SOUTH EAST EUROPE
Transnational Cooperation Programme

Programme co-funded by the EUROPEAN UNION

EU.WATER

JOINTLY FOR A NEW EUROPEAN AGRICULTURAL WATER MANAGEMENT

The EU.WATER regional answer for South East Europe

JOINTLY FOR A NEW EUROPEAN
AGRICULTURAL WATER MANAGEMENT

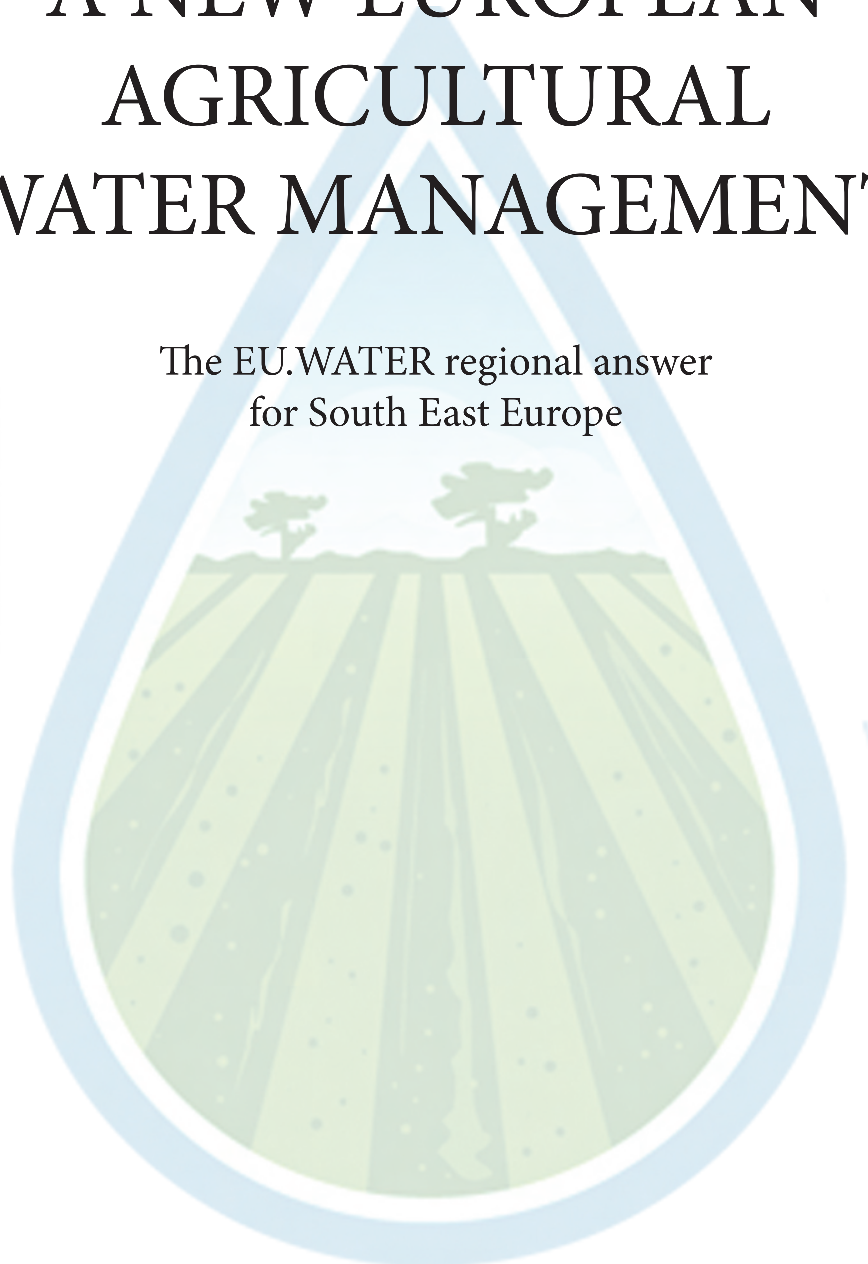
The EU.WATER regional answer
for South East Europe

Project co-financed by the South-East Europe
Transnational Cooperation Programme

www.eu-water.eu
www.southeast-europe.net

JOINTLY FOR A NEW EUROPEAN AGRICULTURAL WATER MANAGEMENT

The EU.WATER regional answer
for South East Europe



DEBRECEN, 2012

Authors

Marco Meggiolaro
Euris srl, project coordinator

Basil Manos
Kostas Voudouris
Aristotelis Tagarakis
Nerantzis Kazakis
Olympia Papadopulou
Despoina Zioga
Thomas Bournaris
Jason Papathanasiou
Aristotle University of Thessaloniki

Gianluca Carraro
Agronomist , on behalf of the Province of Rovigo

Giuseppe Castaldelli
Niccolò Colombani
Fabio Vincenzi
Enzo Salemi
Micol Mastrocicco
University of Ferrara

Sandro Bolognesi
Agro-Industrial Technology Park of Ferrara

Riccardo Loberti
Province of Ferrara

Enrico Tesini
ENEA - National Agency for New Technologies, Energy and Sustainable Economic Development

Zoltan Karacsonyi
Judit Karacsonyi
Tunde Szabo
University of Debrecen, Centre for Environmental Management and Policy

Bela Kelemen
Trans -Tiszanian Inspectorate for Environment, Nature and Water

Stratos Arampatzis
Agronomist, on behalf of the Region of Western Macedonia

Danut Maria
Ion Serbu
Ilie Biolan
Animary Arghirescu
National Institute of Research-Development for Land Reclamation I.N.C.D.I.F.

ISBN 978-963-473-577-9

Published by the EU.WATER Project
Debrecen, 2012

CONTENT

INTRODUCTION

Joint Technical Secretariat of the South East Europe Transnational Cooperation Programme

EU.WATER is one of the several projects that have been approved under the framework and by the financial support of the South East Europe Transnational co-operation programme.

The South East Europe programme is a unique instrument which, in the framework of the Regional Policy's Territorial Cooperation Objective, aims to improve integration and competitiveness in an area which is as complex as it is diverse. The programme is in line with the Lisbon and Gothenburg priorities, and is also contributing to the integration process of the non-EU member states.

In this respect, EU.WATER strongly contributed to improve the programme's territorial integration through a common topic for a shared problem and a varied partnership, which included EU Member States, Candidate and potential Candidate Countries, as well as neighbouring Countries.

The environmental challenges that the SEE area is facing are many and diverse. The threat to clean water is among the priorities that need to be transnationally addressed through different aspects. EU.WATER contributes in addressing this challenge by producing concrete answers to the problem of water consumption and contamination caused by the exploitation in agriculture.

EU.WATER succeeded to address this priority by matching concrete and understandable outcomes - aimed at testing and applying innovative practices, processes, products and technological services for the rural stakeholders - with the need to raise awareness at political level through tailored initiatives that increased the relevance and visibility of the outcomes, also in the perspective of a broad replication of the project recommendations across Southern and Eastern Europe.

The value-added of EU.WATER lies, first, in its effort to focus existing policies and traditional agricultural practices towards innovation and, second, in its nature as a dynamic, cross-sectorial and transnational network linking policy-makers, farmers, stakeholders, and researchers.

In this sense, EU.WATER represents a common macro-regional answer to the environmental and sustainable growth challenges of the rural sector in the SEE Programme space, where the agriculture still represents a dominant economic and land-use share, paving the way towards new and future partnership for agricultural innovation in the frame of Europe 2020 Strategy.

EXECUTIVE SUMMARY

EU.WATER
Improving the water resources management in agriculture in South East Europe

Marco Meggiolaro

In Eastern and Southern Europe, where the economies are characterized by intensive agriculture, one of the main environmental issues is the high consumption of water resources for irrigation, the low efficiency of water distribution networks and the pollution of groundwater caused by the massive use of fertilizers of organic origin.

