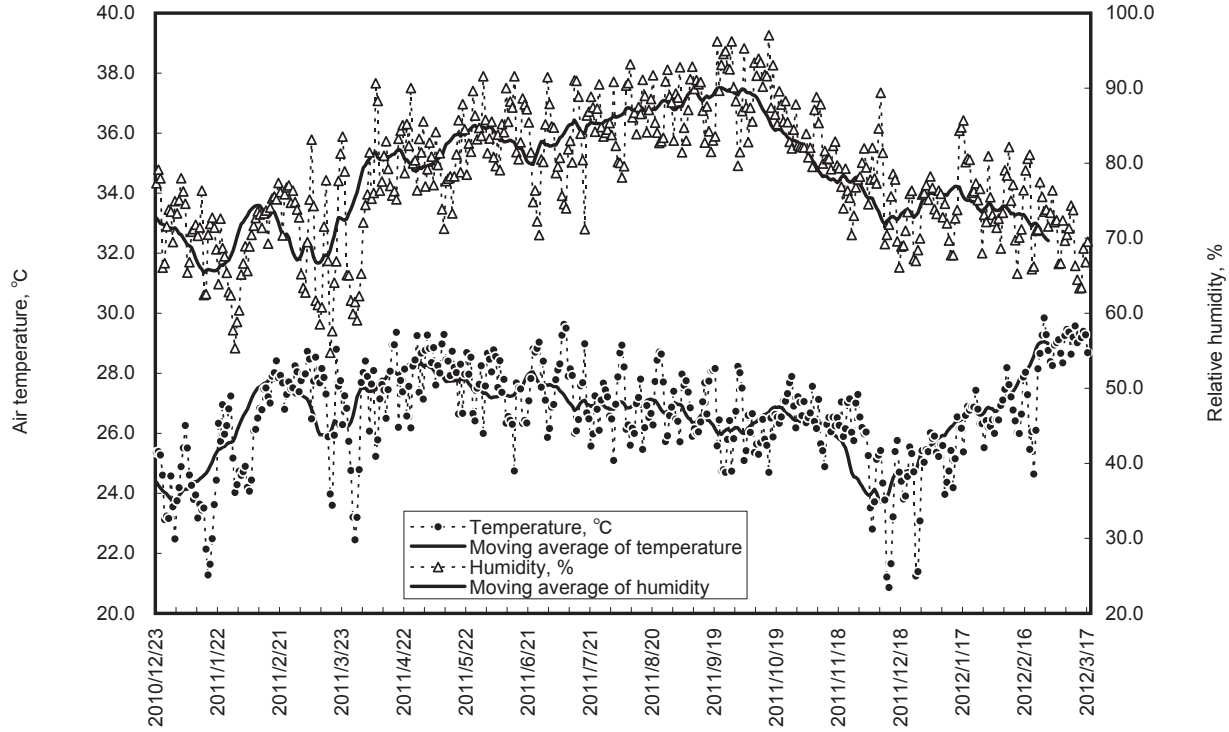

Figure 4 Daily fluctuations of temperature (℃) and relative humidity (%) from December 2010 to March 2012.

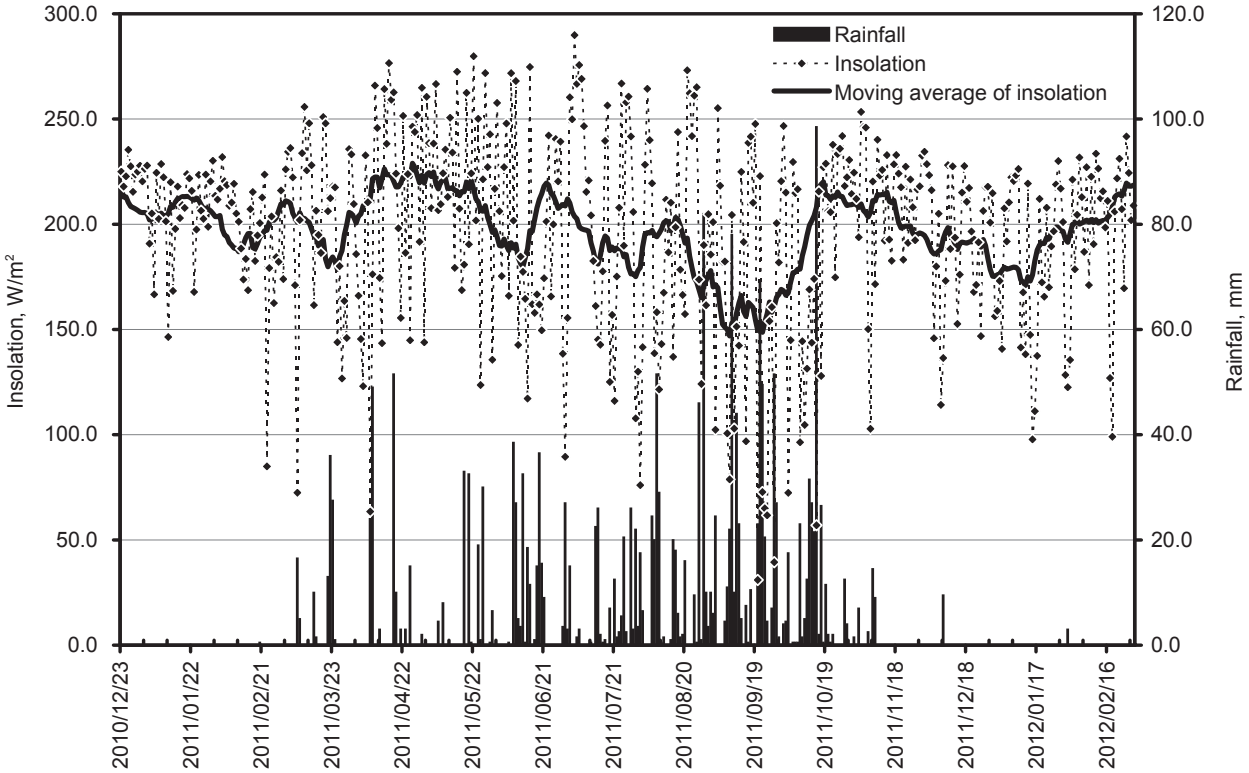

Figure 5 Daily fluctuations of rainfall (mm) and insolation (W/m^2) from December 2010 to March 2012.

minimum temperatures observed were 36.1 ℃ (15:10, March 20) and 15.3℃ (6:10, December 12), respectively. Therefore, the absolute annual range of air temperature reaches 20.8℃ , and is large.

Daily relative humidity shows a minimum of about 54% in January and March, although more than 70% is recorded in other months. In particular, high humidity of 80-90% continues from the middle of May to the middle of October.

