

SURFACE METEOROLOGICAL MEASUREMENTS AND
METEOROLOGICAL SERVICES IN PAKISTAN



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Abstract:

In this study, effort has been made to examine the observations of the meteorological elements, near the surface of the earth with the aid of sensors such as Thermometers, Barometers, weather Surveillance Radar and Remote sensing units. The information's regarding the Atmospheric Pressure, Air temperature, Humidity, Wind speed & Direction, Rainfall, Visibility used operationally in day-to-day weather analysis and forecasting is discussed here. Some observations like a solar radiation; Soil & Grass Temperature and Potential Evaporation are essential for studies in the fields of climatology, Hydrology and Agro meteorology. The main objective of this study is to assess the function of instruments installed in Pakistan meteorological Department before 1980s and the new development in instrumentations after 1980s. In view of the changes, some suitable adaptation strategies have been proposed. A brief about the meteorological services provided by Pakistan meteorological department (PMD) to different agencies is also mentioned in this paper.

1. Introduction

For day today weather analysis and forecasting, surface observations like an atmospheric pressure, air temperature, humidity wind speed & direction, rainfall and visibility are the basic tools. Without instruments, observations are impossible. The surface Meteorological observation Instruments (SMOI) mostly uses Conventional in Site Sensors to obtain 1-minuts and 30 minutes average of the surface wind speed, wind direction, air temperature, reletive humidity barometric presser and precipitation.

Routine surface Meteorological observation begins at Pakistan observation in 1947. The atmospheric presser, Clouds, Temperature, amounts and direction of movement, rainfall amount recorded, Relative humidity. Air temperature, observations were made by observer at synoptic hours. The brief of instruments installed before 1980s and some develop instruments after 1980s are explained (Byers, 1959). Recent advancement in technology has allowed a significant expansion in remote weather sensing capability during the past 10 years. The state of see was calculates by the Jinnah international Airport met office Karachi (Pakistan), based on the costal winds. Agro meteorological stations normal meteorological parameters are measured on daily bases and the data is conveyed to the national Agro meteorological center Islamabad, after every 10 days. Flood forecasting division collected the observation from the catchments areas and issued a flood forecast. Weather services are compasses a wide range of forecast, warning and information services to the general public, national and international shipping and aviation, the Department of Defence and other users (A.Bureau, Met, Report,).

2- Observing stations in Pakistan

The following types of meteorological station/ offices established in the country, shown in table –1.

Table-1.

S.NO	OBSERVATORIES	NUMBERS
1	Surface observatories	45
2	Pilot Balloon	28
3	Aero-met	32
4	Atmospheric	04
5	Marine	01
6	Main Meteorological offices	04
7	Dependant Meteorological offices	02
8	Regional agro met center	04
9	Solar radiation stations	12
	TOTAL	145

The role of the a national Meteorological services starts from the establishment of a network of meteorological Observatories where real time World Meteorological Organization (WMO) Meteorological Observations are recorded all over the world at an interval of three hours, starting from 0000 UTC. For the recording of various types of Meteorological data, different types of Meteorological stations set up, detailed as below.

Main five types of surface Meteorological stations

i-Surface synoptic Meteorological station.

Three hourly observations are taken about the mentioned weather parameters beside the past weather during the previous three hours. Minimum Temperature and total rainfall during previous 24 hours is noted at 0300 UTC and Maximum is recorded at 1200 UTC.

ii-Aeronautical stations

Hourly/half hourly Met. Observations are recorded regarding Atmospheric pressure, Air temperature, Prevailing wind speed / direction, cloud types/amount, visibility and present weather. Climatologically stations.

iii-Climatological stations: Those, which record meteorological observations at selected synoptic hours for climatological purposes and submit their records to Regional centers by post at the end of the month.

iv- Rain gauge stations ions or Hydro meteorological stations:

Those which record only rainfall or snowfall once a day or more often at synoptic hours and send their data by post to the authorities maintaining them.

V-Ships observatory: Ships observatories that record synoptic weather observations while out at sea and report them in coded messages by wireless to the nearest coast radio stations for weather forecasting and warning purposes.

3-Metrological instruments

i) List of the Instruments Installed in PMD before 1980s:

Different types of surface observation instruments used before 1980s are in Appendix (i).

ii) List of the Instruments Installed in PMD after 1980s:

Different types of surface observation instrument used after 1980s are in Appendix (ii). The instruments that are normally installed in the observatory are shown in table-2 as well as in appendix (iii).

Table-2

S.NO.	INSTRUMENTS	PAMETER MEASURED
1	Rain gauge	Rainfall
2	Cup counter Anemometer	Wind run
3	Sun shine recorder	Sun shine hours
4	Evaporation pen	Evaporation
5	Stephenson screen	Housing for instruments
6	Dry & wet bulb thermometer	Dry & Wet bulb temperature
7	Grass Minimum	Grass minimum temperature
8	Soil minimum	Soil Temperature in different depth
9	Thermograph	Temperature & Humidity.
10	Mercury Barometer	Pressure

