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THE CONTROL OF THE INFRASTRUCTURE OF THE RURAL WATER WELLS IN THE PLAIN AREA

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Abstract. In the Romanian rural area, esspecialy in the plain areas, water well infrastructure is spread in the entire landscape. However, very little is known about the condition or distribution of the water well infrastructure on which much of the rural population depends on.

Groundwater is the preferred water supply source in most rural areas, because it is readily available and accessible over large parts of the Romanian Plain and West Plain which have the tendency, regarding the climatic changes, to turn into semi-arid area.

A current review is a necessary way in ongoing efforts to know climate adaptation challenges and to develop instruments that will allow water wells to endure drought conditions without disruption at these critical times.

A medium strategy at a local level and a long term strategy at a national level, as well as creating a database concerning the water wells and permanently upgrading the datas regarding these wells will constitute the premises for some viable alternatives for water supplies.

INTRODUCTION

Generally, natural resources disappear in time. As compared to other natural resources, water, under a continuous renewal process, is a regenerating resourse, following the natural cycle which ensures its continuity.

Water resources are categorised as surface waters and ground waters – water reserves existing within phreatic aquifers and very deep layers.Due to the fact that using ground resources is less costly, and that they theoratically have better qualities, they are meant, mostly, for providing the population with potable water.

The groung water sources can be phreatic layers, free level water layers or with one pressure, small depth layers (under 50 m), medium depth layers (50 – 100 m) and big depth layers (over 100m).

According to the definition, a well is a hole dug through artificial drilling through earth, through which water or other liquids in a deposit can be extracted. Wells are built for exploitation or other technical purposes.

Wells are usually meant for providing potable and household waters in locations where there are not centralized systems of water supply. Frequently, the waters in the first water layer in the field area are infested with nitrates above the legal limits. The second layer contains enough imperfections as well, fact which imposes correct treatment and higher costs. The third layer offers adequate conditions for consumption.

According to their depth, drills are of small, medium and big depth. In the case of those of small depth, there is serious contamination risk, due to the high possibility of the polluting substances to get to the water, but this risk is almost impossible in the case of big depth, due to successive geological layers which filtrate efficiently, and the waters from deeper aquifers do not contain organic impurities.

In executing drills for water supply, a very important element is the geophysical investigation (geophysical sampling), research method which involves a set of records – diagraphies – performed in drilling holes for establishing the geological profile, for identifying the type of the formations crossed, the thickness, successiveness and depth of the layers crossed.

The standard geophysical investigation of the hydro-geological drills, according to the physical parameter recorded , generally involves the use of electric and radioactice sampling methods, with or without thermometry or cave measuring records.

The general information obtained after interpreting the sampling diagraphies allow the separation of clay formations from the rest, the identification of the poriferous – permeable areas with fluid circulation, of the layer limits, their thickness etc.

In the case of tubed, old, hydrogeological drills, the natural gamma radiation diagraphy can provide data about the poriferous – permeable layers, possibly aquifers, and also establish efficient methods for rehabilitating drills.

Drilling for water supply involves hydrogeological studies.

The hydrogeological research is meant for identifying ground waters, potable or industrial water supply, as well as for preventing and eliminating their negative effect in the case of civilian or industrial constructions or means of communication.

Thus, the hydrogeological study highlights two essential elements:

÷ the deposit made from the permeable rocks which accumulate water;
÷ the ground waters contained in this deposit.

The research methods used in elaborating this hydrogeological study are:

÷ hydrogeological drills;
÷ experiment pumping works;
÷ identification using indicating substances.

The geological data provided by drilling and the information about the depth and thickness of the poriferous – permeable formations, possibly aquifers, obtained after interpreting the diagraphies of the geophysical investigations are the ground for establishing the best building and permanent equipping program of the drilling holes.

In the plain areas, the wells are spread at random all over. There is very little information known about the conditions and the distribution way of the wells infrastructure, on which a large part of the rural population rely. Ground water are preferred as water sources in most of the rural areas, for they are available and easily accessible in wide areas in plains, which, due to the clime changes, have the tendency to become semi-dry. They can be considered as alternative water supply source, characterized by a fairly high tolerance to drought.

From this perspective, an extremely important consequence of clime changes, meaning the increasing frequency of very high temperatures, droughts, will be reconsidering the rational use of ground waters, by small or big depth wells. This could represent a necessary step toward anticipating the challenges of the adaptation to the clime changes and elaborating plans which would allow water wells to resist under circumstances of long drought.

There is requirement for an analysis to bring information about the relation between the characteristics and the distribution of the water wells infrastructure, about the pattern of the ground water development, about the major geographic influences, as well as about the demographical patters which are changing due to birthrate, to the population's migration toward economic-social centers or life standards.

The presentation of the water wells infrastructure involves the collective effort of local and county authorities, coordinated by the ”Romanian Waters” National Administration, through its local directorates.

The premises of a good alternative for water supplies are provided by a medium term strategy at local and county level and by a long term one at national level, as well as by an up to date data base about water wells.