The third report on implementation of the EU Nitrates Directive confirms the significant contribution of agriculture to nitrate pollution in groundwater and surface waters and to eutrophication phenomena, highlighting the fact that Southern European Countries are in delay in the application of the Directive or quite distant for achieving standards in line with the provisions of the EU Nitrates Directive and Water Framework Directive. With specific reference to the livestock sector, where progresses are reported in almost all Southern Europe countries, there are still structural weaknesses in terms of legislation, especially if compared to hygienic and sanitary standards (with particular reference to the EU framework for control systems) and the introduction of traceability systems (identification and registration of herds) (EUROPEAN COMMISSION, 2010 Country Progress Reports, 2010).

Therefore, while presenting considerable differences from country to country, both in the perception of the problem and in the design of appropriate policy interventions, the issue of the sustainable management of water resources in agriculture and the abatements of nitrates loads is a priority for the South East Europe area, where the primary sector continues to maintain a consistent weight on the economy and on jobs (if for example EU agriculture counts for 1, 8% of gross domestic product and occupies less than 6% of assets, in Croatia the primary sector accounts for 6.4% of GDP and 13.2% for employment, while in Serbia, respectively, for 12% and 21.4%) and every single reform can generate multiplier effects for the growth of their national systems.

Although the rural development policy is still widely undermined compared to the agricultural policy, the equilibrium is changing and the mainstreaming in many of the national policy agendas of the South East Europe Countries (also in the prospect of future EU membership) is progressively identifying patterns of agriculture, capable of arbitrating between the necessity to preserve (if not to increase) crop yields and the need to protect the environment, minimizing the effects of fertilizers on land and water resources. In this perspective, the agricultural sector continues to play a key role in the economic choices of a territory, but is no longer the only characterization of an area, and certainly not the only factor on which to rely to address strategic choices for local development.

In this sense, a sustainable rural development that uptakes as distinctive element an integrated, multi-systemic and multi-functional approach is a complex process that requires awareness from policymakers towards this challenge and trained personnel capable in managing and attracting funds, involving with skill and experience private actors and socio-economic associations (i.e. the farmers corporations) which are rooted on the territory, identifying problems, elaborating strategies and proposing a long-term vision.

Hence, an effective planning of resources and the launch of international cooperation initiatives with the scope of achieving stronger technical expertise and accompany the growth of agriculture systems are important elements to be considered in a wider strategy lined up with Europe 2020 (in particular, its flagship on the sustainable use of natural resources) and the future of EU Common Agriculture Policy.

The EU.WATER project co-funded by the European Union under the South East Europe Transnational Cooperation Program was born upon these premises. EU.WATER aims at investigating shared strategies in eight countries (Greece, Hungary, Italy, Romania, Serbia, Croatia, Moldova and Ukraine) to address the problem of rationalization of water use in agriculture and the reduction of nitrogen loads and other pollutants caused by intensive cultural exploitation, in order to enhance - in the Member States - the effective and coherent implementation of the Water Framework Directive (Dir 2000/60/EC) and on Nitrates (Dir. 91/676/EEC), supporting the accession process to the EU by the candidate countries and transfer practices and tools for the sustainable management of natural resources in third countries according to the EU Neighbourhood Policy.

The objectives of EU.WATER are:

- the development and updating of vulnerability maps for the eight pilot areas located in some hydrographical systems of Eastern Europe, in order to detect and - in some cases - reclassify hydro-stress phenomena associated with the use of fertilizers and to the high consumption of water for irrigation;

- the implementation of pilot actions, characterized by a strong scientific and agronomic background, to experiment new techniques and new approaches for the control of pollutant loads, for a precision fertilization and for the water saving in agriculture;

- the preparation of a transnational roadmap aimed at defining a common set of recommendations and strategies for a water-friendly agriculture and to strengthen policy development in local areas considered vulnerable to Nitrates, in line with the EU provisions;

- the improvement of the skills of professionals and farmers in the integrated management of water resources, through capacity building actions and a sharp communication strategy both at transnational and regional level, in order to address the traditional and local-based cultural practices models towards eco-friendly patterns, in line with the European standards.

The main result of the project is connected to the creation of a coordinated and harmonized transnational system for the management of the water resources in agriculture, according to the EU legislative framework and based on the direct involvement of the main government actors and farmers associations in the eight concerned rural areas. At this aim, EU.WATER, during its three implementation years, has produced studies, researches and innovative practical actions that can integrate and upgrade the regional planning tools and the strategies to reduce the pollution from fertilizers and improve the irrigation systems on the basis of a wide scientific horizon.

EU.WATER project has also represented an ideal opportunity to strengthen the dialogue between institutional actors, farmers and technicians in order to govern the transformations in the rural agricultural sector through measures that can ensure a compromise between the objective of increasing the farm profitability and the protection of the good ecological status of waters in the South East Europe rural areas.

CHAPTER A – NEED FOR A NEW WATER POLICY

A common methodology to assess the vulnerability of water systems in rural areas

Manos B., Voudouris K., Tagarakis A., Kazakis N.,
Papadopoulou O., Arampatzis S.

1. EUROPEAN UNION WATER POLICY

1.1 European Union Water Framework Directive

The European Union Water Framework Directive (EU WFD 2000/60), through planning and integrated management, pricing and cost recovery represents an important tool towards sustainable use of water resources in Europe. The identification of environmental pressures, the long term ecosystem management and the river basin management plans are some of the applied mechanisms to secure sustainable water management and "good water status" of waters.

The WFD requires the achievement of its principal objectives; good groundwater status by the end of 2015 at the latest. The Directive also encourages the participation and improved decision making and it is complemented by the Flood Directive (2007/60) and the policy on water scarcity and droughts. As European Union seeks to revitalize and reinforce its economy, devising an effective strategy towards water efficiency can make a substantial contribution.

1.2 The implementation of the Water Framework Directive (WFD) in the EU partner areas

The implementation of the Water Framework Directive in the project target areas is presented. It refers to the laws, regulations and measurements that were developed to implement the WFD in the areas. It also analyzes the progress made, in terms of legislation, institutionalization and implementation at national and local level in order to achieve the directive goals.

1.2.1 Implementation of the WFD in Greece

The Directive 2000/60/EC sets the framework and objectives for sustainable management of water resources in Greece. Initiatives have been taken by Greek authorities in order to harmonise Greek water polity by the end of 2002 (Law 3199/2003) and the Directive is in process of implementation. Priorities for the sustainable water resources management are as follows: improve knowledge of water resources, prevent the water pollution, reduce the water demands for irrigation use, increase the water efficiency, transboundary rivers management and floods and droughts management.

The transposition of the WFD into Greek legislation has led to a new institutional organization with a new Central Water Agency, 13 Regional Water Directorates, a National water Committee (interministerial political body), national and regional water councils (consultative bodies). The protection and management of the river basins and the implementation of the WFD are a responsibility of the 13 Regional Water Directorates. In case of shared river basins, the National Water Committee must determine which regional authority is responsible. The National Water Agency is responsible for defining a national water policy and coordinating the activities of the regional directorates.

National Water Committee, plans the policy for the protection and management of water resources, monitors and controls the application of policy, approves the national management and protection of water resources plans after proposals of the respective ministries after the approval of the National Water Council. The National Water Committee submits to the Parliament and to the National Water Council annual report regarding the status of national water resources, the application of legislation about the protection and management of water resources, as well as legislation compatibility with European status.

1.2.2 The implementation of the WFD in Italy

The Water Framework Directive 2000/60/EC (WFD) establishes a European frame for the protection and management of water resources whose main aims are the prevention of water resources deterioration, both in terms of quality and quantity, using as 'precautionary' principle the reduction of the pollution at its source and intending to reach a 'good status' before 2015.

In the Italian context and particular in the Po River Basin, which is the largest in Italy and represent also the most important economic area for the country and of whom the Ferrara and Rovigo Provinces are the lowed portion the WFD in Italy was first transposed in 2006, with the legislative decree no. 152, which despite the effort of unifying the several previous regulations concerning the environment and water use soon had to face the extreme fragmentation of competencies which is still the major problem as several Authorities for the different uses of water (civil water use and supply, wastewater treatment, water irrigation in agriculture, wildlife management and biodiversity protection) are only little connected and integrated.