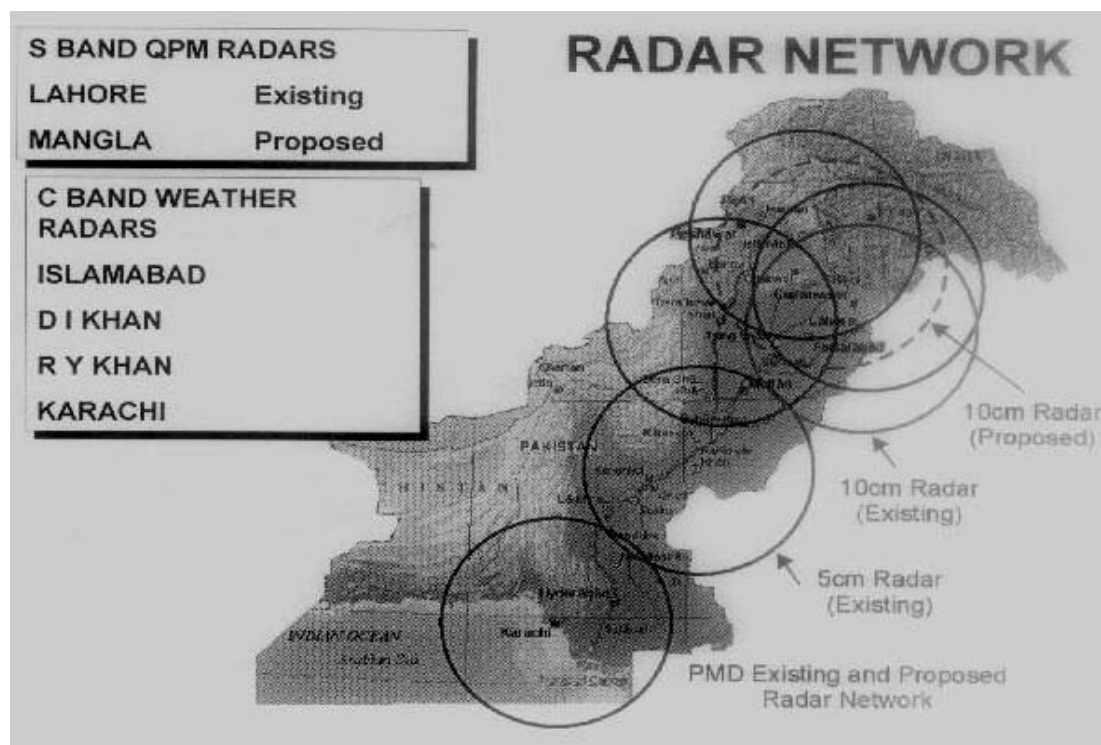
4. Surface Observations

The following observations, instrumental and non-instrumental, are recorded at the Surface Meteorological Stations (A. Miller.et.al).

- (i) Direction and speed of the wind: The direction from which the wind is blowing is recorded with the help of a wind vane in tens of degrees or according to the points of the compass. The speed of wind is measured by means of an anemometer and is expressed in nautical miles per hour or knots, a knot being about 2km or about 1.25 miles per hour.
- (ii) Barometric Pressure: The pressure of the air is measured in millibars with the help of a barometer. A millibar is one-thousandth part of a bar, which is the meteorological unit of atmospheric pressure in the GGS system, and is equivalent to a force of 1000 dynes acting on a surface of one sq.cm. Dyne is the unit of force and stands for the force, which produces a unit acceleration in one gram. A column of 29.92 inches of mercury in a barometer represents 1013.2 mb.
- (iii) Temperature of the air: It is measured in degrees Fahrenheit or Centigrade by means of a thermometer exposed to air in shade in a Stevenson screen, which has double louvred sides for free ventilation.
- (iv) Wet Bulb temperature: If the bulb of thermometer containing mercury is wrapped up in muslin and is kept wet, the temperature recorded by such a thermometer is generally lower than that recorded by an ordinary thermometer whose bulb is dry. This is called wet bulb temperature. The lowering of the wet bulb thermometer reading depends upon amount of water vapor present in the atmosphere.
- (v) Dew point temperature: this is the temperature at which the water vapor present in the atmosphere would begin to form dew. The drier the air the lower will be the dew point temperature as compared to the dry bulb temperature. It thus gives a measure of the water vapor content of the atmosphere. In air saturated with water vapor the dry bulb, wet bulb and dew point temperatures are all equal.
- (vi) Humidity: When the amount of water vapor actually present in the atmosphere at the time of observation is expressed as a percentage of the amount that is needed to saturate it at its dry bulb temperature, it is called relative humidity.
- (vii) Rainfall: Rainfall is measured by a rain gauge. One inch of rainfall means that if the rain that falls on a horizontal surface is collected there, its depth would be one inch.

- (viii) **Visibility:** It represents the maximum horizontal distance at which objects can be seen distinctly at the time of observation, and is estimated by experienced observers by observing known landmarks at known distances. This is also measured precisely by electronic equipment wherever available.
- (ix) **Present weather and past weather:** The weather phenomena like haze, mist, fog, sandstorm or dust storm, drizzle, rain, shower, snow, thunderstorms, etc., along with an indication of their intensity and time of occurrence are divided into 10 main groups and 100 categories. The phenomena experienced within one hour of the time of observation are termed present weather and those experienced since last observation or within the last 24 hours as past weather.
- (x) **Amount and type of cloud cover:** The clouds are classified into three main categories—high, medium and low—depending on the level of their formations and under each category ten sub-divisions are made (I.C. Atlas, WMO.1956). For the purpose of observation, the whole sky as observed from an open observing position, is considered as consisting of eight parts. The amount of sky covered by each category of cloud is estimated by mentally combining the clouds present in different parts of the sky and recorded in terms of the eight parts of the sky (oktas). The kind of the cloud is determined and the amount of the sky covered by the clouds of each of the three categories is estimated and reported.
- (xi) **Height of base of clouds:** This is determined by observers with the help of a small hydrogen filled balloon, called ceiling balloon, or by a search-light or by electronic equipment. At observing stations not having any of the above equipment the height of base of cloud is obtained by estimation (I.C. Atlas, volume, 1987).
- (xii) **Sea and Swell:** At coastal stations, as well as on ships, observations are also recorded on the state of sea and swell and the direction of swell.
- (xiii) **Weather Warning radar Stations:** Weather warning radar station is a high powered, land-fixed radar designed to locate the cyclones, fronts, thunderstorms and areas of precipitation and their movement within a radius of 150 to 200 miles by means of the reflection of radar beams by the suspended obstructions. This equipment has been provided at Karachi, Sargodha and Cherat and is of great use for weather warning service with a high degree of accuracy and confidence. Storm warning radar networking after 980s in Pakistan is shown in the maps I.