Daily rainfall (mm) and insolation (W/m^2) are shown in Figure 5 with a 20-day moving average of insolation. Annual precipitation in 2011 was 2,065mm (Table 4). Rainfall occurs frequently between March and November, but hardly at all in other months (Fig. 5).

Since the annual number of rainy days in 2011 was 139 (about 38% of the year), the precipitation was concentrated in the rainy season. Of the rainy days, there were 77 days of 1-10mm of diurnal precipitations and 62 days of heavy rain which exceeded 10mm (Daily maximum rainfall is 98.5 mm at October 15, Table 3). Therefore, approximately 55% of the rainy days had weak rainfall. When analyzing rainfall data in a 10-minute interval in 2011, ordinary rain of 1-3mm/10min accounts for approximately 86 %, and

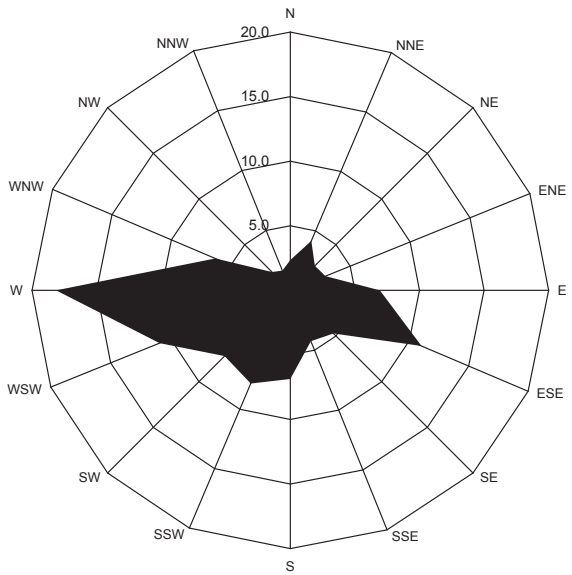

Figure 6 Wind direction in 2011

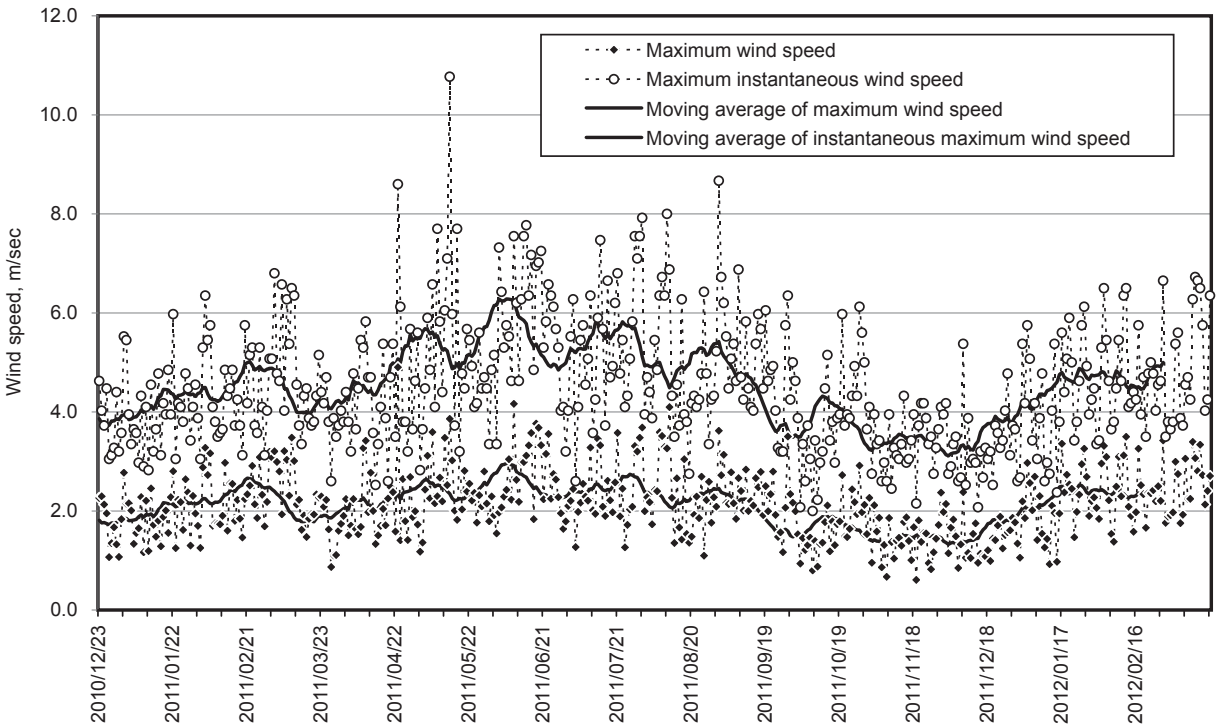

Figure 7 Daily fluctuations of maximum wind speed (m/sec) and instantaneous maximum wind speed (m/sec) from December 2010 to March 2012.

Table 3 Observation data of the AMOS compiled to the daily in 2011.

