Online ISSN 2067 - 9564 Volume 7, Number 2/2015

THE GPRS TRANSMITTING DATA PLUVIOMETER (RAIN GAUGE)

Raluca HANDLEY GIURMA[1], Constantin – Marin ANTOHI[2], Ion GIURMA[3], Marius HAGAN[4]

Summary.*Given the importance of the present climate changes, the paper presents a GPRS Transmitting Data Pluviometer, transmitting pluviometric data and the intensity of some concomitant transmitted meteorological phenomena. The equipment is going to be finalized at the Faculty of Hydrotechnical Engineering, Geodesy and Environmental Engineering within "Gheorghe Asachi" Technical University of Iasi. The resulted data is very important as it is used mainly in hydrologic stations, environmental agencies or the dispatcher of disaster commandments within city halls, prefectures or individuals, in order to evaluate the meteorological phenomena and to take preventing operative measures for floods and land slides. This equipment is made of rainfall transducer which has inside a new system for getting the impulses resulted when swinging a tipping cup. The apparatus is made of a Hall sensor, an accelerometric sensor and within the evacuation pipes of the volumetric measured water there are fixed a radiation sensor and a Ph sensor for establishing the rainfall quality; on the exterior surface are fixed a light and air ionizing sensor, a microphone for catching the background noises of some meteorological phenomena that accompany the rainfalls. The resulted data is taken by a microcontroller. After processing the resulted parameters are transmitted via a GPRS module to a web server and via a GPS relay broadcasting station. These parameters are stored in a flash memory together with a time base. The access to the data stored on the web server is given to disaster dispatchers, city halls, environmental agencies, meteorological and hydrologic stations or to any interested person.*

INTRODUCTION

The climate is a multiannual regime of the meteorological processes and phenomena, firstly determined by the solar radiation and the general circulation of air masses that vary according to the geographical situation, the absolute altitude and the land configuration of the respective region, having as main components air temperature, nebulosity, atmospheric rain falls, vertical and horizontal circulation of air currents.

[1] Associate professor, Faculty of Hydrotechnical Engineering, Geodesy and Environmental Engineering within "Gheorghe Asachi" Technical University of Iasi.
[2] Professor, Faculty of Hydrotechnical Engineering, Geodesy and Environmental Engineering within "Gheorghe Asachi" Technical University of Iasi.
[3] Professor, Faculty of Hydrotechnical Engineering, Geodesy and Environmental Engineering within "Gheorghe Asachi" Technical University of Iasi.
[4] Teaching assistant, University of Agricultural Sciences and Veterinary Medicine, Bucuresti.

Climate changes are one of the major challenges for the beginning of 21st century. Given the gravity of its implications, the climate changes matter has become a priority for the members of the global scientific community. The researchers state the fact that the global warming is mainly due to natural causes, to which the gas emissions produced by the human activity is added – however, the last factor is not a decisive one. The natural causes can be listed as follows:

- According to the data the specialists have so far, it is a "cyclic" phenomenon which is normal within the circumstances of the cosmic changes – our solar system, in its movement around the galaxy centre it would have entered a cosmic region of high energy; the sun, which is a star belonging to the second or the third star category out of "The Milky way", having the spectral class 2GV, presents a series of intensifications of the thermonuclear reactions proton – proton leading to strong variations of the generated magnetic field, influencing dramatically the Earth climate, provoking natural disasters (notice the severe drought in Moldova during the summer of 2015), in many regions inhabited by the continuous increasing population.
- The changing of the dip of the Earth axis due to the earthquake in Japan that caused the destruction of the atomic power plant in Fukushima, which modified the angle of incidence of the Solar rays on Earth surface.
- The intended modification or nature manipulation, such as climate and weather of the planet system by some developed countries. The manipulation of natural phenomena represents a preventively weapon by itself, although it is not very well known by the public opinion. The examples of the climate modifications are numerous: provoking droughts followed by huge flooding, having as result the complete destruction of the whole agricultural system, or provoking devastating earthquakes. The modification of natural phenomena will soon become integral part of the security national systems, with internal and international application of some developed states.
- These modifications are made through sending to the ionosphere some beams of high energy electromagnetic waves and large field of frequencies (networks such as HAARP).
- Modification of the circulation of air currents and ground temperature due to forest cleaning can be considered a cause of the climate changes, to which

it can be added the gas emissions with green house effect as results of the human activities.