Map-1.



Automatic Weather stations and Lightning Detectors are also installed at few stations in Pakistan recently.

5- Meteorological communication system/services.

The role of the media in a successful public weather services programme is thus crucial and every effort should be made to build a cooperative and trusting relationship between the national meteorological services (NMS) and the media. PMD are used four main communication systems.

- i) GTS system
- ii) SADIS system
- iii) AFTN system.
- iv) V set system

To collect & transmit the Met data's from these systems, the products are prepared and the following services are provided to the clients.

Meteorological services:

Weather services are compasses a wide range of forecast, warning and information services to the general public, national and international shipping and aviation, the Department of Defence and other users. It consists of the following six individual outputs.

i) Aviation meteorological services

Aviation Weather services continued to enhance the safety, regularity and efficiency of national and international aviation operations. Services are provided within the international technical and regulatory framework of the International Civil Aviation Organization (ICAO) and the World Meteorological Organization (WMO).

Products supplied for aviation users are as under.

- Upper level wind charts
- Significant Weather prognostic charts
- METAR (current weather)
- SPACI (special weather report)
- TAFOR (Terminal Aerodrome Forecast)
- ROFER Route Forecast)
- SIGMET (significant Meteorological information)
- VOLMET broadcast

ii) Hydro meteorological services and flood forecasting

Hydro-Meteorological services encompass aspects of water resources assessment, the provision of flood forecasting and warning services and Hydrological and Hydro meteorological advice for design. These services depend on the information collected through the Pakistan Meteorological Department net works of Meteorological Observatories.

The flood warning services also operate a special purposes network of rainfall and river level station in cooperation with state and Local Government agencies.

Flood Forecasting Center in Pakistan provides the following main products.

- i) Flood forecasting.
- ii) River stream flow forecasting.

iii) Water management at Dam s especially in South West Monsoon.

iii) Agro meteorological services

The PMD continued to provide the Agro-met services, Included the provision of Rain predictions Frost predictions, Soil Moisture information, Time of crop sowing/ Harvesting, Spring of pesticides on crops, Water requirement of crops, Heat and cold waves forecast, Special Weather Advisories for farmers, Monthly Agro met bulletin of Pakistan, Research on regional Basis in collaboration with Agriculture research institutions.

iv) Climatological services

Long-term climatic data obtained from both basic and special observatories networks and store in the Computer data center (CDPC) Karachi, Pakistan. These are published in the form of climate summaries and normal, and made available in both hard copy and computer computable form for use in research. Climatic services are also under pointed by the month-to-month and year to year monitoring of climatic fluctuation including extremes such as Drought and Flood rain. The Prediction of climate anomalies and trends likely to effects the Environment, Agriculture and other Weather and climatic sensitive are of the economy (A. Bureau, Met, Report.

Climatological information for national Developmental projects (e.g. Tunnel in the northern Area, water level in lake & Rivers, Design For Dams Motorways, Roads), and for Environment Pollution, and Ozone monitoring are used.

v) Marine Meteorological services

PMD- Areas of responsibilities under GMDSS (Global Maritime Distress& safety system).

Forecast is issued twice daily through INMARSAT Coastal station Perth, Australia for the ship already in sea.

Issued warning when the port is threatened & issued sea bulletin for fisheries broadcast by Radio.

vi) Weather forecasting services to publics.

The PMD provides a wide range of weather information and forecasting services in the public interest for the benefit of the community at large in all states. Public weather services are distributed through mass media, the Internet, and telephone information systems. A few products are as under.

- i) Next t 24 hours weather forecast.
- ii) Next 2-3 days forecast for farmers.
- iii) Weekly weather forecast.
- iv) Seasonal weather prediction for planning.

Others services

PMD are provided the following other services.

- i) Astronomical information for public e.g. Sunrise/sunset timing, Moon rising/moonset timings,

Information for moon sighting,
ii) Geophysical and seismological services e.g. Earth quakes monitoring, Monitoring of nuclear Explosion in the region, Building sector.

6-ACHIEVEMENTS

The Pakistan Meteorological Department, at the time of its establishment in 1947, inherited only 15 Meteorological Observatories from the Central Meteorological Organization then operating in the Subcontinent. The Department with its continuous efforts has improved weather forecasting capabilities by expanding the network of meteorological observatories, developing methods of observation, improving telecommunication facilities and forecasting techniques.

The major achievements of the Department are introduction of modern flood forecasting system, earthquake and nuclear explosion detection system, radar, satellite, computer technology, flight safety consultancy services in seismic design of dams, buildings and other development and disaster relief schemes.

The Department has also played vital role in research work and its scientists have made valuable contribution. More than 300 scientific papers have been written and published in both national and international scientific journals. Major emphasis in the research has been laid on the field of artificial rain making, ground water detection, arid zone research, ozone measurements, solar energy, wind power potential, oceanographic and space research.

Many of the Research Organizations such as Arid Zone Research Institute (AZRI), Space and Upper Atmospheric Research Corporation (SUPARCO), and Pakistan Atomic Energy Commission (PAEC) started their functioning with the initial assistance of the Pakistan Meteorological Department. Meteorological services are extended on regular basis to Civil Aviation Authority (CAA), Federal Flood Commission (FFC), Pakistan Agriculture Research Council (PARC), Ministry of Environment and Ministry of Food & Agriculture.