The objective of increasing the water quality is pursued by the writing and application of Regional Plans of Protection Water designed and developed to monitor surface and groundwater bodies, identifying also interventions and measures. According to these Regional Plans, with a monthly frequency for the period time of two years, the main superficial water bodies are check with bio-chemical analysis. With a "points for quality" method, the water body is given a specific level of "Ecological Status" (ES)

In the River Po Basin case, difficulties were found and still are present to carry out a profound complete economic analysis and to define the mechanism of water cost recovery with particular reference to the most exposed terminal areas, such as Rovigo and Ferrara.

1.2.3 Implementation of the WFD in Ukraine

Water Framework Directive is not implemented in the country.

1.2.4 Implementation of the WFD in Croatia

Water management works comprise a number of activities ranging from legislation activities to organization of immediate management and monitoring of the water system status. The authorized and responsible leaders of such activities are: Croatian Parliament, National Water Council, Croatian Government, Ministry of Regional Development, Forestry and Water Management, as well as other state administration organisations, local and regional selfgovernment units and Hrvatske vode as the company in charge of water management.

The National Water Council (appointed by the Croatian Parliament) is a body established to harmonize various interests and to examine systematic issues related to the water management area at the highest level. The Ministry of Regional Development, Forestry and Water Management perform administrative and similar expert tasks, in particular:

(i) Water policy and strategic planning

(ii) Monitoring of the status, implementation of administrative and inspection supervision

(iii) Preparation of laws and regulations

(iv) Provision of financial means to fund the activities in the field of water management

(v) Decision-making in single important cases and adopting decisions of second instance in cases already decided upon by other bodies.

The territory of Croatia is organized in 34 river basins managed by 32 water-management subsidiaries plus the Water Management Department for the river basin district of the City of Zagreb. As candidate country for the EU membership, the Republic of Croatia is liable to harmonise the national legislation with the EU acquis communautaire.

1.2.5 Implementation of the WFD in Hungary

The necessary measurements to the realization of the aims of Water Framework Directive (2000/60/EC) are included in the River Basin Management Plan (RBMP). During the planning of river basin management the classification of groundwaters and water bodies that are the basic units is based on the quantitative and chemical (quality of water) aspects.

According to the RBMP prepared on the basis of the Water Framework Directive of the EU the emissions of baths have to be reconsidered and have to be re-regulated. A decree controls the protection of groundwater reserves, that controls additionally the working and proposed reserves of waters. In case of vulnerable, public purposes reserves of waters, the external and internal defender profiles and areas have to be determined by official orders.

The regulation on irrigation of 2010 says that for these purposes surface waters must be used. If it is not possible, groundwater can be used, primarily shallow groundwater. Aquifer systems can be used only for micro irrigation. Obviously the aim of these orders is the thriftiness of underground waters, but another question is how to apply them in practice. The river basin management plans (RBMP) accepted in 2010, summarize the aims of WFD. In RBMP, groundwaters and water bodies are also qualified by quantitative and chemical aspects. All qualification has two values: good or poor quality. The criterion of good quantity status is that the quantity of water taken out does not exceed the stock of waters that can be utilized.

1.2.6 Implementation of the WFD in Serbia

Water Framework Directive is not implemented in the country. Therefore, no management zones or nitrate-vulnerable zones (NVZs) have been developed.

1.2.7 Implementation of the WFD in Romania

In Romania, the adopted acts that aim to harmonize with existing EU legislation on water resources and their quality protection include different laws. The Water Framework Directive is in process of implementation.

In compliance with provisions of Law 310/2004 the so called water boards (approximately 15 members) have been established, which were organized at territorial level into Water Directorates of the 'Apele Române' National Administration, with responsibilities of involvement in decision making of the beneficiaries and also in the efficient collaboration of water management territorial units with public local administration bodies, for the purpose of maintaining a balance between conservation and sustainable development of water resources.

Participation of various stakeholder groups in the decision making process offers greater commitment to the success of their specific water-related activities. This is one way of alleviating the negative impact of human interventions throughout the whole river basin territory. Decentralized activities and a greater decisional autonomy also offer real opportunities for a practical approach to specific issues which require solving.

2. KNOWLEDGE CAPITALIZATION & SENSITIVE AREA MAPS

2.1 Common methodology

Agricultural-dominated systems, where fertilizers and pesticides are extensively used, are the main sources for surface and groundwater pollution. In order to assess the vulnerability of agricultural land to water and nitrogen losses and the pollution potential of groundwater a new methodology was introduced. A set of indices was developed in order to classify the vulnerability of agricultural land to water and nitrogen losses (LOS), setting a basis for the integrated water resources management in agricultural systems.

The LOS indices (in $mm.year^{-1}$) are: LOSW-P=the annual losses due to deep percolation beneath the root zone of the 30 cm, LOSW-R=the annual losses due to surface runoff and LOSW-PR=the sum of annual losses due to deep percolation and surface runoff. The indices are correlated with hydraulic conductivity ($mm.day^{-1}$), the slope (%), precipitation ($mm.year^{-1}$), potential evapotranspiration ($mm.year^{-1}$) and irrigation ($mm.year^{-1}$).

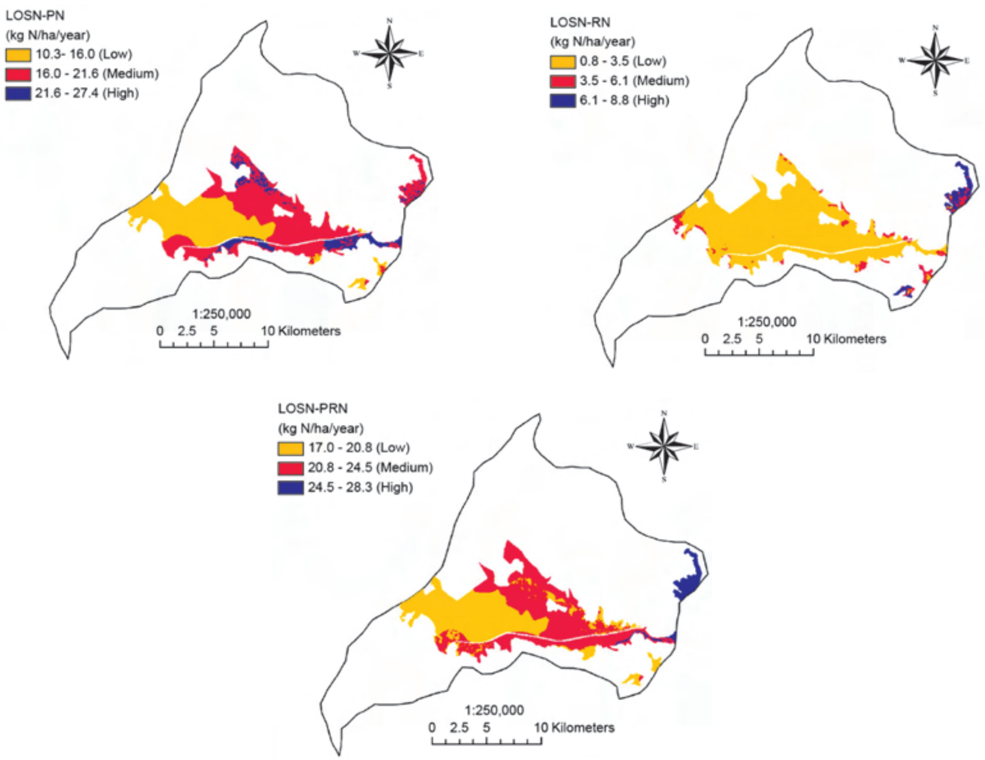
The GLEAMS V3.0 model is a computer program used to simulate water quality events on agricultural fields. GLEAMS has been used internationally and especially in the U.S.A. to evaluate the hydrologic and water quality response of many different scenarios considering different cropping systems, wetland conditions, subsurface drained fields, agricultural and municipal waste application, nutrient and pesticide applications and different tillage systems.

