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Smart energy and water meter: a novel vision to groundwater monitoring and management

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Abstract

Water crisis and threat of shortage in water resources have been raised as a direct consequence of various factors such as limitation of precipitation, use of traditional irrigation methods and lack of efficient monitoring and controlling systems in agriculture section. The fact is that dry regions all over the world are facing water shortage and sharp decrease in groundwater tables as a result of over-pumping. In this paper RSA Electronics offers a solution which is an effective management system on monitoring and controlling groundwater resources. This solution for information management includes three main elements: Metering Device, Communication Device and Software. The specific Information of water wells which are calculated and measured by the metering device through a patented method will be transferred to the control center through telecommunication infrastructures; subsequently in control center, data compiling, information processing and reporting is performed by Meter Data Management (MDM) software.

Selection and peer-review under responsibility of the CCWI2013 Committee.

Keywords: Groundwater, Management, Monitoring, Over pumping, Solution, Resources

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١. Introduction

In this paper a practical solution for groundwater monitoring and management is offered by mentioning a real case of groundwater saving with application of the solution.

Nomenclature

A	Hand-Held-Unit A digital device used for reading/setting digital meters
B	Patrol-and-audit groups Groups of experts looking for the occurred problems/misuses in order to solve/report them

١,١. *Background*

Drought and shortage of water resources has been a major issue in many parts of the world. According to WWAP records, around 20% of the total water used globally is from groundwater resources, and this share is rising rapidly, particularly in dry regions. Although experts in agriculture section have been warning about over pumping risks and the inevitable consequences of continuing the current consumption pattern, the fact is that arid/semi-arid regions all over the world are facing water shortage and sharp decrease in groundwater tables as a result of continuous over-pumping of groundwater and surface water resources. In fact, water scarcity has been a serious problem since last decades; in a way that evidence has proved that the world will face a big challenge in the near future, projected by Keller A. (2000).

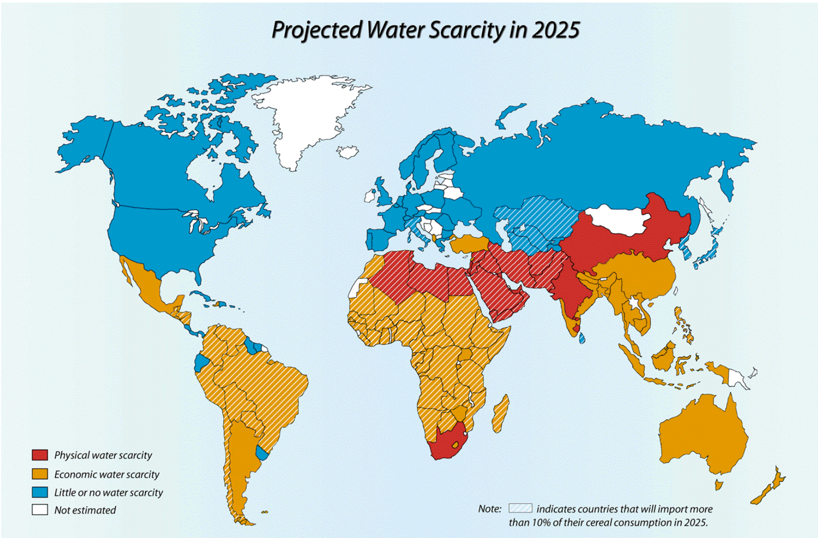

Fig. 1. Countries which will be facing water scarcity in 2025

١,٢. *Water consumption data management*

In numerous countries the significant amount of these precious resources are squandering due to traditional irrigation and lack of controlling systems in agriculture section. Therefore, water specialists have been prompted to manage and control water extraction in order to prevent the possible treat of water crisis.

Generally, there are two methods to conserve groundwater resources: recharging the resources and restricting water withdrawals. Undoubtedly, groundwater pumping management is a major and practical solution for groundwater conservation. In addition, another important subject is managing water withdrawals from a single resource which is shared among a number of water wells in a vast plain. In general, methods which are applied to determine water use include: data collection from the field, compilation and evaluation of measured or estimated data, and derivation of data.