Cambodian date	Average temperature (℃)	Average humidity (%)	Integrate rainfall (mm)	Average wind direction (degree)	Average wind speed (m/sec)	Maximum wind speed (m/sec)	Instantaneous maximum wind speed (m/sec)	Occurrence time of instantaneous maximum wind speed	Integrate insolation (W/m²)
2011/1/1	22.5	74.9	0.0	86.9	0.3	1.8	3.6	14:46	220.4
1/2	23.8	73.3	0.0	71.9	0.6	2.8	5.5	10:16	226.3
1/3	24.2	75.1	0.0	70.1	0.6	2.1	5.5	11:57	227.9
1/4	24.9	78.0	0.0	72.2	0.3	2.2	4.0	10:36	190.8
1/5	25.5	76.2	0.0	70.4	0.3	2.0	3.4	14:02	205.1
1/6	26.3	74.6	0.0	52.1	0.2	1.3	3.7	14:33	166.7
1/7	25.5	65.4	0.0	90.9	0.3	1.6	3.6	10:34	224.5
1/8	24.6	66.8	0.0	82.6	0.2	1.7	3.0	12:59	202.5
1/9	24.3	70.9	0.0	72.6	0.5	2.3	4.3	9:49	228.6
1/10	23.8	71.2	0.0	112.9	0.3	1.2	2.9	14:32	222.3
1/11	23.9	71.8	0.0	71.9	0.5	2.2	4.1	8:43	201.3
1/12	23.2	70.3	0.0	152.2	0.3	1.2	2.8	16:03	146.4
1/13	23.6	71.4	0.0	66.1	0.4	2.5	4.6	11:16	220.0
1/14	23.4	76.3	0.0	72.1	0.4	1.7	3.2	16:11	168.3
1/15	23.5	62.4	0.0	70.3	0.3	1.5	3.7	14:30	197.8
1/16	22.1	62.6	0.0	116.2	0.3	1.8	4.8	12:30	217.9
1/17	21.3	70.5	0.0	114.9	0.2	1.3	3.1	4:31	203.0
1/18	21.6	71.9	0.0	83.2	0.5	1.9	4.2	14:18	209.1
1/19	22.5	72.7	0.0	58.3	0.3	2.0	4.0	10:54	207.8
1/20	23.6	71.4	0.0	66.8	0.3	1.6	4.9	14:00	223.8
1/21	24.4	68.5	0.0	82.5	0.4	2.3	4.0	15:21	221.8
1/22	26.3	63.9	0.0	60.4	0.6	2.8	6.0	12:45	215.9
1/23	25.7	72.6	0.0	98.0	0.2	1.2	3.1	14:11	167.8
1/24	27.0	68.7	0.0	71.4	0.4	2.2	4.2	9:08	197.5
1/25	26.0	67.6	0.0	81.0	0.4	2.2	4.1	12:55	223.5
1/26	26.3	65.4	0.0	64.6	0.3	1.6	3.8	14:07	206.5
1/27	26.8	62.8	0.0	64.7	0.3	2.6	4.8	13:20	202.6
1/28	27.2	62.4	0.0	69.3	0.4	2.4	4.5	10:48	223.6
1/29	25.2	57.7	0.0	151.6	0.3	1.3	3.4	13:44	198.8
1/30	24.0	55.3	0.0	143.4	0.3	2.3	4.1	12:25	220.4
1/31	24.3	58.8	0.0	103.0	0.4	2.0	4.6	14:16	230.2
2/1	24.7	60.4	0.0	83.7	0.3	1.7	3.9	11:40	213.5
2/2	24.6	65.2	0.0	96.7	0.3	1.3	3.1	14:02	211.7
2/3	24.7	66.6	0.0	76.6	0.6	2.9	5.3	7:54	216.9
2/4	24.9	68.9	0.0	78.2	0.8	3.3	6.4	9:24	231.9
2/5	24.2	65.6	0.0	71.2	0.7	2.7	5.5	11:19	220.5
2/6	24.1	68.9	0.0	76.0	0.8	3.2	5.8	8:42	218.6
2/7	24.4	70.5	0.0	75.8	0.5	1.7	4.1	9:11	208.8
2/8	26.1	71.7	0.0	107.9	0.4	1.8	3.8	14:48	210.3
2/9	26.1	72.7	0.0	84.7	0.4	1.7	3.5	14:48	219.2
2/10	26.5	73.6	0.0	79.0	0.4	1.7	3.6	14:00	205.1
2/11	26.8	73.2	0.0	76.5	0.4	1.9	3.7	5:45	201.2
2/12	26.8	71.4	0.0	88.9	0.9	3.0	4.9	10:22	188.5
2/13	27.5	73.3	0.0	91.6	0.3	1.6	4.3	9:49	173.7
2/14	27.5	73.7	0.0	84.1	0.6	2.6	4.5	8:43	183.5
2/15	27.2	69.3	0.0	167.5	0.8	2.5	4.9	8:45	168.6
2/16	27.0	74.1	0.0	119.8	0.5	1.8	3.7	16:36	207.1
2/17	27.9	75.3	0.0	143.0	0.5	2.2	4.3	13:50	215.3
2/18	28.0	75.6	0.0	120.5	0.5	1.8	3.7	14:07	182.6
2/19	28.4	75.2	0.0	124.1	0.4	1.5	3.1	0:21	194.7
2/20	27.8	77.4	0.5	109.2	0.4	2.2	5.8	15:57	200.5
2/21	27.9	76.1	0.0	97.9	0.7	2.3	4.2	8:45	212.7
2/22	27.7	70.4	0.0	104.6	0.6	2.5	5.2	9:45	223.6
2/23	26.8	75.8	0.0	150.0	0.7	2.9	5.3	9:27	84.9
2/24	27.3	76.8	0.0	129.7	0.4	2.1	3.7	16:27	179.2
2/25	27.7	77.0	0.0	115.4	0.5	1.9	3.6	6:55	203.7
2/26	27.5	74.7	0.0	94.0	0.8	3.1	5.3	8:46	162.5
2/27	27.5	76.3	0.0	84.2	0.6	2.3	4.1	13:13	184.4
2/28	28.2	74.8	0.0	169.5	0.6	1.7	3.1	14:47	182.1
3/1	28.0	73.8	0.0	104.5	0.6	2.2	4.0	13:26	216.0
3/2	27.4	72.8	0.0	122.0	0.8	3.2	5.1	7:56	173.9
3/3	27.8	65.2	0.0	91.8	0.9	3.1	5.1	8:42	226.1
3/4	28.0	63.4	0.0	84.3	0.8	3.2	6.8	8:59	234.4
3/5	28.0	62.8	0.0	79.3	0.8	3.0	4.8	9:23	236.2
3/6	28.7	69.5	0.0	85.0	0.8	2.8	4.6	12:08	222.2
3/7	28.5	75.1	0.0	126.3	0.5	1.9	6.6	6:15	171.0
3/8	26.5	83.1	16.5	84.5	0.7	3.2	4.0	11:53	72.4
3/9	27.7	74.3	5.0	85.1	0.6	3.0	6.3	12:53	202.0
3/10	28.5	61.7	0.0	74.2	0.8	2.3	5.4	11:34	233.7
3/11	27.8	61.1	0.0	76.8	0.9	3.5	6.5	9:46	255.8
3/12	27.7	58.5	0.0	95.6	1.0	3.0	6.4	8:37	225.6
3/13	28.2	60.8	0.0	89.8	0.7	2.1	4.6	9:12	248.0
3/14	27.9	71.5	0.0	99.1	0.6	2.2	3.7	14:51	228.0
3/15	27.3	77.7	10.0	183.8	0.4	1.6	3.4	9:34	161.6
3/16	25.9	67.0	1.5	126.8	0.4	1.9	4.3	9:04	206.5
3/17	24.0	54.7	0.0	203.0	0.4	1.5	4.5	18:03	194.9
3/18	23.6	57.6	0.0	196.9	0.5	1.8	3.9	12:45	186.4
3/19	25.9	64.1	0.0	129.5	0.4	1.9	3.7	14:00	250.9