7-Future program

The present trend of automation in meteorological measurements, real time data processing and recording on computer compatible media will continue into the future. The existing work of automatic stations will be expanded to further improve special coverage. Weather stations will be set up at Pakistan & this will provide valuable information on the weather system affecting Pakistan from various directions.

TO UP GRADE AND EQUIP THE DEPARTMENT

A National Center for "Drought / Environment Monitoring and Early Warning" has been set-up in Islamabad as part of PMD.

Instruments will be installed to measure the Green House Gases, Soil Moisture data, River & Stream Flow Data, and Sub-surface water situation. The details are shown in table-3.

Table-3

S.NO	Item	Quantity	Area
1	AWS with Soil Moisture Sensors	50	Southern half of country
2	Self Recording Rain gauges	30	Catchments areas of Dams
3	Ordinary rain gauges	350	Southern half of country
4	Remote Sensing & GIS.	1	Whole Country.

8-Recommendation

To control the natural disaster, the author personally recommended and suggested to provide the technical supports including training and equipments to reduce the disaster and saved the human life. e.g. Tsunami Warnings could have saved thousands Peoples. A warning center such as those used around the Pacific could have saved thousands of people in Asia who were killed by the earthquake and tsunamis (Tidal waves).

9-References

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- 2-Australian Govt: Bureau of Meteorology Annual report 2002-2003. Weather services Page 78-95.
- 3-H.R.Byers, General meteorology (1959) Third edition- Mc Graw-Hill book company, INC, Observation and station instruments Page-61.
Haleh Kootval Regional Training
- 4-International cloud Atlas, WMO, 1956, Page 8-13.
- 5-International cloud Atlas, WMO, 1987, volume 2.

Appendix i Instruments Installed in PMD before 1980s

S.No	Name of Instrument	Company Name	Received Date & Year
1	Minimum Thermometer -35C° to +40 C°	G.H.Zeal Ltd London	10-6-1965
2	Gran Minimum Thermometer -35C° to +40C°	M/s.C.F.cassella and Co Ltd London	17-10-1965
3	Minimum Thermometer sheath pattern -35C°to +40C°	Associated Instrument Casella standered	23-4-1963
4	Minimum Thermometer -30C° to 50C°	G.H.Zeal Ltd London	10-6-1965
5	Minimum Thermometer -30C°to 50C°	C.F.Casetter C.O. ltd London	17-6-1965
6	Minimum thermometer -20C°to 55C°	Associated Instrument Po Box - 4800 Karachi	19-11-1964
7	Grass Minimum Thermometer -35C° to 40C°	DO	16-1-1972
8	Minimum Thermometer Wooden From -25C° to 50C°	Salmul Co Karachi Casseter London	30-6-1971
9	Minimum Thermometer -25C°to 50C° Mugni Fram with N.P.L.	Assicuated Instrument Karachi canella london	7-3-1972
10	Slandered Thermometer -30C° to 50C°	Sermina Ltd Karachi Tunuya &Co Japan	17-8-1976
11	Sea Temperature Thermometer with Shild & Convas Buket -10C° to +42C°	Samina Ltd Karachi Tanuya &Co Ltd Tokeyo Japan	17-8-1976
15	Maximum Thermometer -10C° to 50C°	Associated International Po Box No 4800 West Wahorf Road Karachi	19-11-1964
16	Maximum Thermometer -10C°to 50C°	G.H.Zeal ltd London	10-06-1965
17	Electrical Anemograph	R.W. Munro Ltd	10-12-1964

	Velocity & Direction Recorder	London	
18	DO	Are Kos Karachi	29-10-1965
19	W.T. Bathy Thermograph depth Range 0-900ft or 0-275m	Nazer & Co Bender Road Karachi)2-04-1964	02-04-1964
20	Rain Recorder Hilmas 200 cm receiving surface	KARAL Kolb Thranfunt /Main Hum burg (Runtimes Naki 34	10-12-1964
21	Halifax weather Chart Transmenting Scanner TYP WF-204	Samina &Co Karachi	23-2-1965
22	PBO Theodolite Day& Night	Hilgen & Watts London	15-10-1952
23	PBO Theodolite Day & Night	Modem Trading & Co Vielona Road Karachi	15-10-1961
24	DO	Associated Instruments Pak Karachi	29-11-1965
25	Barograph BMO Range, 950 to 1050 Small Pattern	Associated Insh Karachi	25-3-1972
26	Fortin Barometer 670 to 1100 Mbs	Ahmed international Equipment Karachi	25-3-1972
27	Nephi scop	Fraucis Barker & Sons London	21-1-1949
28	DO	J.S. Industries Bundir Road Karachi	10-6-1965
29	Pocket Watches Assoted 15/16	Luntion Watch & Co Karachi	6-2-1966
30	Soil Thermograph Mercury remote type with three Recording system	International Commissariat Agencies Karachi	4-1-1973
31	Thermograph Temperature Range 15C° to 40C°	Selwel Corporation Bambino Chambers Golden Road Karachi	19-5-1973
32	Kp Marine Barometer Range 25" to 32"	F. Darton London	18-7-1955
33	Barograph Weekly 940-1045 Mbs	Selewel Corporation Karachi	5-9-1973
34	Barograph Daily 940-1045Mbs	DO	10-11-1973
35	Micro Barograph	DO	1-611974

