How to measure the water usage in Agriculture

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Hungary is one of the small countries of Europe (93 thousand square km). The **natural conditions**, the climate, the location, the water supply and the soil conditions provide a rather unique opportunity for agricultural production above the European average.

Geographically Hungary is situated in middle-east Europe, in a basin more or less surrounded by mountains – the Carpathians. The **temperate climate** of Hungary is determined by the oceanic, the Mediterranean and the continental climates together. Due to the small area of the country and the fact that only less than 2 percent of the area is higher than 300 metres above the sea level, its climate is rather steady, and there are no extremities.

The annual average **temperature** is 10 °C; the coldest month is January, while the warmest is July. The average summer temperature is less wayward than over the winter. The average annual **rainfall** is around 600 mm, but there are significant differences within the country. The number of **sunny hours** is between 1700-2100 in average. The north-western **wind** is the most frequent and strongest.

Over the past 30 years **the average temperature has raised in particular in the most agrarian regions of the country** (east and north-west). The annual rainfall decreased significantly during the 20th century, especially in spring, when it would be the most important for agricultural production. The rainfalls in summer did not change notably, but parallel with the gradually rising temperature the droughts are more frequent. This situation can be characterised graphically by the drought-index. All these mean that the importance of irrigation is increasing.

Agriculture

Agriculture has always played an important role in the Hungarian economy. Over the past centuries there were decades when agriculture was the leading sector and it provided a level of food supply for the domestic population well above that of the majority of European countries while the surplus was sold on export markets.

Around the turn of the century the Hungarian agriculture was subject to significant changes. In the 1990's following the political and economical transformations far-reaching changes took place both in the society and the agriculture. As a result of the privatization the private holdings ousted the earlier overwhelming state ownership and two key groups of farming – the private holdings and commercial farms in agricultural activities – became

characteristic. Since the accession to the European Union in May 2004, the Hungarian agriculture has been facing new challenges and opportunities.

In Hungary 62 percent of the land area (about 6 million hectares) is arable land, permanent crops, grassland and kitchen gardens, about one-fifth of the country is covered by forests and woodland. The latter type of land use is mainly concentrated in areas of poorer conditions, where the diminishing ruminant livestock also contributes to the reduction of its area.

The climatic conditions of Hungary allow the production of an extremely large variety of crops from the general arable crops to the horticultural branches: vegetables, fruits and grapes. A large number of household gardens producing mixed crop contributes to the supply of vegetables and fruits for the Hungarian population. Each region has its specific crop-pattern.

On about two-thirds of the arable land cereals are grown, followed by sunflower (12 percent) and rape (almost 6 percent). The area of all the other crops is hardly reaching 10 percent. About 5 percent of the arable land was not covered by crops in the past years (e.g. fallow land, green manure, etc.), these figures vary by regions.

Available statistical data on irrigation

The Hungarian Central Statistical Office (HCSO) collects data on irrigation annually with a limited extent. Data on commercial farms and private holdings are collected separately. In the case of commercial farms the annual survey is exhaustive, while for private holdings it is a sample based data collection.

Both questionnaires are rather simple; we survey data on

- irrigable, irrigated area and water amount used for irrigation by main land use categories (arable land, orchards, vineyards, grassland, and in the case of the private holdings other categories)
- irrigation of crops
  - area of main groups of crops in the case of commercial farms,
  - area of different crops in the case of private holdings.

The majority of the above listed indicators have also been included in the Farm Structure Survey questionnaires since 2003, their definition were developed in line with the European guidelines.

The **number of holdings reporting irrigation** is between 2-4 percent in Hungary. The regional distribution of the holdings irrigating is in close correlation with the average rainfall maps: the drier region means higher number of irrigation-holdings.

The analysis of the results of the structural surveys carried out between 2000 and 2007 reflects besides the influence of the weather conditions the economic possibilities of the farms as well. The proportion of commercial farms irrigating their crops is 3-4-5-times higher than that of the private holdings and the gap is opening.