Cambodian date	Average temperature (℃)	Average humidity (%)	Integrate rainfall (mm)	Average wind direction (degree)	Average wind speed (m/sec)	Maximum wind speed (m/sec)	Instantaneous maximum wind speed (m/sec)	Occurrence time of instantaneous maximum wind speed	Integrate insolation (W/m²)
3/20	28.8	66.9	0.0	137.3	0.5	1.9	3.8	16:06	247.9
3/21	27.6	77.6	13.0	113.9	0.5	2.3	4.3	17:07	206.2
3/22	27.8	81.3	36.0	81.7	0.5	2.3	5.2	23:26	212.4
3/23	26.3	83.5	27.5	120.5	0.5	2.3	4.4	13:10	218.0
3/24	27.3	78.9	1.0	101.0	0.3	2.1	4.2	11:46	217.5
3/25	26.8	65.1	0.0	76.7	0.1	2.2	4.7	14:29	143.9
3/26	25.7	65.1	0.0	97.4	0.2	1.6	3.8	11:47	180.1
3/27	24.8	61.7	0.0	131.7	0.2	0.9	2.6	12:08	126.7
3/28	23.2	59.9	0.0	174.5	0.4	1.1	3.9	16:41	163.6
3/29	22.5	61.5	0.0	164.2	0.3	1.1	3.5	13:28	146.0
3/30	23.2	59.1	0.0	194.6	0.4	1.6	3.7	13:16	235.7
3/31	24.8	62.3	0.0	189.1	0.4	1.7	4.0	13:57	233.2
4/1	27.7	65.3	0.0	95.8	0.4	1.9	3.8	5:04	209.6
4/2	28.0	72.1	0.0	75.3	0.5	2.2	4.4	11:41	185.8
4/3	28.4	74.4	0.0	152.1	0.4	1.5	3.8	21:56	166.1
4/4	27.9	75.8	0.0	146.1	0.4	1.7	3.2	20:50	145.5
4/5	26.1	81.4	0.0	67.8	0.6	2.2	4.8	8:35	123.0
4/6	27.6	75.3	0.0	134.9	0.6	1.6	3.7	9:04	232.7
4/7	28.1	76.0	0.0	144.2	0.4	1.5	4.5	12:24	210.4
4/8	25.2	90.6	24.0	124.3	0.2	1.7	5.5	5:41	63.5
4/9	25.8	88.3	49.0	101.0	0.6	3.3	5.3	12:29	176.2
4/10	27.1	76.3	0.0	76.1	0.8	3.4	5.8	9:26	265.9
4/11	27.6	77.5	0.0	121.2	0.5	2.0	4.7	14:42	245.7
4/12	27.4	81.0	3.0	129.7	0.5	2.8	4.7	15:14	174.5
4/13	26.5	82.9	0.0	72.2	0.4	2.0	3.6	15:42	143.5
4/14	27.5	79.2	0.0	112.2	0.2	1.3	2.5	11:49	264.2
4/15	28.1	77.0	0.0	142.3	0.4	1.5	3.4	9:18	238.2
4/16	28.9	75.7	0.0	119.3	0.4	1.7	4.1	14:58	276.6
4/17	28.9	76.3	0.0	165.2	0.5	2.0	5.4	16:57	259.2
4/18	29.4	75.2	51.5	162.8	0.6	1.7	3.9	23:42	262.6
4/19	26.2	83.2	10.0	78.8	0.3	2.3	2.6	12:53	224.1
4/20	27.8	84.3	0.0	64.7	0.4	2.5	4.7	13:38	198.1
4/21	27.4	85.1	3.0	140.0	0.6	2.4	5.4	11:51	155.5
4/22	28.1	78.7	0.0	96.8	0.4	1.6	3.5	14:39	251.5
4/23	26.6	85.2	3.0	108.8	0.4	4.9	8.6	15:10	186.4
4/24	27.6	82.3	0.0	79.3	0.4	1.4	6.1	6:27	223.8
4/25	26.2	90.0	15.0	57.6	0.3	2.6	3.8	7:22	144.9
4/26	28.2	80.0	0.0	155.5	0.4	1.8	3.8	17:09	246.4
4/27	28.4	80.4	0.0	158.7	0.3	1.4	3.2	13:51	243.8
4/28	29.3	76.4	0.0	171.7	0.5	2.7	5.7	21:23	251.9
4/29	27.4	83.2	0.0	115.3	0.3	1.9	3.7	11:42	191.7
4/30	28.7	81.4	2.0	68.8	0.5	2.0	4.6	12:56	264.8
5/1	27.1	85.6	0.0	170.5	0.3	1.7	5.6	12:44	143.9
5/2	28.8	76.9	0.0	166.4	0.3	1.2	2.8	15:23	260.6
5/3	29.3	79.2	0.0	112.6	0.3	1.4	3.7	14:50	238.5
5/4	28.8	82.7	0.0	124.9	0.5	2.4	4.5	14:47	207.6
5/5	28.4	80.9	0.0	76.6	0.4	3.1	5.9	14:33	238.4
5/6	28.9	77.1	0.0	140.0	0.6	2.3	4.9	16:01	266.6
5/7	27.6	84.2	4.5	89.0	0.4	3.6	6.6	15:45	206.7
5/8	28.3	79.8	0.0	161.9	0.6	2.2	4.1	22:32	209.5
5/9	28.0	81.3	8.0	132.5	0.6	2.3	7.7	13:39	224.3
5/10	29.0	73.9	0.0	191.3	1.2	2.7	5.8	11:05	235.5
5/11	29.3	71.3	0.0	233.8	0.9	2.2	4.4	15:07	213.0
5/12	28.4	77.6	0.0	144.0	0.7	3.5	6.1	15:54	250.7
5/13	28.4	77.9	0.0	94.6	0.6	2.5	7.1	16:40	234.0
5/14	27.9	78.3	0.0	94.9	0.7	3.9	10.8	16:16	179.3
5/15	28.7	73.3	0.0	112.2	0.8	3.0	6.0	18:14	272.5
5/16	28.2	78.2	0.0	119.9	0.5	2.0	3.7	14:13	207.4
5/17	28.0	81.2	0.0	90.2	0.5	1.8	7.7	1:59	168.7
5/18	26.6	85.7	33.0	122.9	0.3	3.2	3.2	6:46	180.8
5/19	28.3	78.8	0.0	129.0	0.8	2.0	4.8	18:13	262.5
5/20	26.7	87.9	32.5	86.4	0.4	2.8	4.5	14:24	190.4
5/21	28.0	84.5	0.5	108.4	0.3	2.4	5.7	14:28	224.2
5/22	28.7	78.5	0.0	197.2	0.7	2.6	5.5	14:08	279.8
5/23	28.0	82.6	0.0	166.7	0.4	2.2	4.9	14:18	201.7
5/24	28.5	81.5	19.0	128.3	0.4	2.4	4.1	20:47	250.1
5/25	26.7	89.6	1.0	89.3	0.2	1.8	4.2	5:12	123.6
5/26	26.4	86.3	30.0	96.8	0.5	2.3	5.6	17:35	221.3
5/27	27.5	83.2	0.0	121.5	0.4	2.1	4.5	17:32	271.8
5/28	27.6	84.7	0.0	120.3	0.4	2.8	4.7	17:53	227.1
5/29	28.3	83.6	0.5	129.9	0.5	2.2	4.5	22:34	242.7
5/30	26.0	91.6	6.5	91.5	0.3	1.8	3.4	13:00	135.6
5/31	27.6	85.8	0.0	115.9	0.3	2.3	4.9	14:05	216.8
6/1	28.7	81.3	0.0	122.6	0.4	1.9	5.2	18:17	257.6
6/2	28.5	83.3	0.0	79.9	0.3	1.5	3.4	12:49	206.2
6/3	28.0	85.5	0.0	89.2	0.3	2.0	7.3	17:02	175.4
6/4	28.8	80.8	0.0	115.0	0.4	2.1	6.4	19:06	227.1
6/5	28.6	79.6	0.0	115.9	0.5	2.3	5.3	18:56	247.9
6/6	27.5	83.8	0.5	127.9	0.4	2.4	5.8	14:53	166.0
6/7	28.4	79.1	0.0	141.6	0.6	3.0	5.5	18:20	271.8