	Weekly 990-1020Mbs		
36	Thermometer Ordinary Range 0° to 130F°	Nagrethi & Zombra London	16-9-1958
37	Thermometer Ordinary Hill Range - 30° to 120F°	S.M.London	19-1-1953
38	Thermometer Ordinary Hill Range -30° to 120F°	DO	19-1-1953
39	Thermometer low Temperature -30° to 80F°	In Assets Fram I.M.D PONA	12-10-1954
40	Low Temperature Thermometer Range 0° to 550C°	Short & Mason Ltd Aneroid Works 280 wood welth abstias London	
41	High temperature Thermometer Range 0° to 110C°	Bird & thad London	20-2-1952
42	Thermometer Comical range 0° to 110C°	Griffin & Tat lock London	20-2-1952
43	Comical Thermometer range 0° to 200C°	DO	DO
44	Comical Thermometer range 0° to 360C°	DO	DO
45	Test Thermometer in C° & F° Scale -40° to 140F°	S.M.London	14-5-1955
46	Inspector thermometer standard range +10° to 140F°	In asset fram I.M.D. PONA	12-10-1949
47	Standard thermometer range -20° to 120F°	George Backer London	20-10-1955
48	Standard Thermometer +30° to 400F°	DO	DO
49	Standard Thermometer -90° to 30C°	DO	DO
50	Standard Thermometer -90° to 30C°	Bird & Tat lack London	17-1-1962
51	Standard (assorted dacoratui Thermometer -20° to 20F°	In asscts fram Imd PONA	12-10-1949
52	Thermometer Boiling Point -95° to 105C°	S.M.London	3-6-1958
53	Distance Thermometer	Do	15-901952

	Murcury in steet Air Temperature recorder - 36°to 56C°		
54	Thermograph Daily (Dry) Casella	C.F.Cessella London	6-11-1957
55	Thermograph Dry And Wet Daily	S.M.London	13-6-1962
56	Hygrograph wet dry daily	Associated International Karachi	13-3-1962
57	Hygrometer type 5635 daily clade	DO	1-2-1963
58	Thermograph Wet & Dry Daily	Arkos Cowan Road Karachi	23-4-1963
59	Recording Dry Wet Thermograph S.M. Type	S.M. London	1-6-1961
60	Hygrothermograph Daily	C.F.Cessella & CO London	6-11-1957
61	Earth Temperature	M/S with leمبر re-utgottijam Germany	6-July-59
63	Galvanometer range 12/0/12	M/S Cambridgeing LTD London	07-July-59
64	Gelavanometer (Micro Amp)	M/S Associated Inst. Mnfg Karachi	21-May-60
65	Air Meter Casella	M/S C&FCasella LTD London	20-Dec-60
66	Earth ThermometerNo, 1001	M/S N&Z London	11-Feb-61
67	Psychrometer Range 10 to 00 DG (ASSMAM)	M/S Reliance Pak Corp Khi	11-Feb-61
68	Sunshine Recorder Card No 1603	M/S C&F Casela London	11-FEB-61
69	Psychrometer Range 10 To 00 Dg (Assmam)	M/S Associated Inst Mnfg Karachi	11-SEP-61
70	Aspiration Psychrometer -10 to 00 C(Assmam)	M/S Modern Trading Comp Khi	4-DEC-62
71	Soil Thermometer-10 TO 40 C Depth 10 CM	M/S Jaylam Short & Masion Ltd London	4-DEC-62
72	Soil Thermometer-10 TO 40 C Depth 10 CM 20CM	DO	4-DEC-62
73	Soil Thermometer-10 TO 40 C Depth 10 CM 50CM	DO	4-DEC-62
74	Soil Thermometer-10 TO 40 C Depth 10 CM 100CM	M/S S & M LONDON	4-DEC-62

75	SUNSHINE RECORDER	M/S WLLH Lember Re-Utgottijom Germany	4-DEC-62
76	Solar Radioation Thermometer Range - 10 TO 70 C	M/S N& Z LONDON	5-MAR-62
77	Dew Guage Equipment	M/S Associated Inst Mnfg, Karachi	10-May-62
78	Suushine Recordedr Card No 1603	M/S C & F Casella &Co Ltd London	10-MAY-62
79	Whirling Psychrometer 5 To 50 C	M/S Associated Inst Mnfg Karachi	10-MAY-62
80	Solar Radioation Thermometer Range - 10TO 70 C	M/S Modern Trading Comp Khi	10-NOV-62
81	Preshmatic Copass Th Stand	M/S C & F Casella & Co Ltd London	15-MAY-63
82	Ordinary Thermometer -5 To 55 C W Th Npl	M/S Associated Inst Mnfg Karachi	17-JUL-63
83	Whrling Hygrometer -5 To 50c	M/S Associated Inst Mnfg Karachi	17-JUL-63
84	Galvanometer 8.00c Pi No A2003	M/S General Agencies Ltd Khi	5-DEC-64
85	Galvanometer Upper Suspention	M/S General Agencies Ltd Khi	5-DEC-64
86	Galvanometer Lower Suspention	M/S General Agencies Ltd Khi	5-DEC-64
87	Soil Maxture Meter Completer	M/S Lodhi & Co Khi	5-DEC-64
88	Ordinary thermometer range -20 to 55 c	M/S Associated Inst Mnfg Karachi	19-NOV-64
89	Whirling Hygrometer T-0724 Range 5 To 50 C	M/S Associated Instrument Ltd Khi	19-NOV-64
90	Rain Recorder Hlmon	M/S Kasl Kolb Main Nka Hamburg	12-OCT-64
91	Micro Galvanometer	M/S Ins Trading Comp Khi	14-DEC-64
92	Hair Hygrograph	M/S G.Luff Metell Barometer Hambur	20-DEC-64
93	Ceilo Graph Brand Celometer	M/S Ahmed Inst Equipment Khi	23-FEB-65
94	Sun Shine Recorder	M/S With Lember Re-Utgottijam Germany	17-MAR-65
95	Lolar Rdiation Thermometer -10to 95 C	M/S G.H Zeal London	06 OCT-65
96	Goto model 303 ginch equetorial refractor	M/S Inst Trading Comp Khi	10-DEC-66