To calibrate the indices using multiple regression analysis, the simulation results of GLEAMS V3.0 model for combinations of different soil properties, topography and climatic conditions of a reference field-crop were used as "observed values". All the simulations to gain the LOS indices were carried out for the same reference field-crop, the same nitrogen fertilization and the same irrigation practice, in order to obtain the intrinsic vulnerability of agricultural land to water and nitrogen losses. The LOS indices were also combined to derive nitrogen concentrations in the percolated and in the runoff water. Finally, the connection of LOS indices with the groundwater was performed using an additional equation, which determines the minimum transit time of the percolated water to reach the groundwater table.

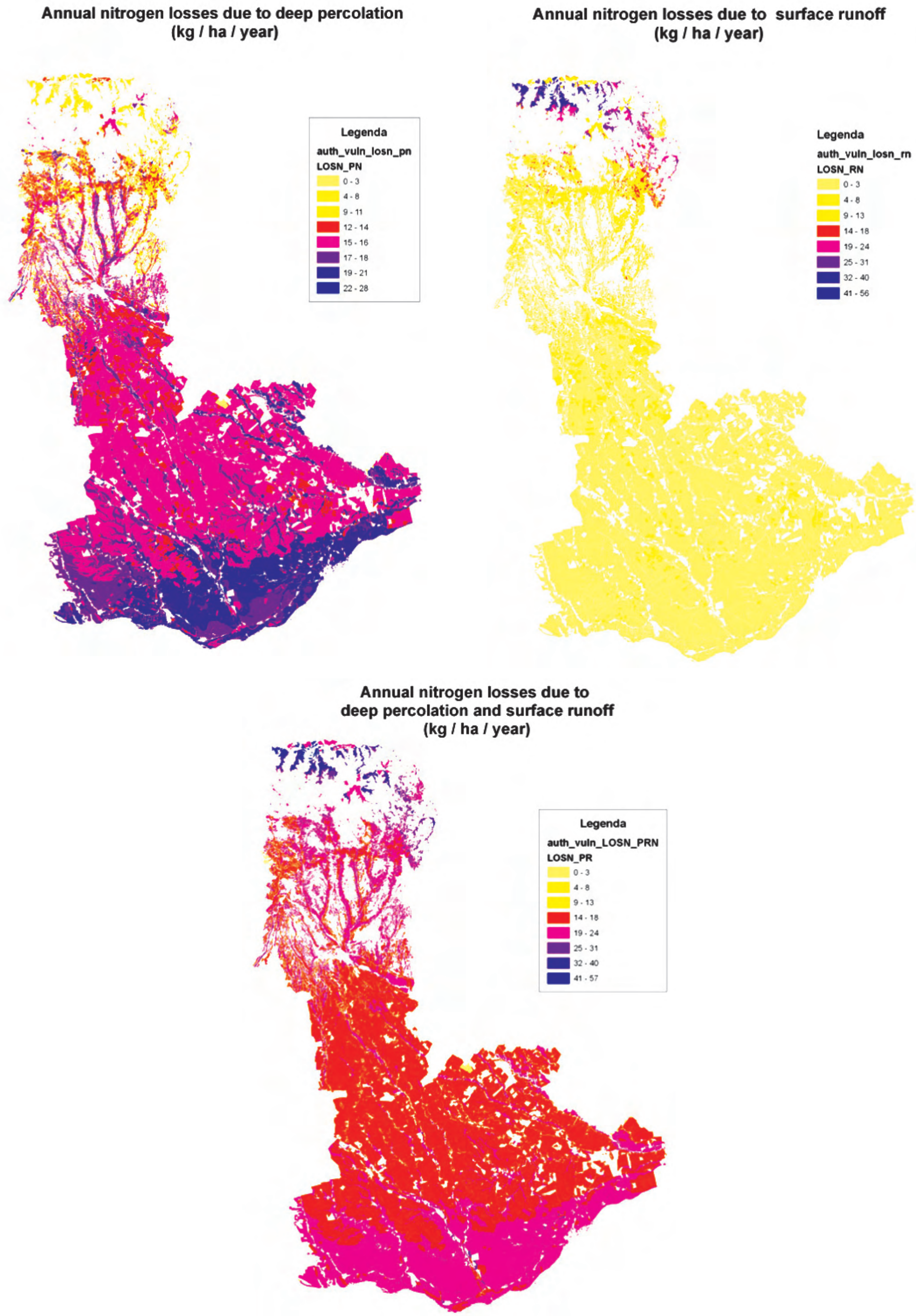
In order to include the unsaturated zone, an additional index that gives the minimum relative transit time of water and consequently substances losses from the surface to reach the groundwater was used. The relative transit time is a measure of groundwater vulnerability. The less the transit time, the greater the chances of the pollutant to be transported to the groundwater surface (high vulnerability). It is pointed out that, the deeper the water levels are, the longer the pollutant takes to reach the groundwater table (low vulnerability).

The required data include: Hydrogeological data, meteorological data (annual rainfall, temperature, evapotranspiration etc), depth to groundwater, topography, soil data and land uses. A database was established, in order to input the collected data into GIS, which offers the facilities to store, manipulate and analyze data in different formats and at different scales. The final maps were created using the tools of Arc GIS from the combination of the different parameters. In the frame of the EU.WATER project an Information Data Bank was developed (http://www.eu-water.eu/). It is pointed out that the GIS platform is included in the EU.WATER wed site and is used as a map viewer and navigation tool for the uploaded GIS data in the Information Data Bank. Using the selection bars of GIS layers, the web visitors can view data concerning: digital boundaries, land use, soil types classes, surface and groundwater, pollution sources, protected areas etc. Finally, guidelines have been prepared by the Aristotle University of Thessaloniki in order to help the EU-Water partners to standardize the completion process of the questionnaire, the mapping process for the development of the GIS platform and the collection of available data regarding water and nitrogen management in the designated target areas of the project.