Cambodian date	Average temperature (℃)	Average humidity (%)	Integrate rainfall (mm)	Average wind direction (degree)	Average wind speed (m/sec)	Maximum wind speed (m/sec)	Instantaneous maximum wind speed (m/sec)	Occurrence time of instantaneous maximum wind speed	Integrate insolation (W/m²)
6/8	27.4	85.2	38.5	120.3	0.5	2.2	4.6	15:06	201.7
6/9	27.8	84.1	27.0	168.9	0.8	4.2	7.6	17:53	268.0
6/10	26.3	90.0	5.0	143.3	0.4	2.6	6.2	13:36	142.7
6/11	26.6	85.5	3.5	170.8	0.6	2.2	4.6	19:58	184.6
6/12	26.4	88.2	32.5	126.1	0.5	3.0	6.3	15:04	177.4
6/13	26.3	87.4	0.5	134.9	0.5	3.0	7.6	15:42	164.6
6/14	24.7	91.6	18.5	110.5	0.3	3.1	7.8	13:07	117.2
6/15	27.7	81.5	11.5	176.2	0.9	3.3	6.4	18:49	274.7
6/16	27.5	80.5	0.0	245.9	1.0	3.6	7.2	8:38	161.9
6/17	27.5	82.8	1.0	208.7	0.6	1.8	4.9	12:01	157.9
6/18	26.3	88.6	15.0	141.0	0.6	3.8	7.0	14:50	166.7
6/19	26.4	87.8	36.5	177.0	0.8	3.7	7.0	14:15	161.9
6/20	26.3	87.2	15.5	187.1	0.7	3.3	7.3	15:10	149.6
6/21	27.1	85.4	9.0	203.0	0.6	2.2	5.3	12:18	174.3
6/22	27.8	81.5	0.0	206.1	0.9	3.2	5.8	12:42	201.2
6/23	28.8	74.8	0.0	256.4	1.3	3.6	6.6	14:31	242.1
6/24	28.7	76.4	0.0	237.5	1.1	2.2	6.4	12:45	165.7
6/25	28.8	72.2	0.0	223.1	1.4	2.7	6.1	14:33	199.9
6/26	29.0	70.4	0.0	201.6	1.2	2.6	5.7	17:03	240.5
6/27	27.5	80.5	0.0	142.0	0.8	2.3	5.3	11:53	220.4
6/28	28.4	80.2	0.0	158.6	0.5	2.0	4.0	11:06	239.2
6/29	27.1	85.2	3.5	151.7	0.5	1.6	4.1	14:13	138.5
6/30	25.9	91.5	27.0	105.0	0.6	1.8	3.2	11:33	89.5
7/1	26.2	87.9	3.0	95.7	0.6	2.1	4.0	12:11	155.5
7/2	26.9	84.9	15.0	116.1	0.3	2.2	5.5	16:39	260.3
7/3	27.0	84.7	0.0	172.4	0.3	2.4	6.3	16:03	249.9
7/4	27.8	78.7	0.0	168.3	0.3	1.3	2.6	12:22	289.9
7/5	28.1	79.5	1.5	140.5	0.4	2.0	4.1	19:42	266.7
7/6	28.3	80.7	3.0	157.7	0.6	2.2	5.5	11:48	275.6
7/7	29.3	75.7	0.0	174.0	0.8	2.6	5.8	15:28	269.1
7/8	29.6	74.6	0.0	218.6	0.8	2.3	4.6	11:34	246.6
7/9	29.5	74.0	0.0	233.4	0.8	2.2	5.1	10:28	215.3
7/10	27.9	81.8	0.0	168.2	0.7	3.3	6.4	16:00	220.8
7/11	28.1	83.0	0.5	131.9	0.5	2.0	3.6	9:15	204.2
7/12	27.9	80.1	0.0	132.8	0.5	1.9	4.3	14:59	182.6
7/13	26.0	91.0	22.5	92.6	0.4	3.5	5.9	15:22	161.1
7/14	26.1	91.0	26.0	92.7	0.4	3.3	7.5	15:10	145.2
7/15	26.5	88.9	2.0	156.2	0.7	2.1	5.7	11:22	142.8
7/16	27.6	83.9	0.5	139.0	0.5	1.9	3.7	17:51	177.6
7/17	27.7	80.4	1.0	209.9	0.7	2.6	6.7	16:38	239.6
7/18	29.0	71.2	0.0	253.3	0.9	2.2	4.7	12:25	256.5
7/19	26.7	86.4	7.0	159.9	0.5	2.0	4.9	15:39	125.1
7/20	26.5	86.9	0.0	125.6	0.5	2.6	6.2	13:44	156.9
7/21	25.6	88.9	12.5	176.9	0.5	3.6	6.8	16:46	116.1
7/22	26.0	87.4	1.5	173.1	0.4	1.9	4.8	18:27	175.2
7/23	27.2	84.2	2.5	175.1	0.5	2.5	5.5	17:50	207.9
7/24	26.8	87.3	5.5	117.2	0.2	1.3	4.1	16:18	266.9
7/25	26.1	90.5	20.5	106.7	0.5	1.7	4.3	12:40	189.8
7/26	27.1	84.8	2.5	169.7	0.6	2.0	5.1	18:18	258.0
7/27	27.7	83.5	0.0	174.7	0.7	2.1	5.8	10:53	260.6
7/28	27.4	84.1	26.0	182.9	0.5	3.3	7.6	18:25	241.7
7/29	27.2	84.5	3.0	208.7	0.9	3.2	7.1	16:08	205.8
7/30	26.6	85.4	22.0	221.9	1.2	3.5	7.6	14:30	107.8
7/31	26.5	83.8	3.5	187.3	0.9	3.7	7.9	12:54	130.0
8/1	25.1	90.8	17.5	134.5	0.4	2.0	4.0	14:54	76.0
8/2	27.0	82.3	6.5	167.3	0.7	2.3	4.7	15:36	141.6
8/3	27.9	80.2	0.0	141.2	0.5	2.2	4.4	12:53	228.3
8/4	28.7	80.0	0.0	196.2	0.5	1.7	3.9	14:56	264.4
8/5	28.9	78.1	0.0	234.1	0.8	2.4	5.5	13:26	240.0
8/6	28.2	79.6	24.5	215.1	1.0	2.4	4.9	11:56	219.4
8/7	26.1	90.3	20.0	138.1	0.4	3.6	6.4	15:06	138.7
8/8	26.3	90.7	51.5	105.0	0.4	3.5	6.7	15:14	158.2
8/9	25.6	93.2	29.0	108.0	0.4	3.3	6.4	12:14	121.5
8/10	26.2	86.1	0.5	216.3	0.5	3.3	8.0	15:49	143.1
8/11	26.0	86.7	1.5	129.8	0.6	4.1	6.9	18:02	167.5
8/12	27.0	83.9	0.0	143.7	0.4	2.3	4.3	13:56	211.7
8/13	27.2	87.5	0.0	91.3	0.2	1.4	3.5	12:38	186.6
8/14	27.8	86.5	1.0	116.1	0.3	2.7	4.6	23:58	210.2
8/15	25.5	91.1	20.0	80.6	0.3	1.7	3.7	17:35	137.0
8/16	26.2	89.0	18.0	150.6	0.2	1.4	6.3	1:47	198.6
8/17	26.9	84.1	6.0	171.4	0.4	3.0	4.0	12:59	243.8
8/18	26.5	87.1	1.5	143.8	0.4	1.5	3.8	11:59	178.4
8/19	26.7	88.6	2.0	121.5	0.3	1.4	2.8	8:52	166.4
8/20	26.3	91.7	16.0	53.0	0.1	1.5	4.2	11:10	157.3
8/21	27.7	85.4	0.0	108.3	0.4	1.9	4.3	13:31	273.1
8/22	28.4	84.1	0.0	118.6	0.5	2.3	4.1	11:43	262.3
8/23	28.7	82.7	0.0	163.0	0.5	1.9	4.3	9:56	241.9
8/24	28.6	82.9	9.5	149.7	0.5	2.7	4.8	20:20	261.1
8/25	27.7	83.4	0.5	133.8	0.2	1.1	6.4	4:19	265.1
8/26	25.7	90.9	46.0	139.4	0.2	2.2	4.8	19:18	173.8