	Telescope complete		
97	Ceilograph Brand Ceilometer Const Meter Recorder Only	M/S Ahmed Inst Equipment Khi	21-OCT-66
98	Micro Barograph Daily 580-670 Mbs	M/S Arkos Come Saddar Khi	14-DEC-66
99	Hair Hygrograph Fig 5 Eos08	M/S Ahmed Inst Equipment Khi	23-JUN-67
100	Micro Barograph Type 524451 Daily	DO	27-SEP-69
101	Whirling Psychrometer Model 520550 Range 30 To 40 C	DO	27-SEP-69
102	Hand Anemometer Tyse 52	DO	27-SEP-69
103	Natural Siphone Rainfall Recorder 203mm	M/S Associated Instrument Khi	30-MAY-70
104	Measuring Jar	DO	30-MAY-70
105	Sunshine Recorder	DO	30-MAY-70
106	Glass Measuring Jar 10mm	DO	30-MAY-70
107	Magnometer Typ 592/N	M/S Mslittle More Scientific Engineering Co Paching Chine	30-MAR-71
108	5335 Binifellicinet & Dry Hygrometer Range 15 TO 40	M/S Cosmo Polition Treders Karachi	1-JAN-72
109	Hair Hygrograph Compleat	M/S Assocated Inst Mnfg Karachi	1-JAN-72
110	Whirling Hygrometer -5 TO 50 C	DO	1-JAN-72
112	Natural Siphone Recorder	DO	1-JAN-72
113	Solar Radiation Therometer -10 To 95 C	M/S G.H Zeal london	7-MAR-72
114	Hair Hygrograph	M/S Selwel Corp Khi	19/5/73
115	Hand Anemometer Osk 756	M/S Associated Mechine Tool Makers	1/12/73
116	Temp Indicator Model No 5500102-1-01-02	M/S Zelin Ltd Khi	17/10/74
117	Ken Pattern Barometer E 430	M/S Azam Trading Corporation Khi	5/4/75
118	Fortin Barometer Be 380	DO	5/4/75
119	Sea Temp Thermometer -10to 42 C	M/S Samina Ltd Karachi	17/8/76

120	Temp Indicator Telex Model T Range -20 To 50c	M/S Samina Ltd Karachi	31/11/77
121	Apt Equipment	Donate By French Met Service Free Of Cost	31/8/78
122	Murihead Automatic Compositive 198,230 Am/Fm Weather Recorder	M/S Ial Pvt Ltd Khi	13/4/78
123	Thermograph Daily 0250 C	M/S G.R Trading Comp Karachi	28/8/78
124	Self Recording Raiuage Daily 0.10	DO	28/8/78
125	Hair Hygrograph Daily Range 0-100%	DO	28/8/78
126	Rain Measuring Glass 5 Inch Ordinary	DO	28/8/76
127	Micro Barograph Daily 950 To 1050	M/S G.R. Trading Comp Karachi	13/10/79
128	Micro Barograph Weekly Range 950 To 1050	M/S G.R. Trading Comp karachi	13/10/79

Appendix(ii).List of the Instruments Installed in PMD after 1980s

S.No	Name of Instrument	Company Name	Received Date & Year
1	Maximum Thermometer -20C°to 55C°	G.R.Trading Fida Chambers Karachi Cassella London	8-9-1986
2	P.B.O. Theodolite TAMYA TYP E0 Cat No 1940 Japan	Samina Ltd Nalson Chambers 4th floor I.I.Chundrigals road karachi	10-5-1983
3	Digital Barometer Pt.No –M 2236A Range 800-1050Mbs plus minus 0.4Mbs	Mayyar International Karachi M/sNegrte &zambra (Aviation) Ltd England.	21-8-1983
4	Fortin Barometer range, 700-1050Mbs	Schwet Corporation Abdullah Haroon Road Karachi	24-10-1984
5	K.P. Barometer (station Barometer) Range 700-1100Mbs	DO	24-10-1984
6	Hair Hygrograph (Hygrometer T2-16)	Azam Internationl Shahe- de- Millat Road Karachi	24-10-1986
7	Thermograph T2-16	DO	24-10-1986
8	Thermograph daily	Rizvi & Co Ghulshan Center S.B –B Block 130, Ghulshan-e-Iqbal Karachi	9-2-1988
9	Thermograph T2-18	Azam & Co International Shahe-de-Millat Road Karachi	29-10-1984
10	Barpgra[j TZ-20	DO	29-10-1984
11	Fortin Barometer Range, 700-1100 Mbs	G.R.Trading & Co Fida Chambers M.A. Jenah Road Karachi	29-10-1984
12	Kew Pattern Barometer 700-1100Mbs	DO	DO
13	Prexion aneroid Barometer 850-1100Mbs	Arkos Pakistan Ltd 307 Mehboob chambers Victoria Road Karachi	31-12-1986
14	Precision Aneroid Berometer 750-1020 Mbs	DO	DO
15	Precisan Aneroid 650-1050Mbs	DO	DO
16	OMS-10 Combined Wind speed and Direction trams	Internaional Aeradio Pak (privat) Ltd Po. Box -3160	21-2-1987
17	OMC-170 Digital Display units	DO	21-2-1987
18	Two channel Rushtak Recorder For Wind Speed & direction	DO	DO
19	PBO Thedolite SMI/MK-5	Samanters Street No-25 F- 8/2 Islamabad	23-12-1987
20	Hair Hygrograph daily &	Rizvi & Co Gulshan centre	9-2-1988