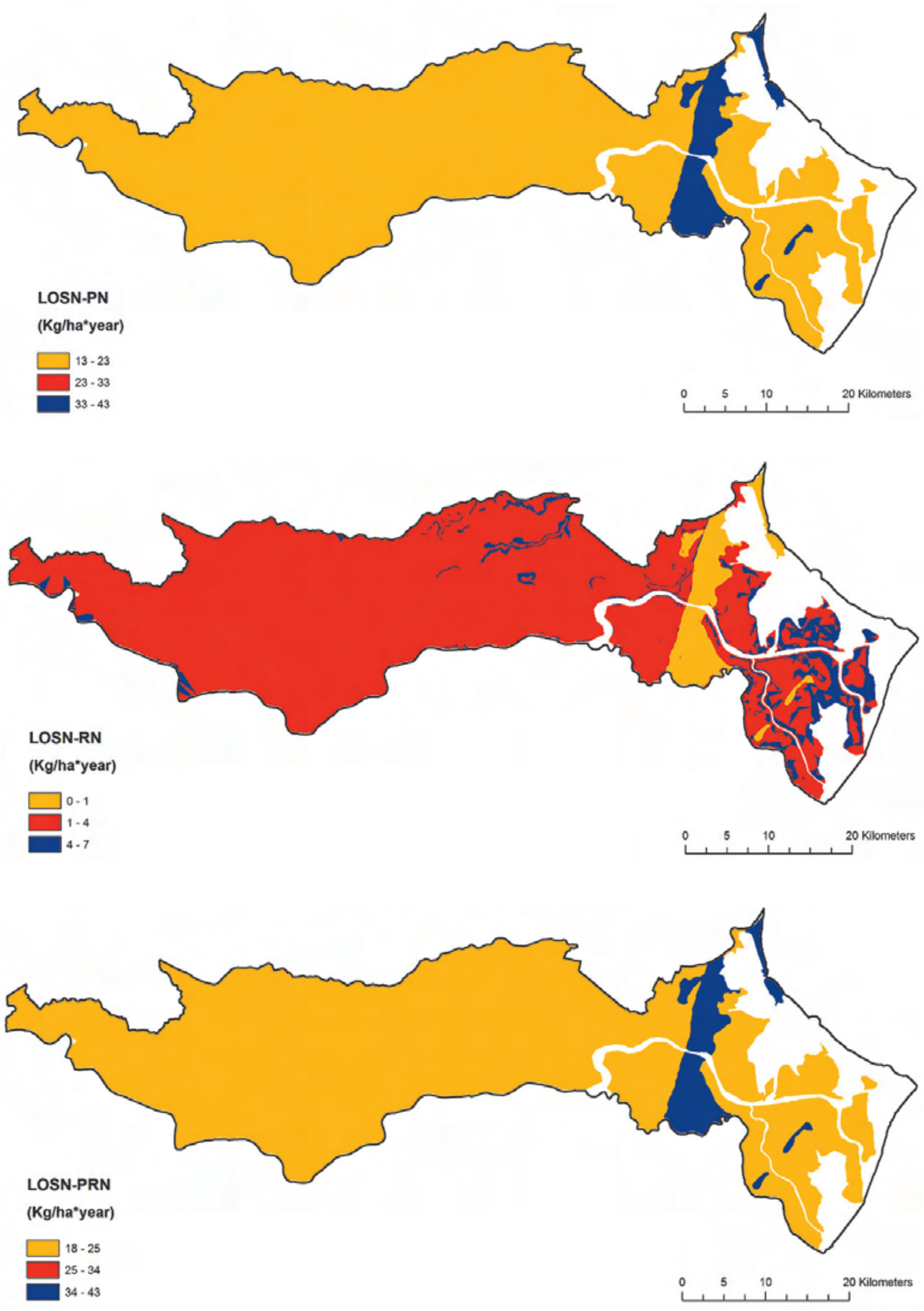
The aforementioned method was applied in Sarigkiol basin, located in Kozani Prefecture (Western Macedonia region), covering an area about of 469 Km^2. The land is mainly used for cultivation of cereals and cows and sheep graze the area. In a large part of the area irrigated agriculture is practised. Overexploitation and nitrogen pol-



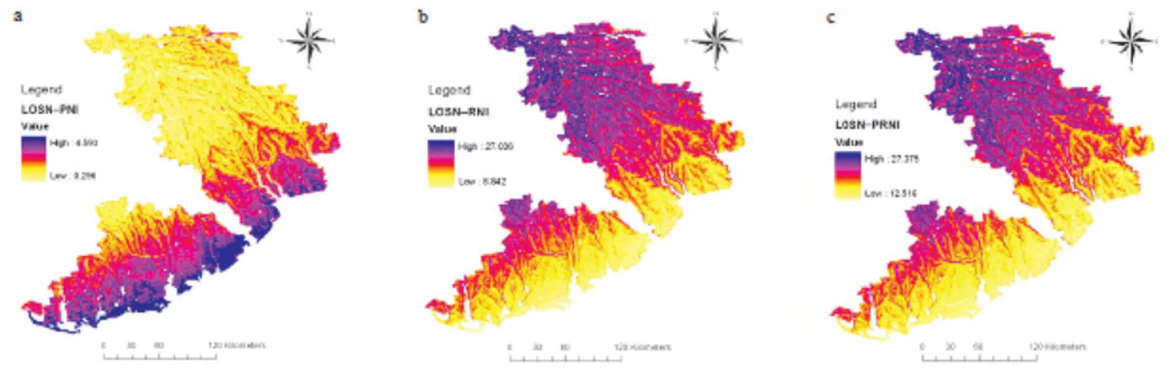
LOSN indices for the agricultural land of Sarigkiol basin, Greece:
a) LOSN-PN, b) LOSN-RN and c) LOSN-PRN in kg N ha^{-1} $year^{-1}$.



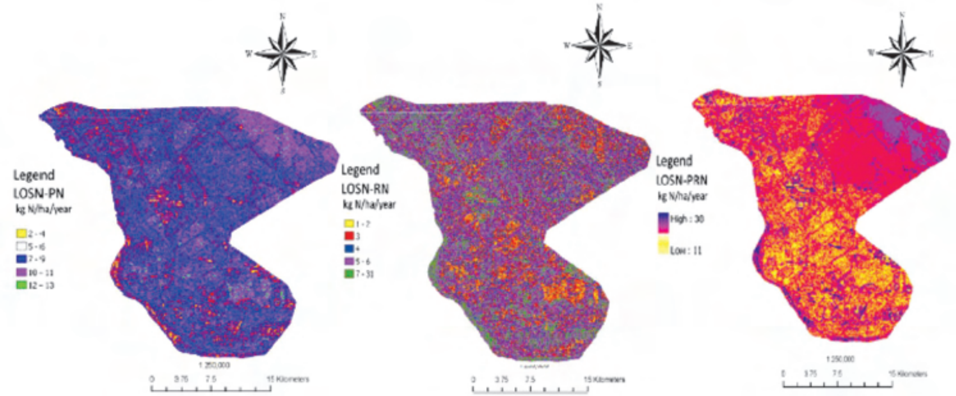
LOSN indices for the agricultural land of ARGEŞ - VEDEA river basin, Romania:
a) LOSN-PN, b) LOSN-RN and c) LOSN-PRN in kg N ha^{-1} $year^{-1}$.



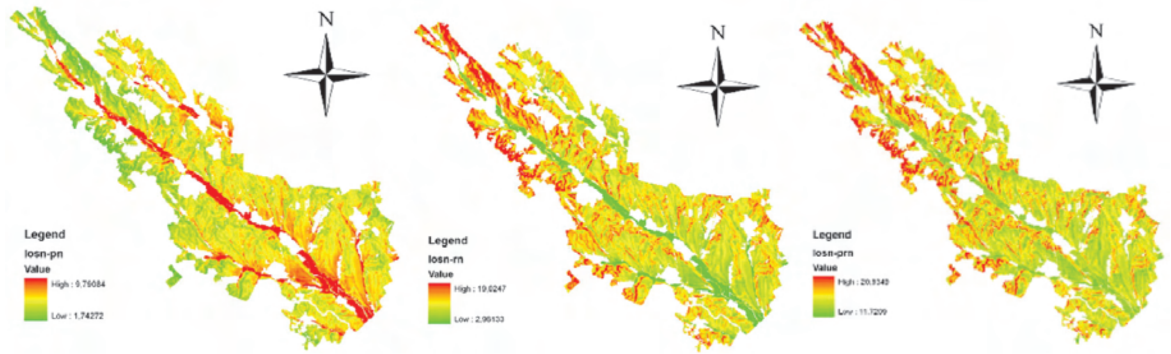
LOSN indices for the agricultural land from Province of Rovigo, Italy:
a) LOSN-PN, b) LOSN-RN and c) LOSN-PRN in kg N ha^{-1} year^{-1}.