The size of the **irrigable area** of Hungary shows the potential of this activity from the technical side. According to the statistical data the irrigable area is rather small (less than 5 percent of the area); on the other hand it has been halved over the last decade. Behind the changes one can assume the existence of financial difficulties: it is simply too expensive to maintain the existing irrigation systems or even to invest into them, not talking about the multiplication of the water prices. Generally these problems have an effect on the smaller – mostly private – holdings.

The actually **irrigated area** was between 75 and 150 thousand hectares over the past years. The predominant part of the irrigated area is arable land (over 90 percent), about 4-8 percent is covered by orchards. The irrigated vineyards, grasslands or other lands are not significant in Hungary.

According to the regular annual surveys, about 80 thousand hectares were irrigated in Hungary which means about 1.4 percent of the utilised agricultural area. 94 percent of the irrigated area was in the crop rotation system under arable crops, and 5.5 percent were cultivated by fruit trees and bushes. Similarly to the previous years, the size of the irrigated vineyards and grassland was insignificant. Average volume of water per irrigated hectare was about 1 124 m^3.

In the case of the irrigated arable land and orchard area the average volumes applied as irrigation water by regions shows a good correlation with the production zones and the rainfall-map.

System of Farm Structure Surveys (FSS) in the EU

The system of Farm Structure Surveys is one of the most important pillars of the Statistical System of the European Union. The surveys give information on the structure of agriculture in the Member States, the economic-social characteristics of the agricultural holdings, which explains the importance of the selection of the farms to be observed.

The surveys on the structure of agricultural holdings are regulated by regulations of the European Parliament and of the Council covering a period of 10 years during which a full scope agricultural census is carried out every 10 years with intermediate sample surveys being carried out every 3 years. The indicators to be surveyed and other stipulations are contained in the Annexes, which are revised and updated – taking into consideration the emerging new information needs – on the occasion of each survey.

The first agricultural survey at Community level was carried out in the European Union in 1966/67 and the survey conducted in 1989/90 was the first when the Member States had to transmit to EUROSTAT the data at the level of agricultural holdings. The individual farm data are kept in a separate database (EUROFARM). The EUROFARM database is used for detailed analysis with a strict compliance with the data protection rules. In the past years, the reform of the Common Agricultural Policy (CAP) has influenced considerably the System of Farm Structure Surveys. The new regulation of the European Parliament and of the Council (No.1166/2008/EC) requires the collection of new information as well, like geographical information (the location of the holdings with geographical coordinates) and agro-environmental data. Since 2010 one of the new elements of the Farm Structure Surveys is the module concerning agricultural production methods, which requires the collection of new

indicators related among others to water use by the holdings, mainly irrigation. Beyond professional considerations, it is also expected from the Member States to satisfy the new information requirements without causing extra burden on data suppliers and in a cost-efficient way, statisticians should strive to use – where it is possible – administrative data sources and reliable statistical estimations. This is well illustrated by the observation of water use and irrigation in agriculture. Based on the results of the Farm Structure Survey 2007, several countries, including Hungary have elaborated a new estimation procedure which on the one hand can satisfy the new information needs and on the other hand – taking into consideration the specificities of the Member States – aims at cost-efficiency.

How to fulfil the new data needs

One of the new information needs is the growing information need on agricultural inputs which are getting more and more important due to their significant impact on the production and the environment. The micro-data on the use of fertilisers, pesticides and irrigation would satisfy the users' needs when allowing appropriate analysis between the Common Agricultural and Rural Development Policies and the environment.

The data collection system on irrigation, in particular on water usage is a rather difficult issue, especially in the frame of an already quite complex survey, like the Farm Structure Surveys (FSS). Therefore new statistical method had to be developed calculating average application rates for irrigation water usage on agricultural crops and grassland.

It was obvious that good quality data on irrigation could only be collected through specific surveys. What is more, not having holding level data it was not possible to assess the water usage according to the type of holdings or economic size of holdings. When these data are linked to geo-referencing, even greater analytical possibilities are allowed (environmental aspects, structural information, agricultural practices, agro-environmental indicators etc.).