PRESENTATION OF THE PROTOTYPE

In order to diminish as much as possible the effects of these climate changes, all the efforts need to be focussed for finding new technologies, equipments, and installations that should protect the planet population should violent meteorological manifestations occur, due to the causes listed above.

The GPRS Transmitting Data Pluviometer is used in hydrological hydrologic stations, environmental agencies or the dispatcher of disaster commandments within city halls, prefectures in order to evaluate the meteorological phenomena and to take preventing operative measures mainly for floods.

There are known many appliances and installations for measuring the atmospheric rain falls, made by various companies. Thus, it is known a rain fall transducer and a detector pluviograph to which, when a cup is swinging an electric impulse is released via a permanent anizotrop magnet and of a red contact or a mercury contact; the impulse represents a certain quantity of rain falls, being transmitted to a dispatcher or to a hydrological or meteorological station, where it is taken, assumed and posted in terms of rain falls quantity. These appliances and transducers have the following disadvantages:

- Repeated malfunctions of the generating system of the impulses (modifications of the magnet position towards REED ampoule).
- The impossibility of transmitting the information at huge distances in real time.
- Blocking of the rainfall receiving funnel due to birds.
- Lack of information about the meteorological phenomena that take place at the same time with the rainfalls.

The problem that is solved by the rain gauge described in the present paper consists in carrying out a prototype with the possibility of transmitting, via the GPRS system, information about the rainfalls and of the concomitant manifestations of some meteorological phenomena that take place in real time at the place where it has been installed. The GPRS Transmitting Data Pluviometer removes the above listed disadvantages, as it is made of a rainfalls transducer to which it has been replaced the system for obtaining the impulses resulted when

swinging a cup with a “HALL” magnetic sensor and to which a microphone was added, in order to receive some environmental noises for wind, rainfalls intensification, hail, an optic sensor for receiving the light generated by the lightning of the day light; it also can get information about the thickness of the clouds layer, layer that can establish the duration of the rainfall using the known relation:

$$I = I_o \cdot l^{-KH} where:$$

I – represents the light intensity after it has passed through the clods layers, measured by the optic sensor; **I0** – represents the intensity of the initial light – 1353 W/m^2;

K – the absorption coefficient of the light by the water steams; **H** – represents the height from the place of the sensor installation up to the superior edge of the cloud layer, so the thickness of the layer minus the height of the cloud ceiling.

The rain gauge also contains an ionization sensor that measures the ionization degree due to an electromagnetic field of high intensity, an accelerometric sensor for sensing/noticing the appearance of ascendant air currents characteristic for tornados and sensors for determining the quality of the water out of the rainfalls, acid, alkaline,, and of a sensor for warning the appearance of radioactive rainfalls; all of these sensors are connected to a microcontroller that acquires the data from the sensors, stores them into a local memory and process them in order to determine: the rain intensity, the dimensions of the rainfalls drops, the presence of hail, the level of the wind intensity, the presence of storming phenomena and the distance up to the place where they are produced, as well as the intensity level of an electromagnetic field produced by a source of high intensity or a solar explosion, the thickness of the clouds layer, the installation being powered by a ”long live” battery or bay re-generable source of energy such as an earthly energetic generator, the whole ensemble being fixed on a vertical support through some anchors in a concrete platform, where at the inferior part it is a metal box containing the electronic circuits, box which is very well shielded in order to protect the circuits of a possible electromagnetic emission of high intensity (PEM).