Keller A. (2000) showed that data collection from the field (primary data acquisition) can be obtained by: direct methods which monitor extraction through the application of a purpose-fitted flow measuring device that has been rated and fitted. The primary unit of measurement derived from the device is volumetric, which can be expressed as a flow rate through measurement over a specific time period. The accuracy and reliability of these meters varies considerably; or indirect methods which measure non-flow data obtained from a device at a pumping site. Typically such indirect measurements may be provided as units of time (hours of pump operation), or energy consumption. Such measurements may be combined with assumed extraction rates, or converted to volumes through power consumption to unit volume ratios to derive extraction estimates. The application of indirect metering is somewhat dependent upon the infrastructure and power source at a particular pumping site. The most common power sources for high-volume groundwater extraction (from non-artesian bores) are diesel and electric motors, with energy and water utilities have been looking for an economical, reliable and tamper-proof meter in order to control the amount of water which is extracted from plains as well as consumption of inexpensive energy in water wells. In line with this issue, RSA Electronics has designed and offered an exclusive and practical solution for monitoring and managing groundwater resources in an accurate and reliable way. This study presents a novel and efficient indirect measurement method/device in order to handle groundwater controlling issues.

٢. Method

In order to preserve groundwater resources based on restricting water withdrawals, RSA Electronics' offers an effective system including two main levels: monitoring and controlling/managing. Monitoring consists of making regular data/information gathering from water wells, showing water wells and metering devices' online status (via modem), tracking changes in water wells and metering devices' status as well as tampers, billing for water or/and energy (electricity); while controlling/managing level contains planning and controlling water withdrawals from a defined plain, planning and managing electro-pumps' demand share during peak-hours of energy consumption, issuing direct command for disconnecting electro-pump's electricity.

The figure below illustrates general scheme of the solution by Moazedi A. et all. (2011); information of water wells which are calculated and measured by Smart Energy and Water Meter (SEWM) could be transferred to control center via GPRS, GSM or any other telecommunication infrastructures; then data compiling, information processing and reporting take place in control center by Meter Data Management (MDM) software.

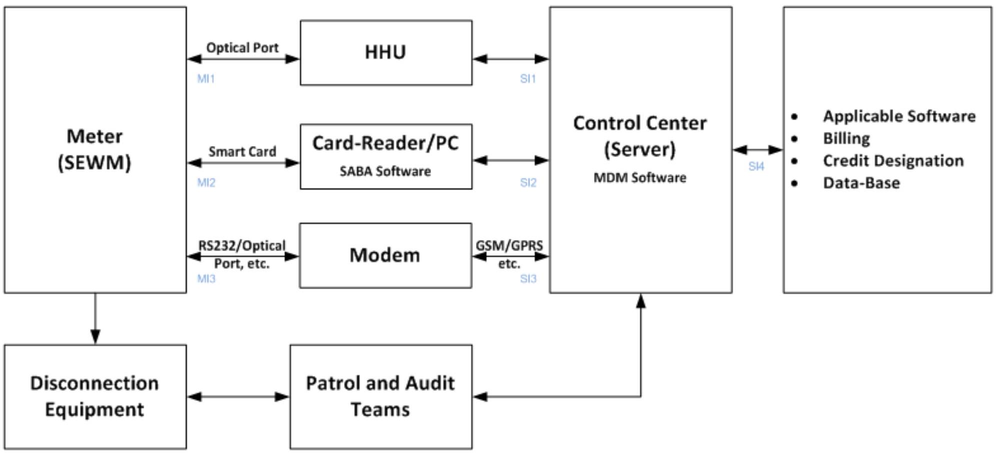

Fig. 2. Method's diagram

The meter which was patented, Taravat M. et al. (2010), in USA is completely capable to be a smart water meter. According to mentioned registered patent, Smart Energy and Water Meter (SEWM) calculates water flow by measuring instant electro-pump's electricity parameters, based on pre-defined pump's curves. This meter which is designed based on the requirements of electricity and water utilities is a combination of three following devices' functions:

- A Digital Energy Meter; an active and reactive multi tariff device that measures and stores consumed energy and other parameters required by the energy utility companies.
- A Digital Water Meter; which measures and stores the amount of water withdrawal, water flow and other parameters required by the water utility companies. There is no other similar water meter with the same capabilities and features, however for the purpose of evaluation it is possible to compare its feature with digital water meters. This product is designed specifically for water pumps and doesn't have common problems that typical meters are usually involved with, such as: sensitivity and vulnerability against suspended particles, air bubbles, pipes' slope, existence of valve, bend and connections.
- A Credit and Control Device; which indicates water credit, validity of start and expiry date; it will react according to the client demand if user exceeds allowed credit water or credit time is over. This reaction includes restoring consumed energy in separated tariff or even can cut electro-pumps power according to the contracted client demand. Mentioned feature is quite unique and only achievable by combining energy and water meter in a single package. It is obvious that no similar device can provide these capabilities which enable water and energy utility companies for fining infringing farmers, savings in energy subsidies and controlling groundwater resources. Credit and other settings could be transferred to the metering device from control center via modem, smart card or Hand-Held-Unit (which is applicable by patrol-and-audit groups).

A combination of these capabilities not only leads to decrease in total costs of ownership and increase in lifetime of meter, but also lessens the risk of being tampered compared with other existing methods.

٣. Discussion

Based on Molden D. (2007), since more than 75% of global water consumption comes from agricultural application and this rate even increases to 95% in developing countries, managing and monitoring water withdrawal is a must in agriculture section which in turn justifies the role of the mentioned solution in potential regions. Moreover, there are other obvious reasons which necessitate this policy. Firstly, global average of water consumption is variable in production of different crops; it is not reasonable to invest on some crops in arid/semi-arid regions or it is necessary to optimize the irrigation systems in order to allocate investment for some strategic crops. SEWM could be used as a credit tool for putting related policies into practice. Secondly, in order to supply water for domestic purposes in cities, especially in arid and semi-arid regions, one of the popular methods is desalination. According to WA report (2012), the cost of water desalination is at least ¢80 per cubic meter which incur high costs of domestic water supply; by using SEWM and application of groundwater resources instead, the cost of water supply decreases sharply. Thirdly, in case of energy consumption, since one of the main consumers of electricity are water wells which are equipped with electro-pump and given that cost of energy during peak-hours is more than the average regular tariffs, it is not logical to pump water during certain hours; it imposes heavy costs to both farmer and electricity distribution network. SEWM is also an energy meter and enables utilities to control the peak-hours energy consumption. On the other hand, when farmers are encouraged to pump water during discounted hours, it helps them to save the costs with applying lower than the average rates. Furthermore, since the meter is capable to cut the power of electro-pumps in non-irrigation season, it is possible to save groundwater resources as well as increase in lifetime of water wells and groundwater tables.

Due to all aforementioned conditions and obtained results of performed projects in Iran and based on thorough economic studies, potential benefits of utilization of SEWM for the Ministry of Water and Power in Iran is far beyond the costs of project implementation all across the country. Based on RSA Electronics (2009), in Arsangan and Sarvestan where are two arid regions of Iran, 1000 smart energy and water meters were installed, from which 830 meters are equipped with relay to cut power during peak hours. Therefore, it saves a great amount of water (about 60 thousand cubic meters per day). Moreover, according to the record of patrol-and-audit groups in Esfaraien, a region in Iran which was facing shortage of water resources famed as forbidden aquifer, while all traditional methods failed, with making use of this innovative solution, in about 90% of water wells' electro-pump's power are cut in non-irrigation seasons for three months or more; according to Vaseteh V. (2010), in this case, yearly water level drop of groundwater has decreased from 75 cm to 28 cm; it means the amount of additional water withdrawal has declined from 30 million cubic meters to 10 million cubic meters per year, in other words an amount of 20 million cubic meters is saved. In order to have a clearer image about the savings, if we compare this amount of groundwater with the same amount produced by desalination methods with referring to the average cost of ¢80 per cubic meter, it suggests a saving of $16 million per year only for the mentioned region.

٤. Conclusion

The smart energy and water meter (SEWM) designed based on the requirements of electricity and water utilities is capable to measure and control the volume of water and the amount of energy simultaneously in a single package; thereby, it can meet the policy of monitoring energy/water consumption. SEWM is a user-friendly and straightforward solution that is economical and easy to install, maintenance free and tamper-proof. Phenomenon product of RSA Electronics, Smart Energy and Water Meter has been proved as one of the most practical solutions for water resources monitoring and management. As a result of using this solution the loss trend in water tables is proved to be effectively controllable.

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