Due to the above mentioned facts the **main goal** of the project was to elaborate a comprehensive statistical methodology for measuring the volume of water used for irrigation at holding and crops level.

First, the statisticians **analysed the available data** on irrigation in the course of the analytical process, available admin data were checked, as well.

The **pilot survey** was elaborated for a test-region. For the purpose of this survey a stratified sub-sample was selected in line with the sample selection of the Farm Structure Surveys.

The pilot survey’s strata were based on the type and economic size of the holdings (EU typology) and the type of activity meaning that these were the criteria of stratification. In the case of **private holdings**, the sampling rate was planned at around 2 percent (approx. 1800 data suppliers; which means about 7 percent within the FSS sample).

Parallel with the private holdings, all **commercial farms** reporting irrigation in the FSS (2007) were considered as basic population of the pilot survey.

The **pilot survey was carried out on a voluntary basis**. For the purpose of the project a new questionnaire was compiled including detailed questions on irrigation. All the selected units were asked to return the mailed questionnaires.

While the **response rate** of the commercial farms was satisfactory, in the case of the private holdings further efforts were required; finally, statistically reliable results were calculated on the basis of the pilot survey.

Data entry was carried by the local Directorate of the HCSO using a program developed in ORACLE. The program covered the most important **control and validation rules**, basic corrections have been made in the data entry phase.

Comparison was done at individual level between the reported data and those of the FSS 2007 data (irrigable area-size). Unexpected change of irrigable area-size was not detected.

In the case of the commercial farms and private holdings the regional estimation factor was calculated as the ratio between the number of the sample units and the targeted population. **Average water volume used for irrigation by crops** was estimated, calculated on the basis of the pilot survey. For the determination of irrigation coefficients (e.g. irrigation water applied by crops or group of crops) all individual data available were used (e.g. from the pilot survey and from annual data collection). There were crops – for example maize, potatoes and vegetables-strawberry – for which the determined coefficients seems more reliable than in case of the less significant crops.

NAMEA-WATER accounts

Nowadays – in the EU Member States – the NAMEA Water emission accounts can provide further information on the impact of water usage. The system includes the physical description of discharges of water pollutants into the sewage system and their removal by wastewater treatment plants. This account as part of the integrated framework for water accounts consists in the physical description of flows of water pollutants in a NAMEA-type format.

The introduction of the European Water Framework Directive (WFD) in Europe raised an increasing demand for information about the economic value of water, and the wider economic consequences of water policy and management has increased rapidly. The Water Framework Directive is one of the first European directives in the domain of water, which explicitly acknowledges the important role of economics in water policy and management. In order to meet this growing demand, Statistics Netherlands has developed an integrated water economics information system called the National Accounting Matrix including Environmental accounts – Water Accounts (NAMEAWA).

The Dutch NAMEA Water-matrix consists of 10 monetary accounts and 4 physical accounts. The first two physical accounts for the emission of substances and water extraction and discharge represent the flows. The third physical account for water extraction and discharge describes changes in stocks, while the fourth physical account for emissions describes the contribution of various substances to ‘environmental themes’ such as eutrophication or the dispersion of heavy metals in water.

The integration of physical and economic information also allows the construction of integrated indicators. By linking water and substance flows to economic flows and doing this systematically for a number of years, insight is gained into the relationship between our physical water systems and the economy. For instance, water use by various economic sectors can be related to the economic interests involved. It is this integration of water and economy at river basin level, which makes NAMEA Water an important information tool to support policy and decision making in the field of integrated water management as advocated by the European Water Framework Directive.

NAMEA Water emissions accounts in Hungary

NAMEA Water emission accounts include the physical description of discharges of water pollutants into the sewage system and their removal by wastewater treatment plants. This account as a part of the integrated framework for water accounts consists in the physical description of flows of water pollutants in a NAMEA-type format. NAMEAWA includes the allocation of substances to environmental themes (eutrophication, acidification and economic accounts for NACE Rev. 1. 90.01).