The advantages of this kind of rain gauge are the following:

The possibility to get some complex parameters regarding the atmospheric rainfall and of meteorological phenomena that take place at the same time through the fusion of the data obtained from more sensors.

- Transmission of data at long distance, which makes possible the access to the information related to rainfalls via mobile (telephone, tablet, laptop) and fix devices.
- The possibility of connecting more rain gauges to the network, making possible the determination of some global parameters for a certain monitored surface which is susceptible to flooding, leading to protection operations.
- Sending in real time the warning signals related to the risk for flood, increasing the level of radioactivity for water and air, acid rains, solar explosions and high intensity emissions of electromagnetic radiations.

Please, find below the description of this kind of rain gauge, related to the diagrams.

The GPRS Transmitting Data Pluviometer is made of a rainfalls transducer **1** (figure 1), that has inserted a new system for obtaining the impulses resulted when swinging a tipping cup **2** made of ”HALL” sensor **3**, an accelerometric sensor **SA**, in the evacuation pipes having attached a radiation sensor **4** and a pH sensor **5**, sensors that are in the rainfalls transducer; at the exterior casing are fixed a light sensor **6**, an air ionizing sensor **7**, a microphone **8**, and, for preventing the blocking of the receiving funnel **9**, near the transducer there is a device for chasing the birds, made of soft metal semi sphere **10** that has at the superior part a series of electrodes symmetrically disposed **11** for increasing the distribution surface of a magnetic field generated by a permanent magnet **12**, as the birds orientate after the terrestrial magnetic field, they notice the appearance of a magnetic perturbation and they fly away from the place where the rain gauge is installed; as nowadays, due to the climate changes, the meteorological manifestations have become violent, the rain gauge is very well fixed on a vertical support **13**, to which tensioning systems **15** anchors are attached **14** and very well fixed to the concrete layer SB, through pillars **16**, the support has at its inferior part a metal case **17** very well shielded against high intensity electromagnetic radiations via a well known technology, where the electronic circuit that takes and transmits the pluviometric signals is fixed **18**, that is made of a microcontroller **19** (Figure 2) that takes the data from the ”HALL” sensor **3**, from