Cambodian date	Average temperature (℃)	Average humidity (%)	Integrate rainfall (mm)	Average wind direction (degree)	Average wind speed (m/sec)	Maximum wind speed (m/sec)	Instantaneous maximum wind speed (m/sec)	Occurrence time of instantaneous maximum wind speed	Integrate insolation (W/m²)
8/27	25.9	92.5	1.0	91.0	0.2	2.6	3.4	5:16	124.1
8/28	26.6	88.9	82.0	181.5	0.4	1.8	4.3	18:39	190.1
8/29	26.9	88.1	10.0	117.4	0.4	2.3	4.3	10:04	161.5
8/30	27.4	83.0	3.5	186.6	0.6	2.1	5.2	13:25	204.8
8/31	26.5	89.3	10.0	141.7	0.5	3.6	8.7	14:22	185.6
9/1	26.4	88.7	6.0	157.4	0.6	2.7	6.7	15:17	201.0
9/2	25.7	92.8	24.5	126.7	0.4	3.1	6.2	13:59	102.4
9/3	28.0	81.4	0.0	157.5	0.5	2.2	5.5	15:51	255.2
9/4	27.6	84.7	0.0	118.7	0.4	2.1	4.5	9:27	218.3
9/5	27.8	83.0	0.0	139.0	0.6	2.8	5.1	15:16	182.1
9/6	27.4	87.1	4.5	106.8	0.3	2.2	5.4	16:31	182.3
9/7	26.8	91.2	11.0	111.7	0.2	1.8	4.6	20:58	100.6
9/8	25.9	92.8	22.0	176.0	0.5	2.7	6.9	16:35	78.8
9/9	26.2	89.9	78.0	191.0	0.6	2.4	4.7	11:59	204.4
9/10	26.0	91.1	10.0	204.0	0.7	2.0	4.3	11:56	102.9
9/11	26.0	90.5	44.0	95.1	0.8	2.8	5.8	12:26	151.4
9/12	26.4	90.8	23.0	79.0	0.5	2.0	4.5	9:15	142.4
9/13	27.1	87.0	5.0	134.1	0.3	2.2	4.1	14:21	224.9
9/14	27.7	82.7	0.0	198.8	0.5	2.1	4.0	14:41	191.6
9/15	26.6	87.6	7.5	177.8	0.4	2.7	5.4	18:52	96.9
9/16	27.7	84.2	0.5	168.5	0.7	2.5	6.0	15:01	238.7
9/17	28.1	81.5	10.5	204.8	0.9	2.8	5.7	12:01	241.7
9/18	28.1	83.0	0.0	158.3	0.5	1.9	4.5	14:42	210.2
9/19	28.2	83.6	0.0	154.3	0.6	2.5	6.1	16:07	247.7
9/20	25.6	96.2	23.0	60.7	0.1	2.0	4.6	8:03	31.0
9/21	26.4	89.7	69.0	150.3	0.7	2.3	4.9	14:45	222.9
9/22	24.8	93.1	49.5	253.9	1.1	2.8	4.9	10:32	72.8
9/23	24.8	94.6	20.5	250.5	0.5	1.9	4.0	9:26	65.0
9/24	24.7	94.9	4.5	154.2	0.3	1.5	3.3	11:48	61.7
9/25	25.8	92.6	0.0	89.7	0.2	1.6	3.2	12:10	154.0
9/26	26.4	92.5	7.0	88.6	0.2	1.2	3.2	4:55	160.6
9/27	24.7	96.2	51.5	145.0	0.2	2.1	5.8	17:42	39.5
9/28	25.8	90.1	27.0	120.8	0.4	3.5	6.4	15:33	200.5
9/29	26.7	88.3	1.5	141.6	0.5	2.3	4.3	12:04	181.9
9/30	28.2	79.6	0.0	215.9	0.9	2.2	5.0	13:50	220.4
10/1	28.0	81.5	4.0	179.5	0.6	2.0	4.6	18:42	246.7
10/2	27.5	86.9	4.5	136.8	0.4	1.5	3.9	15:19	215.1
10/3	25.1	95.3	17.5	55.9	0.0	0.9	2.1	15:11	72.4
10/4	25.4	87.5	0.0	91.4	0.1	1.5	3.4	13:43	144.9
10/5	26.6	82.8	0.5	64.8	0.1	1.2	2.6	13:21	229.6
10/6	26.0	87.4	0.5	76.9	0.2	1.3	3.7	14:45	214.8
10/7	26.7	85.5	0.5	77.0	0.3	1.5	3.1	16:42	216.6
10/8	25.4	93.4	23.0	50.6	0.0	0.8	2.0	12:08	96.4
10/9	25.6	91.7	1.5	92.8	0.2	1.4	3.4	10:40	144.4
10/10	25.3	93.9	5.0	48.8	0.1	0.9	2.2	11:27	104.6
10/11	25.7	93.4	12.5	65.2	0.1	1.3	3.0	12:14	131.4
10/12	26.5	90.2	31.5	101.5	0.2	1.4	3.2	12:36	169.0
10/13	25.8	91.8	27.0	127.2	0.3	1.8	4.5	22:10	143.7
10/14	25.6	91.6	21.5	83.9	0.3	2.1	5.2	16:43	174.1
10/15	24.7	97.0	98.5	116.5	0.2	1.2	3.4	11:36	57.0
10/16	26.5	87.4	2.0	113.4	0.3	1.8	3.8	12:56	215.6
10/17	25.9	93.1	26.5	83.1	0.2	1.3	3.0	10:53	128.0
10/18	26.6	86.5	0.5	100.7	0.3	1.7	3.9	12:06	227.1
10/19	26.5	85.2	11.5	119.8	0.4	1.8	4.0	13:26	228.8
10/20	26.3	89.6	2.0	63.5	0.4	2.7	6.0	14:53	206.3
10/21	26.5	87.8	0.5	91.8	0.2	1.5	3.7	12:45	205.8
10/22	27.1	85.5	2.0	66.0	0.4	1.5	4.0	8:29	237.8
10/23	27.1	88.3	0.0	103.1	0.3	1.6	3.9	15:44	174.8
10/24	27.3	85.5	0.0	60.7	0.5	2.4	4.3	9:09	233.4
10/25	27.7	82.8	0.0	72.8	0.5	2.2	4.9	13:21	235.9
10/26	27.9	82.0	0.0	66.7	0.3	1.9	4.3	10:02	241.9
10/27	26.9	84.5	12.5	102.7	0.5	2.9	6.1	20:44	218.2
10/28	26.2	87.8	4.0	102.3	0.3	2.0	5.6	15:40	222.3
10/29	27.2	82.4	0.0	57.7	0.3	2.1	5.0	14:41	230.6
10/30	27.0	82.2	0.0	71.7	0.3	1.5	3.7	9:44	214.3
10/31	26.6	82.1	1.5	80.0	0.4	2.3	4.1	14:22	224.5
11/1	27.1	82.1	0.0	61.9	0.1	1.0	2.8	9:15	212.1
11/2	26.4	83.9	7.0	72.1	0.3	2.1	4.0	14:27	193.8
11/3	26.5	80.8	0.0	96.9	0.4	1.6	3.4	9:25	253.4
11/4	26.7	82.0	0.0	104.2	0.3	1.9	3.4	16:12	246.3
11/5	27.6	79.5	0.0	144.4	0.2	0.9	2.6	14:54	245.9
11/6	26.4	87.1	2.5	121.8	0.2	1.3	3.0	8:17	150.1
11/7	26.2	88.8	0.0	143.7	0.1	0.7	2.6	13:55	102.8
11/8	27.1	85.3	14.5	136.6	0.5	1.9	4.0	11:10	220.3
11/9	25.7	87.9	9.0	73.7	0.1	1.4	2.5	13:07	171.6
11/10	25.4	79.9	0.0	48.4	0.1	1.0	3.3	12:15	240.2
11/11	24.9	81.6	0.0	86.5	0.3	1.4	3.1	14:58	223.2
11/12	26.3	80.5	0.0	62.2	0.2	1.5	3.1	10:22	225.8
11/13	26.5	80.6	0.0	50.2	0.2	1.3	3.4	12:01	192.2
11/14	26.1	79.2	0.0	87.3	0.4	1.8	4.3	11:41	232.8