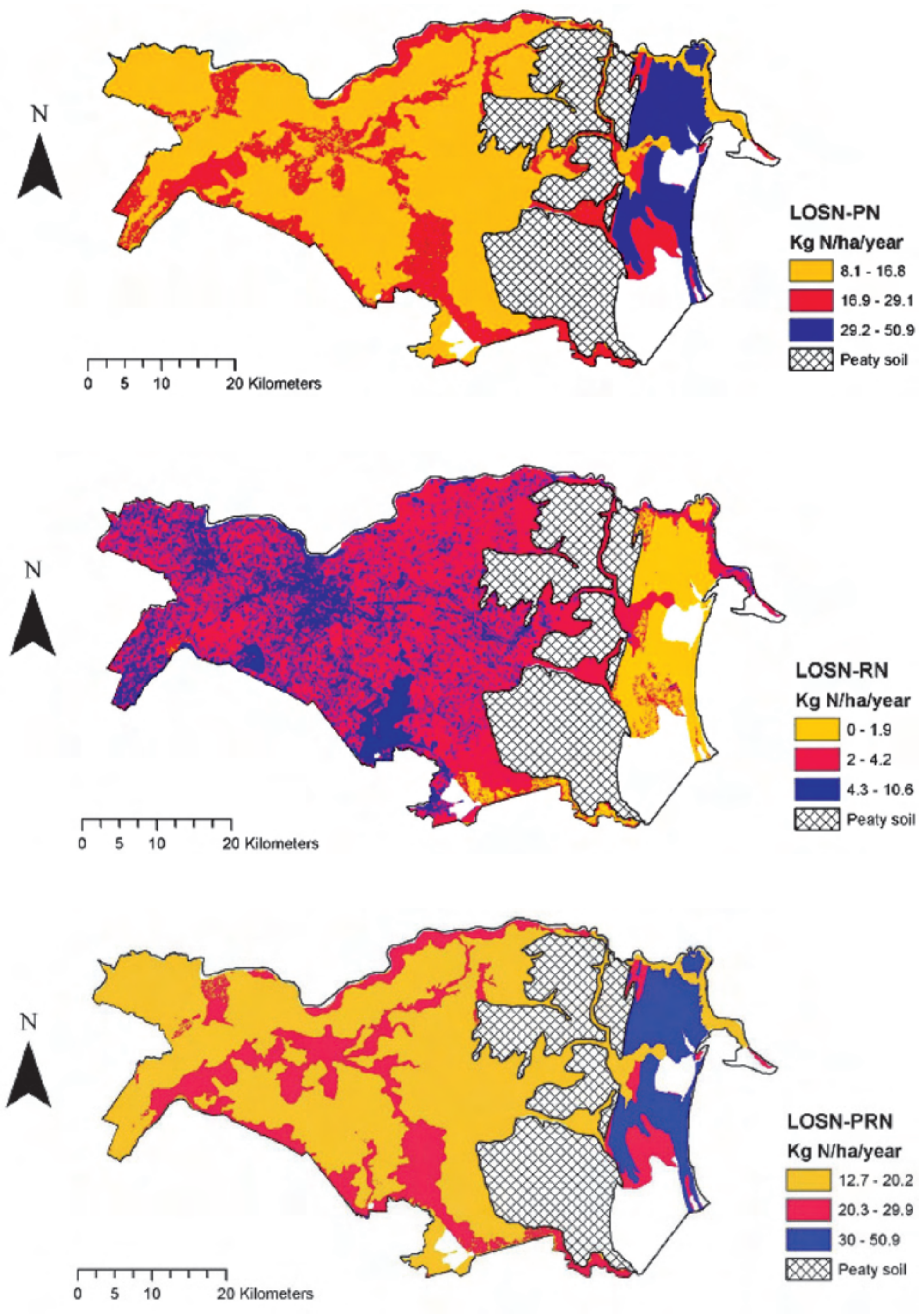
LOSN indices for the agricultural land of Odessa region, Ukraine:
a) LOSN-PN, b) LOSN-RN and c) LOSN-PRN in kg N ha^{-1} year^{-1}.



LOSN indices for the agricultural land of Pančevo Muncipiality, Serbia:
a) LOSN-PN, b) LOSN-RN and c) LOSN-PRN in kg N ha^{-1} year^{-1}.



LOSN indices for the agricultural land of Ialoveni Rayon, Moldova:
a) LOSN-PN, b) LOSN-RN and c) LOSN-PRN in kg N ha-^{1} year-^{1}.



LOSN indices for the agricultural land for the Ferrara Province, Italy:
a) LOSN-PN, b) LOSN-RN and c) LOSN-PRN in kg N ha^{-1} $year^{-1}$.

lution of agricultural origin are the main environmental pressures induced by humans; they have a significant negative effect on the area's groundwater. According to the application of the LOS indices in Sarigkiol basin, two regions have been identified to be more vulnerable to water and nitrogen losses: the region in the north-eastern part of the basin and the area close to the edge of the aquifer. The first area, far from the main aquifer, has a low potential for groundwater pollution but has a high potential for surface waters pollution; while the second area needs more attention because it is above the main aquifer. Finally, it was found that the nitrogen losses were related to the water losses. The methodology also was applied in the other 7 countries (Italy, Hungary, Romania, Croatia, Serbia, Ukraine, Moldova) in the rural study areas Po River basin, Province of Rovigo, Hajdú Bihar county, Teleorman-Giurgiu-Arges region, Istrian region, Teritorry of Pančevo city, Odessa region and Ialoveni Rayon, respectively.

2.2 Usefulness of the maps

The ranking of LOS indices has a physical meaning using units for the amounts and concentrations of water and nitrogen losses; moreover they are originated by a process-based model and can be calibrated simultaneously with the model when experimental data exist. They are focusing on the vulnerability of the pollution source (agricultural land) and not the vulnerability of the pollution recipients (surface and ground waters) which are described by more complex properties. Moreover, LOS indices' results can be introduced more easily in GIS environment compared to process-based models and they can be calibrated using fewer input parameters. Finally, an important advantage derived by the utilization of the LOS indices is that they are comparable for different regions and they can assess the pollution potential not only for groundwater but also for surface waters.

The results provide important information, with the vulnerability map suitable for use by local authorities and decision makers responsible for groundwater resource management and protection zoning. Vulnerability and sensitivity maps could be used for planning, policy, management and contamination assessment.

For example: The higher the water losses LOSN-PN, the greater the water nitrate pollution risk and aquifer vulnerability. In this area, application of code for good agricultural practice, in order to reduce the groundwater pollution from nitrates. The proposed reduction will be achieved by the effectiveness increase in fertilisation application, the application of alternative irrigation techniques, the optimization of crop selection as a function of soil characteristics and financial incentives etc. Training courses should be organized in order to educate people in using methods to optimize water and fertilizer use.

Furthermore, the new EC Directive 2006/118 on the protection of groundwater against pollution and deterioration, developed under Water Framework Directive 2000/60, sets out criteria with which to assess the chemical status of water bodies. The aforementioned Directives have also forced EC member states to ensure good chemical and ecological groundwater conditions.

3. COMMON INTEGRATED STRATEGY FOR WATER MANAGEMENT IN AGRICULTURE

3.1 Measures for sustainable water management in agricultural areas

The reduction of water consumption in agriculture is a crucial issue. The followings could support sustainable water management in agricultural areas:

- Water-saving techniques such as spray irrigation and drip irrigation should be applied in order to decrease the groundwater quantities used for agriculture.
- Training courses should be organized in order to educate people in using methods to optimize water use.
- Application of the code of good agricultural practice in areas affected by nitrate pollution.
- Reduction of groundwater abstraction should be applied in the areas that are affected by aquifer depletion.
- Planning of surface water protection measures, such as domestic effluent disposal in torrents, as well as construction of proper landfills, which are environmentally compatible.
- The low price of water, results in people not saving water; thus, effective measures must be taken to prevent the unconsiderable use of water, e.g. incentives for efficient water use.
- Utilization of the treated wastewater for irrigation purposes in order to decrease the groundwater abstraction. The use of reclaimed or recycled waste water for various non-potable uses has proved to be the most reliable of sources, like in most South East Europe (SEE) countries.
- Construction of small interception dams in the main torrents of the hilly region, aiming at the retardation of wintertime torrential flows and the increasing of the groundwater recharge. In addition, these dams would improve the water supplies for the agriculture requirements.

3.2 The implementation of the Nitrate Directive in the EU.WATER project areas

The implementation of the Nitrates Directive (ND) in the project target areas is presented. It refers to the laws, regulations and measurements that were developed to implement the ND in the areas. It also analyzes the progress made, in terms of legislation, institutionalization and implementation at national and local level in order to achieve the directive goals.