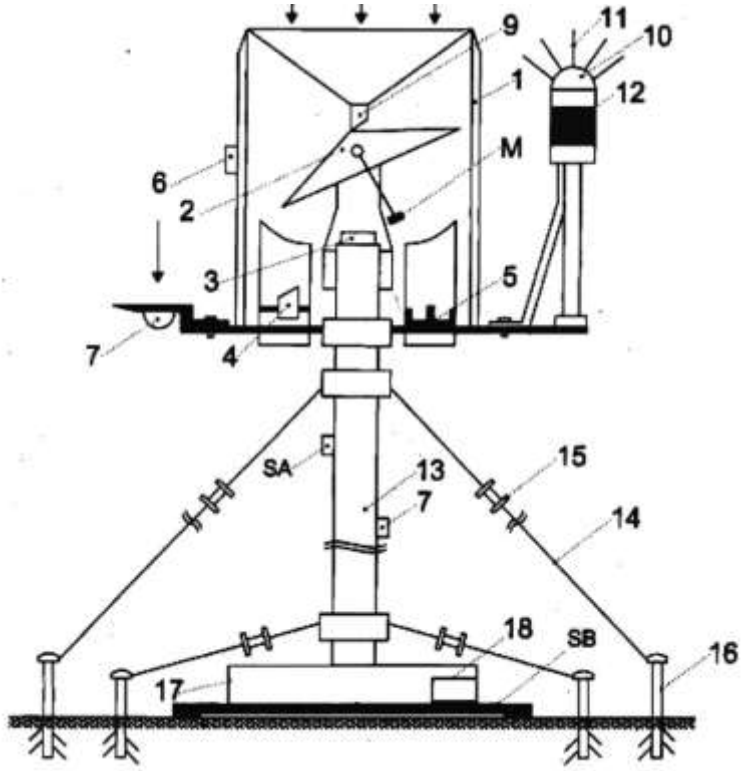
the radiations sensor **4**, from the pH sensor **5**, from the light sensor **6**, from the ionizing sensor **7**, from the microphone **8**, this data being stored and processed in order to get the rainfalls parameters and the parameters of the phenomena that take place at the same time, these parameters being transmitted via a GPRS module **20** to a web server **21**, through a GPS relay **22** in order to represent and follow the variation history of the rainfalls parameters and of concomitant phenomena, the history of these parameters being stored in a flash memory **23** in time data base that is monitored in real time by a clock **24**, the access to the data on the web server is given to disaster dispatches, city halls, environmental agencies, meteorological and hydrological stations or to anyone interested; more rain gauges can be grouped into a network (Figure 3) that will monitor the distribution of the quantities of rainfalls on certain surfaces that are susceptible to floods, the network being made of more rain gauges $\mathbf{sp_1}$, $\mathbf{sp_2}$, … $\mathbf{sp_n}$ displacement of the atmospheric fronts or floods, the data being taken from the rain gauges via GPRS modules **20** or RF short distance transmission modules whose data is collected by a concentrator **CT**; the determination of the rain intensity is done via a computer software that is carried out following a chart (Figure 4) which is made of a start label (label **a**), an label initializing the microcontroller variables (label **b**), a label for sampling the swinging cup (label **c**), a label for conditioning the swinging signal (label **d**), a label for conditioning the swinging index (label **e**), a label for setting the swinging index (label **f**), a starting label for the internal counter of the microcontroller (label **h**), a label for resetting the index swinging (label **i**), a label for calculating the period between two swingings (label **k**), a label for determining the rain intensity (label **m**) and a label for sending the pluviometric signals to a web server **21**.

In the moment of the first swinging of cup 2 (Figure 1) the permanent magnet M is approaching the magnetic sensor ”HALL” **3**, that generates an electric signal which is interpreted by the microcontroller **19** (Figure 2) as being a starting signal for an internal counter. At the second cup swinging, the signal generated by the sensor ”HALL” will be interpreted as a stopping signal of the internal counter, the value of the registered number being proportional with the swinging period. The swinging cycles are repeating as long as the rain intensity is strong enough to fill in the cup. Given the swinging period more levels of rain intensity are established, as follows: low intensity level, medium intensity level, high intensity level, higher intensity level. The rain intensity levels are transmitted by the GPRS module **20** to a web server **21** where they are stored, interpreted and

graphically represented. Should the intensity level overcome some critical points sound warning signals will be emitted and warning messages will be sent to the monitoring centres. In order to detect stormy phenomena two sensors are used, a microphone for sounds produced during the electrical discharges 8 (Figure 2) and light intensity sensor **6**, the latest having the role to detect the lightning appearance. In the case of reduced luminosity of the atmosphere, the distance from the rain gauge to the place where a stormy phenomenon is determined by calculating the delay of the sound signal versus the light signal. The thickness of the cloud layer is determined by analyzing the signal generated by the light sensor **6** that is correlated with time data (hour, day, month, year) that are generated by the clock in real time **24**, the light intensity being inversely proportional with the cloud layer thickness, the light being absorbed and dispersed by the could layer; the duration of the rainfalls depends on the cloud layer thickness. The position for installing the rain gauge is determined with a GPS equipment which can be attached to the rain gauge, or the geographical coordinates can be introduced into the flash memory **23** of the electronic circuit for taking and transmitting the pluviometric signals **18**. The signal generated by the accelerometric sensor SA correlated with the background noise of the microphone **8** leads to taking the decision at the place of installation of the rain gauge of a tornado whose strength is given by the tendency to pull the installation, so the appearance of a ascensional force.