Cambodian date	Average temperature (℃)	Average humidity (%)	Integrate rainfall (mm)	Average wind direction (degree)	Average wind speed (m/sec)	Maximum wind speed (m/sec)	Instantaneous maximum wind speed (m/sec)	Occurrence time of instantaneous maximum wind speed	Integrate insolation (W/m²)
11/15	26.5	82.3	0.0	91.4	0.2	1.9	3.0	14:07	192.8
11/16	26.2	82.9	0.0	90.3	0.2	1.4	3.1	14:55	182.6
11/17	26.5	79.7	0.0	48.2	0.1	1.0	3.4	12:23	228.4
11/18	26.3	79.3	0.0	68.6	0.3	1.7	4.0	13:35	232.9
11/19	27.0	76.9	0.0	57.3	0.1	0.6	2.2	13:23	224.1
11/20	25.9	74.0	0.0	77.8	0.3	1.8	3.7	9:19	217.5
11/21	26.2	79.3	0.0	57.1	0.2	1.4	4.2	12:08	183.2
11/22	27.0	76.3	0.0	49.2	0.2	1.6	4.2	13:43	227.4
11/23	27.1	75.4	0.0	38.9	0.2	1.5	3.9	11:11	191.1
11/24	26.0	70.4	0.0	67.4	0.1	0.9	3.4	10:26	221.3
11/25	25.8	73.0	0.0	72.3	0.1	0.8	3.5	12:51	208.1
11/26	27.0	76.8	0.0	89.2	0.2	1.2	2.8	14:43	192.4
11/27	27.3	77.8	0.0	106.6	0.3	1.4	3.3	13:52	216.5
11/28	26.5	78.2	0.0	79.6	0.5	1.7	3.7	13:33	218.0
11/29	26.2	80.1	0.0	57.0	0.5	2.4	4.1	12:22	232.6
11/30	26.0	82.0	0.0	70.0	0.5	2.0	4.0	8:26	234.5
12/1	26.0	79.4	0.0	67.7	0.5	2.1	4.2	8:16	228.6
12/2	25.3	74.5	0.0	58.0	0.2	1.1	2.8	13:00	223.3
12/3	23.5	77.8	0.0	89.8	0.3	1.7	2.9	12:45	216.2
12/4	22.8	82.1	0.0	67.4	0.3	1.8	3.4	13:22	145.8
12/5	23.7	78.0	0.0	83.7	0.2	1.5	3.5	15:19	179.9
12/6	25.1	77.3	0.0	46.0	0.1	0.9	2.6	14:28	205.0
12/7	25.3	84.6	0.0	101.0	0.1	1.3	2.7	14:20	114.2
12/8	25.4	89.4	9.5	68.4	0.2	2.4	5.4	15:27	136.5
12/9	24.3	81.4	0.0	84.9	0.1	1.1	2.5	11:15	173.2
12/10	23.8	69.2	0.0	114.7	0.3	1.2	3.9	12:54	228.1
12/11	21.2	70.5	0.0	98.6	0.2	1.1	3.0	10:51	188.3
12/12	20.9	71.8	0.0	138.7	0.3	1.5	3.1	8:56	227.5
12/13	21.7	75.6	0.0	154.1	0.4	1.8	3.0	15:35	193.6
12/14	23.2	78.6	0.0	79.5	0.1	1.0	2.1	7:22	152.6
12/15	25.4	77.8	0.0	46.3	0.2	1.1	3.2	10:04	176.1
12/16	25.8	69.6	0.0	72.0	0.2	1.1	2.7	12:37	215.1
12/17	24.7	66.1	0.0	99.7	0.3	1.1	3.3	13:00	227.6
12/18	24.4	68.9	0.0	110.4	0.2	1.2	3.1	13:09	210.7
12/19	23.8	69.0	0.0	94.6	0.2	1.0	3.2	13:33	217.3
12/20	23.9	71.0	0.0	126.5	0.2	1.4	2.5	12:09	196.6
12/21	24.6	73.5	0.0	105.8	0.2	1.4	3.7	12:48	167.8
12/22	25.5	75.9	0.0	112.0	0.3	1.7	3.6	10:25	171.2
12/23	25.3	76.3	0.0	82.7	0.3	1.9	3.3	13:32	191.4
12/24	24.7	67.2	0.0	66.2	0.2	1.2	3.4	11:41	146.8
12/25	21.2	67.0	0.0	108.4	0.3	1.5	4.0	10:56	206.3
12/26	21.4	68.4	0.0	140.5	0.4	1.6	4.8	14:51	217.6
12/27	23.1	70.0	0.0	125.6	0.4	1.6	3.1	14:19	217.9
12/28	25.4	75.8	0.0	78.6	0.3	1.9	3.7	13:55	200.8
12/29	25.0	76.0	0.0	97.4	0.5	1.8	3.7	13:53	214.8
12/30	25.5	77.1	0.0	76.2	0.2	1.3	2.6	12:59	156.3
12/31	25.4	75.1	0.0	85.6	0.2	1.1	2.7	12:16	158.9