3.2.1 Implementation of the ND in Italy

The Nitrates Directive (91/676/EEC) aims to protect water quality in Europe by preventing pollution of groundwater and surface water. As regards Italy, the obligations under the EU Directive have been transposed by Decree 152/1999 subsequently replaced and repealed by the Decree 152/2006, which has essentially taken over the contents.

With the Ministerial Decree 7 April 2006, the national requirements of Article 112 of Legislative Decree no. 152/2006 have been fulfilled, thus allowing the regions to adopt a regulation on the use of agricultural effluents with a legal basis approved at national level. Every Italian region has, therefore, vulnerable and not vulnerable areas identified in its territory and established operational plans, that each company must submit, to demonstrate the correct agronomic use of manure and fertilizer nitrogen.

The implementation of the Nitrates Directive in Ferrara

The Emilia-Romagna Region, with resolutions of the Regional Government n. 1608 of 21st November 2006 and of Legislative Assembly n. 96 of 16th January 2007, has made the application of "Action Programme for Nitrate Vulnerable Zones from agricultural sources" working, as required by the decree of the Ministry of Agriculture and Forestry of 7th April 2006.

The implementation of the Nitrates Action Programme in the Province of Ferrara immediately aroused great concern in the farming sector, as the whole territory has been declared by the Emilia-Romagna as "NVZ" - Nitrate Vulnerable Zone from agricultural sources. The reasons of concern were mainly of two types: the first, linked to the possibility that a limited use of nitrogen of an organic nature could reduce the percentage of organic matter present in soils, whose beneficial effect in favour of fertility and production is well known, the second - the most widespread and shared by most farmers - was also in having an upper limit of the quantities of nitrogen from chemical to be administered to different crops. In this case, farmers have linked the limit of nitrogen quantity to the reduction of crop yields and hence the greatest concern.

This concern has been highlighted particularly in certain crops such as corn (because of high quantities of nitrogen that requires), wheat (in particular the hard one that must have high protein contents reached thanks to nitrogen) and pear (where widespread types of plants of medium-high density and the use of special rootstocks require quantities of nitrogen slightly above the average values).

The implementation of the Nitrates Directive in Rovigo

The Regional Government of Veneto has transposed the Decree 7th April 2006 with DGR 2495/06. The introduction of the provisions of the Regional Action Program gave full application to the law on the protection of waters against pollution by nitrates in Veneto and identifies practical requirements of national and community legislation, differentiated for the Ordinary and the Vulnerable Zones. In the latter, designated under the Directive 91/676/EEC, operating restrictions and temporal prohibitions to the agronomic use of animal manure are significantly higher.

The Region of Veneto, using the possibility offered by Article 19, paragraph 4 of the Decree n. 152/99, made a new and more precise identification of vulnerable areas with the deliberation of the Regional Council of 17th May 2006, n. 62.

In particular, the entire province of Rovigo and the neighbouring territory of the town of Cavarzere were perimeter as a nitrate vulnerable area, already under the Decree 152 (1999 currently DLGS 152/2006). The fact that the territory of Rovigo is designated as nitrate vulnerable area involves the triggering of issues related to the existence of limits of distribution of nitrogen/ha per year maximum of 170 kg, which means that, being the province of Rovigo mainly characterized by a livestock vocation with intensive cultivation of corn, this limit is a major problem for achieving the objectives and the productive potentials of the area.

3.2.2 Implementation of the ND in Greece

The Nitrates Directive came into force in Greece through Joint Ministerial Decree (JMD) 1190/133/1997–"Terms and Measures for the Protection of Waters from Nitrates Pollution from agricultural Sources". Designated vulnerable zones were incorporated into the Country's legal framework. Seven action plans for NVZs were established. Each one provides detailed information about the situation in the area they refer. It also gives detailed guidelines about irrigation, fertilization management (types, rates and number of applications of fertilizers per crop), transportation and storage of fertilizers, livestock waste management.

Code(s) of Good Agricultural Practice have been established to prevent and reduce the pollution of waters. It was established with the 85167/820/20-3-2000 Ministerial Decision, the ''Codes of Good Agricultural Practice for the protection of waters by nitrates pollution from farm origin" (Government Gazette B 477/6-4-2000). They include codes for the storage transport and application of nitrogen fertilizer, the quantity and time of application and land cover during the winter.

3.2.3 Implementation of the ND in Hungary

The Nitrate Framework Directive is in operation and nitrate-vulnerable zones (NVZs) are designated in the target area. The Nitrate Directive and the Water Framework Directive brought changes in fertilization management. The Good Agricultural Practice then the Good Agricultural and Environmental Condition defines the minimum requirements (at the same time premise for single area payment scheme). In the field of the reduction of nitrate pollution the "Statutory management requirements" are determinant and required for the single area payments and livestock-based payments. As these are basic requirements for EU as well as national subsidies (top-up) the compliance with these regulations is essentially ensured (it is known that an adequate controlling body was formulated with a single penalty system).

Protection of waters against pollution caused by nitrates from agricultural sources (Statutory management requirement No 4) - the protection of waters against pollution caused by nitrates from agricultural sources is supported by the Action Plan. The Action Plan provides the compliance with the "Good Agricultural Practice" regulations (Decree No 59 of 2008 by the Ministry of Agriculture and Rural Development amended in 2009 with Decree No 55 of 2009 by the Ministry of Agriculture and Rural Development). It controls the quantity of fertilizing, the protection of water, nutrient management planning, fertilizing technology, the necessity of soil examination, groundwater level and groundwater quality control in every 5 year in irrigated areas, manure storage and data provision.

In nitrate vulnerable areas it controls/prohibits the timing of fertilizer application, grazing in the winter if it exceeds 120 kg/ha at annual level, fertilizing in the winter, maximum 170 kg/ha/year organic manure use, etc. Nitrate vulnerable zones (map): designated areas/blocks; animal husbandry farms and manure storage with IPPC permission. Recording farm management data is obligatory (nitrate data sheet); calculation assistance, forms are available electronically.

The main steps of the Hungarian legislation:

Act on the protection of the environment (1995)

Government Decree No 49 of 2001 regulating the designation of Nitrate Vulnerable Zones:

- surface water above 50 mg/l nitrate content
- surface water for drinking water use above 25 mg/l nitrate content
- danger of eutrophication
- sensitive waters and areas (e.g. lakes, drinking water base, gravel lakes, karst areas; designation - see map).

Since 2007, the database of nitrate sensitive agricultural areas at block level is available. The Government Decree No 27 of 2006 already includes the Action Plan and upgrades nitrate sensitive zones.

3.2.4 Implementation of the ND in Ukraine

Nitrate Directive is not implemented in the country. Therefore, no management zones or "nitrate-vulnerable zones" (NVZs) have been developed. No fertilization plans and limits are set. The only practice that takes place in order to limit leaching during the wet seasons is crop rotation.

3.2.5 Implementation of the ND in Croatia

Apart from harmonisation with the Water Framework Directive, the national legislation is harmonised with other water directives. One of them is the Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources (The Nitrates Directive) – requires designation of nitrate vulnerable zones affected by pollution caused by nitrates from agricultural sources and promotes good agricultural practice.

Conclusions

Farmers are increasingly looking favourably to the protection of the environment and develop new techniques such as the treatment of livestock manure. Nevertheless, against this background certainly encouraging, there are difficulties arising from the implementation of the Nitrates Directive in Europe, and particularly in South-Eastern chessboard. These difficulties are mainly connected to the sense of obligation felt by the farmers about their tax rules as a conditio sine qua non to be respected, without reducing the contribution, and to responsibilities connected with the work done.

Successes, difficulties and expectations recorded in Europe about the effectiveness of the Nitrates Directive are reflected in EU.WATER territories. For farmers, the need to know how organic and chemical nitrogen behaves, according to the different types of land and preceding crop which may characterize the vulnerability, is a crucial aspect.

These questions could be answered through the results of the pilot actions in carried out in five project areas, as well as through the new techniques and approaches that they have allowed to develop.