The data base about the water wells must contain information about the history, building and use of the water wells, so that it can be used intensively in the research of the state of the water wells.

The data digital format – the "Digital Romania" project is such an example – and the use of the GIS technology allow the complex understanding and a flow of information without any precedent.

The water quantity of the wells (productivity) is influenced and relies on a series of systematic factors. The most important factors are:

÷ the spread of the aquifers;
÷ the transmitting and depositing parameters;
÷ the characteristics of the water wells design;
÷ the operational levels of the water.

SHORT PRESENTATION OF THE WATER WELLS INFRASTRUCTURE

Many water wells all over mean the availability of ground waters anywhere in rural areas. Despite this, the tendency to use ground waters as support for development and expansion of rural areas depends on the uneven density of the population.

Without an efficient water wells data base, it is difficult to estimate the number of built wells, at country and hydrographical level, especially for the ones built between the two world wars, in the 50's and 60's.

The average age or the state of the infrastructure is not determined in any of the country's regions, there is no analysis of the abandoned or inactive wells. This data base represents, thus, a series of accumulated notes which relate the wells to the time when they were built. Most wells are drilled with drilling rotary equipment. Usually, these drills have a reduced diameter, getting only partially through the aquifer in which they are installed, and from an operational perspective, they depend on the aquifer's supplying capacity to answer the water demand.

Nowadays, building and rehabilitating very deep wells could solve, or at least, improve the water supply for the rural and sub-urban communities where surface resources cannot be collected and where there is no potable water in the surface phreatic layer or there is no certainty that the water source is at accessible depth. (less than 200 m); the cost for using surface sources is much too high, and this could be another reason in favor of the wells building or rehabilitation. This solution has the following characteristics and includes the following elements:

÷ depth drilled well, H=50-200 m;
÷ the well's diameter D=230-320mm;
÷ mechanized, hydraulic rotary drilling with direct drilling fluid circulation;
÷ the tubes are made of PVC (125x5,4mm, 140x5,4mm ; 160x5,4mm).

The water collection is done in depth, through the aquifer and below the layer, with filters of 20 m (tubes with openings - g=0,3-0,5mm) and with a filtering layer of gravel with a g=3-5mm granulation, within the round space between the tube and the drilled well, all along the filters.

The drilling installations which use the principle of the classical mechanized rotary hydraulic drill, with direct flow of the drilling fluid, generally have the following component and functioning: the drilling tubes system with attached drilling hoe goes round, being pushed mechanically by a drilling head with mechanical (thermical engine) or hydrostatical (slow hydraulical engine) functioning. For the hydraulic drilling, a drilling fluid is injected within the tubes system (pipe type).

The drilling fluid injected through the tubes and through the burner of the drilling hoe washes under pressure the leg of the bore, washing away the rock pieces and the detrirus, which are evacuated through the round space between the tubes and the drilled hole, up to the surface. This is the rotary hydraulic drill, with direct flow of the drilling fluid method. The drilling fluid is reversed through a ditch in a decantation hole, from where it is again recycled and the process is repeated. The tubing is done after the complete drilling deep along the whole well and at its final diameter. To avoid the break of the drill, drilling additives (bentonite+CMC+calcinated soda) are added to the drilling fluid.

There can be drilling at huge depth, all along the well and up to the maximum diameter, without tubing during drilling; tubing is done at the end, after finishing drilling; it represents a simplification and an increase in the productivity, from the drilling technology point of view; for finding rich and clean water sources and for knowing the exact location of the collecting filters. After drilling and before tubing, there can be performed the geophysical research, electrical sampling and resistance method. The diagraphy of the exact form of the drilled layers and the exact location of the clean and rich in water aquifers is obtained, avoiding the collection of tiny dirt infested layers, which cannot be eliminated through desanding; desanding and the operation of the well are done through pomps by the air-lifting method (ejecting tube). Only water wells deeper than 30 m are drilled with this method, with a good cost/ quality proportion, at an acceptable and steady flow (Q=80-100 litres/min).

In what the depth wells reconditioning/ rehabilitation is concerned, which mean drill desanding and dechlorinating, the replacement or repair of the submersible pomps, the cleaning and hygienization of the protection cabins, the average cost for replacement/ well, reaches medium values (between 3000-4000 EUROS), according to the well's depth, and the materials used in construction, without including the auxiliary investment for providing the water reserve.

Desanding involves pomping small grains of sand, their extraction and elimination through the water layer, larger particles remaining around the filters forming a natural filter. The pomping during the desanding is done intensively, the water flow extracted from the well being about 25% higher than the highest future, exploitation flow. The time necessary for pomping depends on the structure of the aquifer.

The operation and the desanding of the drill can be done through pomping, by the air-lifting method. The air under pressure from a compressor is introduced within the syphon device, the air mixture with low water-sand-detritus density being evacuated through a thick hose tight to the syphon device, until the water in the layer clears up and the drill is unplugged (3-5 days). The water thus obtained is clean, filtrated, with no dirt or sand, at the best and steady flow.