For the time being in Hungary only the physical account for emissions is prepared.

Direct and indirect discharges

For the calculation the direct and indirect discharges are taken into consideration. Direct emissions are measured at the point where the wastewater leaves the enterprises. Indirect discharge is, when the waste water is discharged firstly into the waste water collecting system, and then is connected to the urban waste water treatment plants or external Industrial waste water treatment plants.

Methodology

Since the used data sets of measured emissions were not introduced for statistical purposes (not representative sample, few data suppliers) only rough estimations were prepared.

Data were based on the self–checking of the emitters but as they were not collected for statistical purposes estimations were applied for grossing up, corrections and for missing data as well.

Agriculture (Section A) is the main source of pollutants including fertilisers and pesticides, as well as effluent from huge pig farms and agro-industrial units. 95 percent of nitrate and phosphate is emitted to the nature by agriculture.

Most agricultural pollution originates from diffuse sources spread across farmland, and generally this type of emissions is estimated from basic agricultural data by emission factors for different land use categories, livestock and also for game animals.

Emissions for Hotels (Section H) are based on tourism statistics, emissions from public administration (Section L) and from public health (Section N) are based on the number

of employees, while emissions from education (Section M) are calculated by using information on the number of students and teachers.

In Hungary the discharge of non-treated urban waste water is a major cause of pollution of surface water and eutrophication problems. The purpose of these data is to monitor trends in the pressure from urban waste water on surface and groundwater (non treated waste water). 70 percent of suspended solids (mineral particles, organic materials, grease and oil etc.) are emitted by households (Section P).

Conclusion

The two examples presented (elaboration of an estimation method to measure irrigation water and the use of the NAMEA-Water accounts system) show only the first results. In the first case the challenge was to put in place a new methodology, while in the second case we had to „fill in with data" the account system used. The work has not yet been concluded. We are working on the fine-tuning of the estimation method to measure irrigation water. In the case of NAMEA-Water the main task is to improve data quality, including the improvement of the quality of the administrative data sources and the complementary estimations used. We hope nevertheless that even the first results are a source of useful information.

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ABSTRACT

The new global challenge is the climate change in which water is one of the most affected resources. According to statistical data, significant part of water sources is used for agricultural water consumption. Irrigation is expected to have a more significant role not only recently in arid or semi-arid areas, but also in Europe, including Hungary as well.

To assess the agricultural water consumption, it is not only necessary to know where irrigation is possible (irrigable area), but also where irrigation runs (irrigated area), the types

of irrigation techniques applied and the quantity of water consumed by the different types of holdings. In the past years the European Commission has expressed its strong interest also for data on water usage for irrigation at holding level that can be linked to the Farms Structure Survey data allowing in-depth socio-economic analyses too.

The variable weather conditions of Hungary are determined by oceanic, Mediterranean and continental climates together. On the one hand, over the past decades temperature has raised even in the most agrarian areas of the country, on the other hand, the annual rainfall has been reduced significantly especially in spring, when it would be very important for agricultural production.

The Hungarian Statistical Office has been publishing data on irrigation in the frame of annual survey for decades, but currently the data cover only the irrigable and actually irrigated area, and the total amount of water used for irrigation. In order to fulfill the new information needs the alternative is to collect data directly from farmers by new surveys (it would be additional burden on the respondents, and it would be costly) or modeling the data based on existing statistical and administrative data sources (which does not generate additional response and financial burden). The Hungarian Statistical Office has decided to develop a model which produces the data on the water volume used for irrigation taking into account the irrigation methods by crops, types and size groups of holdings.

Nowadays – in the EU Member States - the NAMEA Water emission accounts can provide further information on the impact of water usage. The system includes the physical description of discharges of water pollutants into the sewage system and their removal by wastewater treatment plants. This account as part of the integrated framework for water accounts consists in the physical description of flows of water pollutants in a NAMEA-type format.