	Weekly	SB-B, Block 130,ghulshan-e-Iqbal Karachi	
21	Electrical Anemometer to Measure Wind & Velocity & wind direction to Briths IM-146 Without Recorder	R.W.Munro Ltd London	24-7-1997
22	Barograph Daily Range, 950-1050Mbs	3A Corporation MF.26 th Street Phax V Defance Housing authority Karachi	19-1-1994
23	Prismatic Compass (Breithaupt) No 3010	M/S Electronic Business System Karachi	25/6/81
24	Precision Aneroid Barometer Pressure Range 900 to 1050 Mbs	m/s W.M.O Free Of Cost	27/8/81
25	Set Of Inspector Kit	M/S W.M.O Free Of Cost	27/8/81
26	JV 728 Hygograph	M/S Razvi & Co Khi	24/11/81
27	JV748 Actinograph	DO	24/11/81
28	Earth Thermometer Range 1058c Tcm 10cm,20cm,30cm,50cm &100cm	M/S Associate Instrument Ltd Khi	10/12/81
29	Observatory Type Triple Compound Visual Recorder Wpen Driv	M/S Samakos Trading Pechs Khi	1/11/82
30	Natural Siphon Rainfall Recorder 203mm	M/S Associated Instrument Ltd Khi	19 th May-83
31	Digital Barometer 2236 800,1050MBS	M/S Mayyar Instrument Khi	21/8/83
32	T16324 Portable Anemometer range 50 to 1000 M/M/N	do	08-Nov-84
33	Inspection kit special traveling carrying case	M/S chavs instruments khi	26-Nov-84
34	Vs/ model 80A recorder for 230 v 50 hz	M/ ray trading company khi	26-Dec -84
35	Takamisana model str-300 seismometer	M/S instruments trading corp khi	25-Apr84
36	Dew balance recording type daily hillier type	M/S Alkos Pakistan Ltd khi	08-Sep 85
37	Platinum resistance thermometer shielddo.....	08-Sep 85
38	Foster Cambridge p-130 thermometers range 30 to 5c 50 cycle	M/S commercial instruments khi	08-Sep 85
39	Uhf fm handheld Transceiver 335 -512 Mhz 6 channel	M/s Magnum pak khi	30 Nov 86
40	OMC-170 combined wind speed and direction	M/s IAL pak Ltd khi	21-Feb 87
41	Transmitter		
42	OMC-174 digital display unit	M/s IAL pak Ltd khi	21-Feb 87
43	2 channel ultrasonic recorder for wind speed and direction	M/s IAL pak Ltd khi	21-Feb 87

44	Solar power Automatic weather station Equipment (spares)	M/s Associated instrument Ltd khi	13 Apr 87
45	Solar power system consisting of G- 12- 1336 standard arrays 50	M/s Electronic Business system khi	28 Nov 87
46	Alpha 6121 oMhz walki talki sets	M/s interhome Ltd khi	28 Nov 87
47	Automatic weather station	M/s Associated instrument Ltd khi	19 Mar 88
48	APT system Model- MSG-20	M/s Magnum pak khi	26 Jun.89
49	Hostion instrument DMP29 TG-10H	M/S AWB, UNDP	19 Jul 89
50	Solar arrays system	U N D P	30 Apr 90
51	Radio sound R80-15	M/s I A L pak Ltd khi	15 Jul 1979 20th Dec 1990
52	Liquid damped prismatic compass patted punch	M/s Avionic society int khi	03 June 99
53	Yaesu sys-600 Transceiver	M/S East west khi	17 Oct 00
54	Satellite system pc/sat sadisi/nt	M/s Techno dyngrnic Pakistan	20 Nov 00
55	Automatic plotting system	M/s 3A corp. khi	18 Oct 01
56	Complete Remote seismic station	M/s 3A corp. khi	16 .Nov – 02
57	Ultra sonic Anemometer	M/s Associated instrument Ltd khi	12- Aug-03
58	Seismic. Meters e component	M/s 3A corp.. Khi	25- May –03
59	IMC seismic Montoring system	M/s Associated instrument Ltd khi	20 –May-03

Appendix (iii).

The following instruments are normally found in the observation compound:

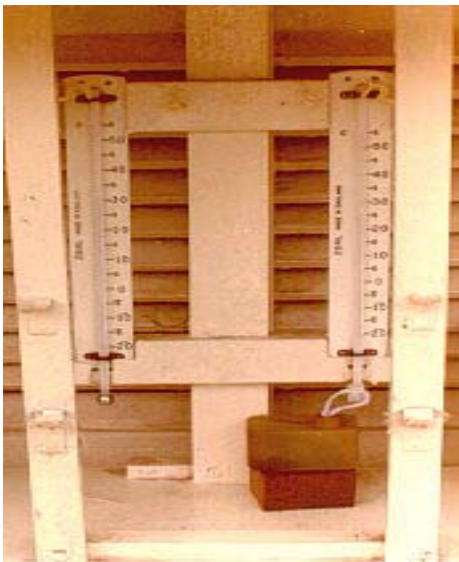
- Stevenson Screens
- Evaporation Pan
- Rain Gauge
- Rain Recorder
- Sunshine Recorder
- Theorize (Tracking Balloon)



The following instruments are kept inside the Stevenson screen:

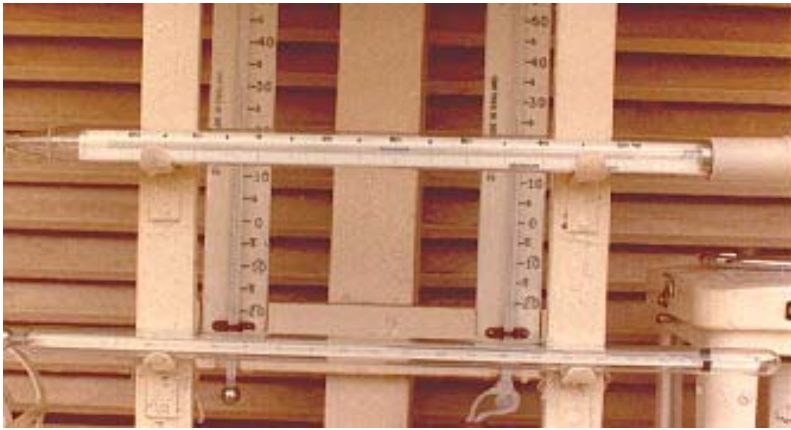
- Dry and Wet Bulb Thermometers
- Maximum Thermometer
- Minimum Thermometer
- Thermograph
- Hygrograph

Dry and Wet Bulb Thermometers



The dry and wet bulb thermometers are placed vertically on supports inside the Stevenson screen. The bulb of the wet bulb thermometer is wrapped with muslin and is tied up with a wick. The wick is then dipped inside a container, which contains distilled water.

Maximum and Minimum Thermometers



The Maximum and Minimum thermometers are mounted horizontally inside the Stevenson Screen. With the minimum thermometer slightly tilted.

Thermograph



Thermograph records air temperature continuously on a chart. Two metals of different alloys are welded together in a coil form. The different in the coefficient of expansions will uncoil or tighten the coil when subjected to temperature changes. The movement is then magnified by a lever system to a horizontal pen, which is attached to the coil with a pen nib slightly rested on a chart. The scaled chart is wrapped around a drum. A clock is built inside the drum.

Hygrograph



The hygrograph is an automatic instrument for measuring relative humidity.

Check Gauge



The Check gauge is used to measure amount of rainfall.

Rain Recorder

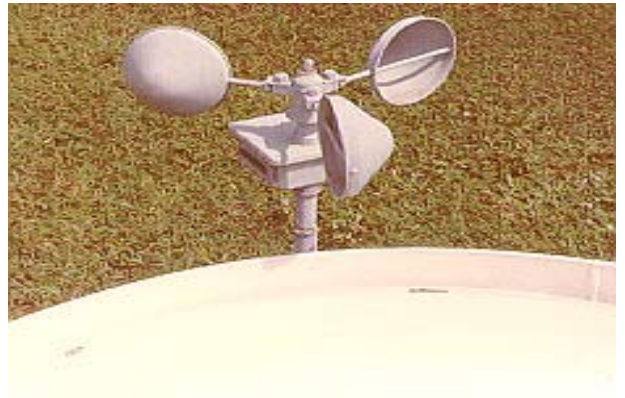
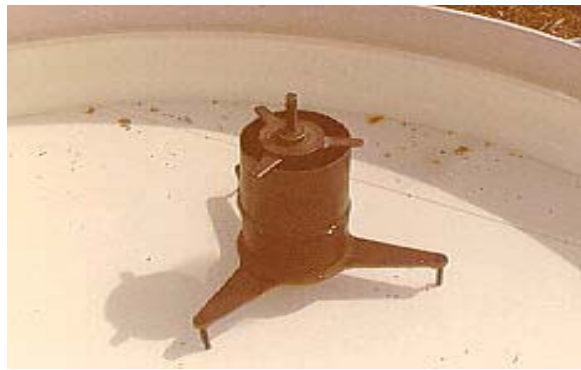


The rain recorder is the instrument for measuring rainfall over a period of time (daily , weekly or monthly depending on the type of recorder and also the chart used)

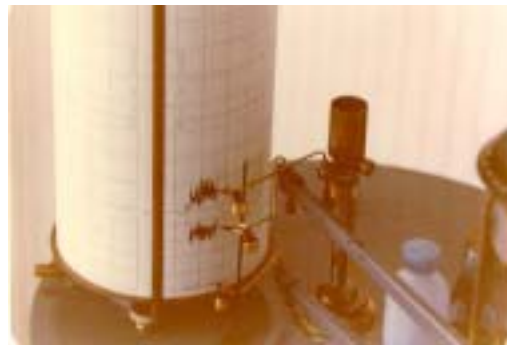
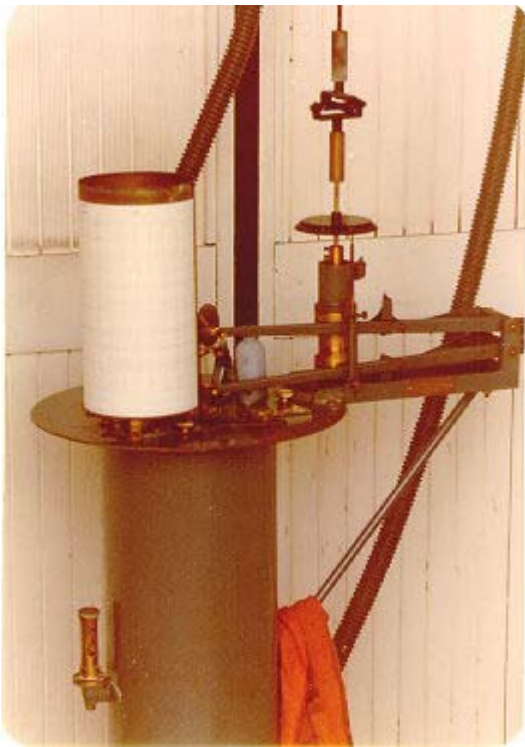
US Class A " Evaporation Pan



"US class A" pan is used to measure the rate of evaporation. A hook gauge is used to measure the water level inside the pan and A cups anemometer is placed beside the pan to measure the surface wind blow over it.



Anemometer



The anemometer is used to measure wind direction and speed and Sunshine recorder measured the sunshine hour of the day.