In the case of small depth wells, almost half of them have a larger drilling diameter, 60 up to 90 cm, whose depth can be increased even below the collection level. Consequently, the wells that stock their own water can be used, which would reduce or diminish, up to a certain extent, the low productivity of poor aquifers. Still, this type of well can provide false supply, since it is vulnerable to drought, and it would be the first one affected by reduced renewal and frequent use during drought.

Small depth drills, between 1-25 m, can be done through dry drilling, with the help of performant equipment. The advantages of this drilling system, as to manual digging of a well, are:

÷ short execution time;
÷ there can reach deep in the water layer to collect quantity as large as possible, or to collect more layers, as the case may be;
÷ the wells are tubed with concrete tubes with ø60 cm in diameter.

The medium depth drills, tubed with PVC tubes, can be performed up to 150 m. By this method of drilling, layers with large quantities of potable water can be collected. The advantages of this drilling systems are:

÷ the water collected through this drilling method will me potable 99% of the cases;
÷ relatively short execution time;
÷ large flows of potable water;
÷ it is performed through hydraulic drilling with direct circulation.
÷ the layers are performed through electric sampling.

MONITORING WATER LEVEL

The well water monitoring network is extremely important, due to the massive information that must be gathered as to the water quantities that can be collected, as well as to their quality.

The design and location of the observation drills must serve the purpose for which the drill is used (water level measurement, water samples collection). The depth which needs to be reached, the filtrating column of the drill must be long enough to cross the saturated area over the annual fluctuation interval of water level; the best inner diameter of the drill is generally between 51,8 mm and 102 mm.

For evaluating the area of the nitrates pollution, the drill must perfectly open the whole saturated part of the phreatic aquifer with the filtrating column.

After establishing the observation drilling location and after performing it, samples at different depths can be collected.

When establishing the ground water quality monitoring network, the quantity of the nitrates in the phreatic waters must be considered, these waters supplying the private wells which are the water sourse for most of the rural areas.

Providing access for the measurement of the ground water levels or of the piezoelectrical surface of the aquifer, and for the collection of ground water samples are main objectives for an observation drilling network.

They also provide hydrogeological data and help identifying the hydraulic properties of the nitrates polluted formations.

The water monitoring parameters are:

÷ the hydrostatic level of ground waters
÷ flow, quality and quantity polluting elements indicators

Location and methods of monitoring:

÷ installing piezometers; according to the necessity at different levels
÷ overflow locations for ground waters

ESTIMATING THE EVOLUTION OF POTABLE WATER DEMANDS, NOW AND FORECAST

According to the estimation, the theoretical resource of potable water in Romania is at the level of 9,600,000 – 10,300,000 thousand m^3 , out of which about 45-46% represent phreatic water. According to the same estimation, 60-70% of this resourse can be technically used, while the water demands for use, according to the collecting capacity in use, rises up to an average of 850,000 thousand m^3.

The water required by rural and urban areas represent water uses such as: the population's household use, public use, small industry use and the use meant for fire extinguishing.

The household needs of the population and the water for public use **(Npp),** estimated at about 11-14% of the whole water need, can be identified using the following formula:

$$\mathbf{Npp = N*Np}$$

in which **N** represents the population number and **Np** – specific water norm**.**

Taking into account only the need for an increased comfort level of the population, the specific daily norm, for the year 2050, will get as high as 340 l/person/day in urban areas and 200 l/person/day in rural areas as compared to the nowadays 310 l/person/day in urban areas and 150 l/person/day in rural areas.

The growth of the population in the areas in which water supplying is done by wells can be identified according to the the data offered by the National Statistics Commission. Starting from the premice that the population number would continue to decrease in the Medium variant, but the level of this decrease would be less than the one in the recent years, the population would be of 21,4 million people in the year 2025, and of 20,3 million by the middle of the century.

After a decrease of 0.1% of the population till the year 2010, an almost steady evolution till the year 2020, and an increase of 0,2 % of the population until the year 2050, it can be easily noticed that an increase in the need of potable water of 21-25% in rural areas will lead to a severe reconsideration of the importance of the rural water wells in the plain area.

BIBLIOGRAPHY

1. C Klepş, N Grumeza, Maria Anghel, *Utilizarea aportului freatic ca sursă deaprovizionare cu apă a plantelor. Studiu de caz: câmpia Covurlui*
2. Blechinger; Erin Consulting Ltd.; Manitoba Water Resources Branch, *An Overview of Groundwater Development and Reliance Trends,*
3. Andreea – Cristina Şerban, *Estimarea evoluției cerințelor de apă în bazinul hidrografic Târnava*
4. STAS 1343/0-89, *Alimentări cu apă. Determinarea cantității de apă de alimentare. Prescripții generale*
5. STAS 1343/2-89, *Alimentări cu apă. Determinarea cantității de apă de alimentare pentru unități industruiale*
6. STAS 1343/1-95, *Alimentări cu apă. Determinarea cantității de apă pentru centre populate*
7. GEPACO Romania, *Puturi pentru apă*