Table 4 Some statistics of the meteorological data (2011) at AMOS

	Daily average temperature (℃)	Daily average humidity (%)	Daily rainfall (mm)	Daily average wind direction (degree)	Daily average wind speed (m/sec)	Daily maximum wind speed (m/sec)	Instantaneous maximum wind speed (m/sec)	Daily integrate insolation (W/m²)
Average	26.5	79.5	5.7	119.0	0.4	2.1	4.5	197.7
Standard error	0.09	0.45	0.68	2.41	0.01	0.04	0.07	2.45
Standard deviation	1.65	8.61	12.97	45.96	0.23	0.70	1.34	46.90
Variance	2.72	74.09	168.33	2112.14	0.05	0.49	1.78	2199.86
Kurtosis	0.85	-0.20	15.29	0.02	1.33	0.35	1.01	0.77
Skewness	-0.87	-0.49	3.50	0.73	0.99	0.62	0.86	-0.86
Range	8.8	42.3	98.5	217.6	1.4	4.3	8.8	258.9
Minimum	20.9	54.7	0.0	38.9	0.0	0.6	2.0	31.0
Maximum	29.6	97.0	98.5	256.4	1.4	4.9	10.8	289.9
Total	9689.5	29029.9	2065.0	43420.3	162.5	762.8	1652.2	72148.9

heavy rain of more than 4mm/10min accounts for approximately 14 %.

In addition, extremely heavy rain of more than 16mm/10min was observed five times in the year (the strongest rain of 19mm/10min is observed 23:50, April 18). Therefore, precipitation has the characteristic that it often occurs in a short time in the rainy season at the site.

Figure 6 shows the results of wind direction in 2011. Although the major wind direction is west and secondary ESE, ESE wind prevails from January to May and westerly wind prevails from June. The frequency of northward winds is very low. With regard to the low frequency of the northward wind, vegetation distributed north of the AMOS may block the northward wind.

Fluctuations of daily maximum wind speed (m/sec) and instantaneous maximum wind speed (m/sec) are illustrated in Figure 7 with a 20-day moving average. The daily maximum wind speed is small in late March and late December, and becomes faster in early June. On the other hand, the instantaneous maximum wind speed was 10.8 m/sec (NNW) on May 14 (Table 3).

4. Future perspectives

The meteorological monitoring station AMOS offers basic environmental data with regard to the stone deterioration at the Angkor monuments. In particular, the meteorological data provides valid data for planning and the techniques of preservation and restoration at the Angkor Wat temple.

The hollows at the base of the sandstone pillar in the first gallery of the Angkor Wat temple are a notable case of stone deterioration. It is considered that wet-dry weathering is especially involved in the formation of such hollows. According to observation in the gallery, the pillar never gets soaked in about 1-3 mm/ 10min rain. However, the pillar changes to a wet condition if heavy rain occurs. After the rain, if desiccation of the pillar due to insolation accelerates, the pillar is subjected to wetting and drying. The data of AMOS shows precipitation is concentrated in the rainy season and occasionally occurs with strong intensity at the temple. The deterioration of pillars is considered to progress by the repetition of heavy rain and the desiccation of columns.

To clarify the weathering processes of the stones forming the monuments, it is important to attempt further accumulation and enrichment of the meteorological data at the AMOS.

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notes

1) According to the Department of Meteorology, Cambodia (2010), weather observation station in Cambodia is as follows: Battambang, Pailin, Prah Vihear, Kampong Thom, Siemreap, Pursat, Banteay Meanchey, KraTie, Mondol Kiri, StungTreng, Ratanak Kiri, Kampong Som, Kampot, Koh Kong, PhnomPenh, Takeo, Kampong Cham, PreyVeng, SvayRieng, Odor Meanchey

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