The programme for calculating the rain intensity is carried out the following sequences: the programme is turned on, at circuit feeding or its resetting (label a, function START) – figure 4 and the programme variables are initiated (label b), after that a rain gauge cup swinging event is expected by sampling the magnetic sensor (label c). If the swinging of the cup **2** takes place (label d) it needs to verify whether swinging index is 0 (for the first swinging) or 1 (for the second swinging), (label e), if the swinging index value is 0 this one (the swinging index) will set to value 1 (label f) and the internal counter of the microcontroller will be turned on (label g), the programme will be introduced to the sampling label of the cup swinging signal; if a new cup swinging is detected and the swinging index is 1, the internal counter of the microcontroller will be stopped (label h) and swinging index will be reset at value 0 (label i), the value registered by the counter will be read between 2 swingings (label k) and, on the basis of this value, the value of rain intensity will be determined (label m). To a higher value of the

period between two swingings a smaller swinging frequency corresponds, meaning that the rain intensity is of smaller value and for a value smaller of the period between the two swinging a higher swinging frequency corresponds, meaning that the rain intensity is of higher value.



General view of the rain gauge

The stormy phenomena are determined by the light intensity sensor **6** (for lightning), by the atmosphere ionizing sensor **7** and by the microphone **8** (for thunderbolt). On the basis of the delays between the luminous and acoustic signal the microcontroller will determine the distance between the rain gauge and the place where the lightning occurred. All the data generated by the sensors and the values of the sizes calculated by the microcontroller is stored in a flash memory, time base, the values of the registered periods being generated by a clock in real time. At the user's request all the data stored in the flash memory is sent to the web server. The radiation sensor 4 and the ionizing sensor offer information about the presence of nuclear radiations in water that have produced the air ionizing as well. This fact can trigger a warning signal that a nuclear accident or a nuclear attack occurred. The pH 5 sensor **5** with the radiation sensor **4** inside the rainfalls

transducer give information about the rainfall PH; should the rain be acid, a warning signal for the environmental agency is emitted. The presence of hail in rainfalls is signalised by the noise produced by the contact of the hail particle with the surface under which the microphone **8** is installed. Likewise using the same method the dimension of the rainfall drops can approximately determined as well as their falling frequency. This fact can be correlated with the cloud layer thickness and, if intense rainfalls are predicted a warning is sent to the interested dispatchers.

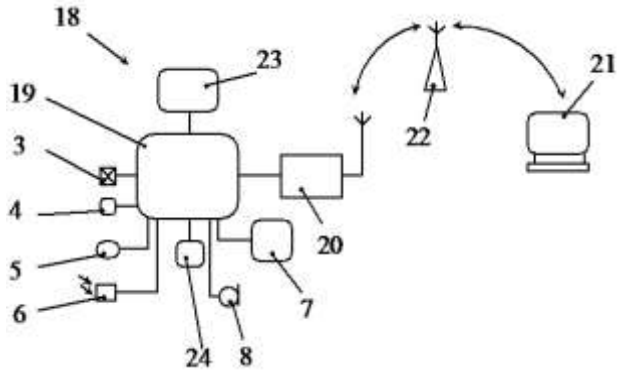


Figure 2. The block drawing of the electronic circuit for taking and transmitting the rain gauge signals.

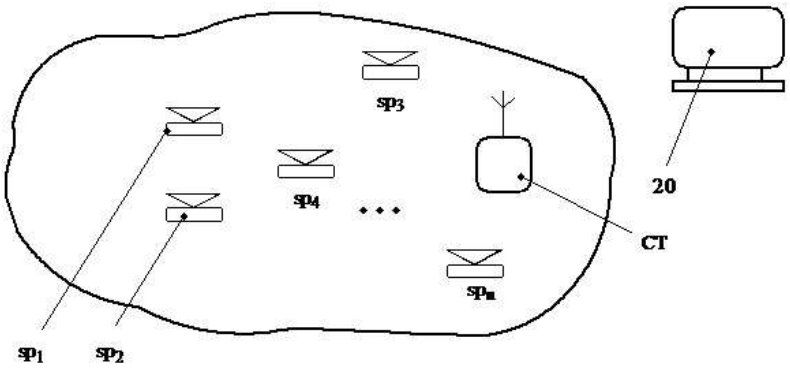


Figure 3. Pluviometric sensors network

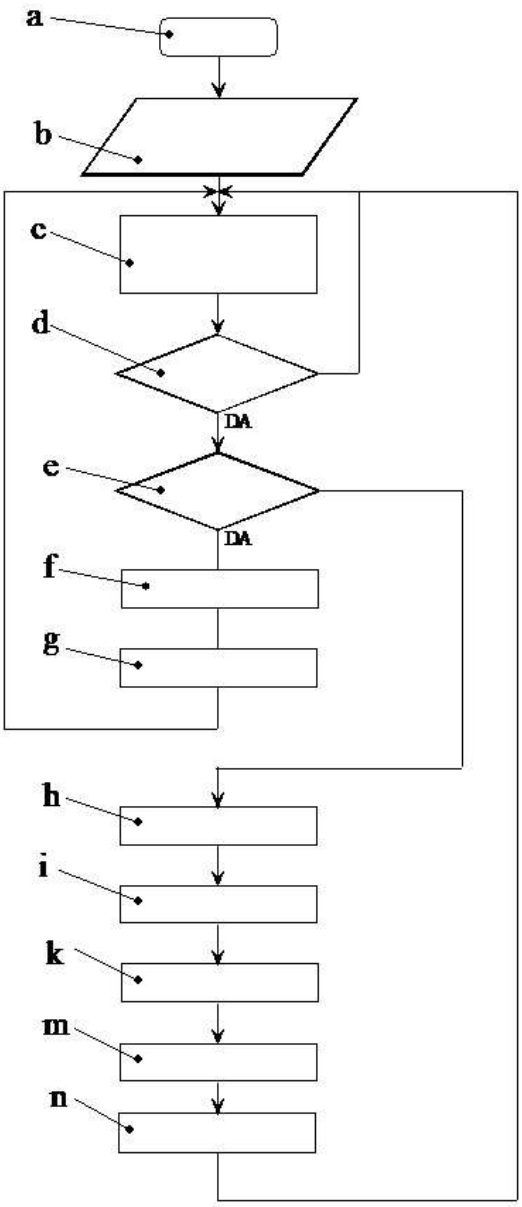


Figure 4. The chart for the rainfalls intensity determination programme.

CONCLUSIONS

The researchers state the fact that the global warming is mainly due to some natural causes to which the noxa emissions produced by the human activity are added; however, the later are not the decisive factor.

In order to diminish as much as possible the effects of these climate changes, efforts must be focussed for finding new technologies, equipments, installations, devices that should protect the planet population in case of violent meteorological manifestations, that can occur due to the mentioned causes.

The GPRS Transmitting data rain gauge can be used in hydrological and meteorological stations, environment agencies or the dispatches of the disaster headquarters within city halls, in order to evaluate the meteorological phenomena in order to take all the operative preventing measures for floods.

BIBLIOGRAPHY

[1] Giurma I., Crăciun I., *Hydrology,* Ed. Politenium, Iași, 2008

[2] Giurma-Handley C.R., *Nummeric Models for Underground Water Flow Simulation and Pollutant Transfer in Aquifers*, Ed. Politenium, Iași, 2006

[3] Giurma I., *Special Hydrology*, Ed. Politenium, Iași, 2009

[4] Patent RO nr.97641

[5] Patent RO nr.83144

[6] Patemt US nr.3705533

[7] Drobot R., Giurma I., *Hydrology,* vol.II, Ed. Rotaprint I. P.Iași, 1990