CHAPTER B – REGIONAL ANSWERS

Regional answers for an environmental-friendly agriculture

Gianluca Carraro

While the preliminary phase of EU.WATER was characterized by the elaboration of maps of vulnerability and sensitivity to nitrates, a set of experimental management practices have been implemented in Italy, Greece, Hungary and Romania to test how meeting environmental goals while maintaining profitability and competitiveness. Five pilot actions were developed in the pilot areas of Po River basin (specifically in the Province of Ferrara and Rovigo), in Arges-Vedea basin (South Romania), in the middle of the Hungarian Great Plain in Tisza River basin and in Sarigkiol basin, nearby the Prefecture of Kozani in the Region of Western Macedonia.

The objective of these experimentation consisted in the trial of new techniques and new approaches for the control of pollutant loads, for a precision fertilization and for the water saving in agriculture. In specific, informative tools such as a nitrate-submission predictive models, decision support systems to steer rural and water policies and high-tech fertilization procedures were implemented for the first time towards an effective and measurable reduction of the water use in agriculture and the reduction of the nitrate release in the above mentioned water basins.

The pilot actions represent the most innovative part of EU.WATER project as the problem of water management in agriculture in South-East Europe is targeted by using a holistic approach, where decision makers improve their government actions by applying strategies based on a large scientific horizon, with the support of technical institutions and the participation of key-stakeholders.

The outstanding value of the pilot actions consists in delivering agronomic models, with a large potential of replication, to enhance the competitiveness of the South-East Europe agriculture economies, by spreading new technologies able to improve water use efficiency and to lower sprawl impacts. Innovation will regard both institutional and productive levels: the public administration own new tools for incentive a more responsible use of water in application of existing and newly developed approaches, whilst agricultural enterprises, thanks to the availability of information and to the sensitization and training actions, have the opportunity to access to new technologies able to improve the overall environmental balance and increase the yields.

In the next pages, the summary of the results achieved through the five pilot actions developed in the frame of EU.WATER project is delivered.

Soil content nitrogen determination for a precisionbased fertilization in the Province of Ferrara

Castaldelli G.[13], N. Colombani[23], F. Vincenzi[13], E. Salemi[23], S. Bolognesi[3], R. Loberti[4], E. Tesini[5], M. Mastrocicco[23]

In 2010, the pilot action of the Province of Ferrara was designed, on the base of previous research, to improve the accuracy of nitrogen fertilization of and minimize losses. A sampling grid of 350 sampling points was designed to assess mineral nitrogen availability in the 7 most representative soils of the province, in late winter, before spring fertilization. Two layers, (superficial, 0-50 cm, and deeper, 50-100 cm) were sampled in February and March 2010. In each soil type, 10 fields of about 1 ha were selected, in each field 5 cores were taken and GIS referenced. Wheat and maize rotation was studied due to its representativeness as soil surface, circa 70% of the agricultural surface. Overall, 350 soil cores (7 soils x 5 fields x 5 cores x 2 crops) were sampled and 700 (350 x 2 layers) soil samples were analyzed for: bulk density, water content, organic matter, total nitrogen, urea, ammonia, nitrous and nitric nitrogen. In 50 of the 70 fields, piezometers were established for sampling the aquifer head, at a monthly frequency, from November 2010 till now.

The results achieved in the first year of experimentation evidenced:

- a generally low content of ammonium, except in acid soil,
- a general absence of significant differences of ammonium and nitrate content in relation to soil type and the two studied crop,
- a lower nitrate content in the superficial layer; this was explained in relation to the intense rain occurred in the period (January and February) immediately before the sampling; a generally lower but not statistically significant nitrate content in the peaty and in the sandy soils.

In the second year of the pilot action (2011), using the same sampling grid of piezometers, the realized vulnerability to nitrates from agricultural sources was measured monthly, by assessing the concentration of nitrogen species in the phreatic aquifer. Nitrate concentration resulted lower than the limit of 50 mg/l in more than 90% of the samples. This striking result contrasts with the attribution of vulnerability

1. Department of Biology and Evolution, University of Ferrara; 2. Department of Earth Sciences, University of Ferrara; 3. Agro-Industrial Technology Park of Ferrara; 4. Province of Ferrara; 5. ENEA – National Agency for New Technologies, Energy and Sustainable Economic Development

to nitrates from agricultural sources attributed to the whole Province of Ferrara. Although these results need to be validated by at least in one year more of sampling, the low nitrates concentrations found in 2011 may be partly explained as a positive outcome of the application of the EU Directive for sustainable agriculture in the Ferrara Province, which started in the '80s, with the introduction of the Disciplinary for integrated agriculture of the Emilia Romagna Region. With this respect, the disciplinary foresaw the adoption of some rules for nitrogen fertilization, as hereafter reported:

- limitation of nitrogen fertilization per each crop (more or less the same values fixed by the EU Directive for vulnerable zones);
- timing of distribution: 1) from the first of November to the 31th of January it was not allow to proceed with any fertilization, neither synthetic nor organic, 2) manure could not be distributed on bare soil also in February.
- split application was required; e.g., for wheat, according to phenological phases: 10-15% at seeding, 30-35% at tillering (double ridge appearance) and the rest at rising (in the middle between terminal spikelet initiation and heading).

This disciplinary has been applied on 40% of provincial and regional agronomical surface, under an incentive program which was founded using EU founds that the Emilia Romagna Region dedicated to pollution prevention; they were assigned through the Regional Agricultural Development Plan or through the Italian Common Market Organization; this regulation is still in force.

Therefore, the second year of the pilot action have represented also a validation of this protocol particularly for the restriction of the autumn-winter fertilization with the aim to decrease the risk of nitrate percolation. Moreover, the results achieved point out other important evidences (please see references hereafter reported) which could be put in practice to improve the disciplinary:

- in the peculiarity of the Province of Ferrara, characterized by very low soil hydraulic conductivity, the use of manure and organic fertilizers may favor nitrate removal via denitrification, preventing groundwater pollution;
- the use of synthetic fertilizers which was so far the most largely adopted in the last 40 years, has heavily decreased soil organic content in most of the province and consequently has impaired the soil capacity to buffer nitrogen excess via denitrification;
- in the light of these evidences, the limit of 170 kg N/ha/year from livestock manure could be increased in these particular soils, in order to prevent the risk of nitrates percolation.

Scientific references of the pilot action of Ferrara

Mastrocicco M., N. Colombani, E. Salemi, G. Castaldelli (2011) Reactive modelling of denitrification in soils with natural and depleted organic matter. *Water Air and Soil Pollution*, 222 (1-4): 205-215.

Aschonitis V. G., M. Mastrocicco, N. Colombani, E. Salemi, N. Kazakis, K. Voudouris, G. Castaldelli (2011) Assessment of the intrinsic vulnerability of agricultural land to water and nitrogen losses via deterministic approach and regression analysis. *Water Air and Soil Pollution*, available on line, DOI: 10.1007/s11270-011-0968-5.

Mastrocicco M., N. Colombani, E. Salemi, F. Vincenzi, G., Castaldelli (2011) The role of the unsaturated zone in determining nitrate leaching to groundwater. In: "Groundwater Quality Sustainability", IAH Book Series (IAH Selected Papers), edited by A. Zuber, P. Maloszewski, S. Witczak and G. Malina - Taylor & Francis Books (UK), in press.

Mastrocicco M., N. Colombani, G. Castaldelli, E. Salemi, F. Vincenzi (2010) The role of unsaturated zone in determining nitrate leaching to ground water. XXXVIII IAH Congress on Groundwater Quality Sustainability, Krakow, 12–17 September 2010, pp. 385-390.

Mastrocicco M., N. Colombani, E. Salemi, G. Castaldelli. Surface and subsurface water continuous monitoring to quantify nitrate leaking to groundwater from maize plots. HydroEco 2011, Vienna, Austria, 2-5 May 2011.

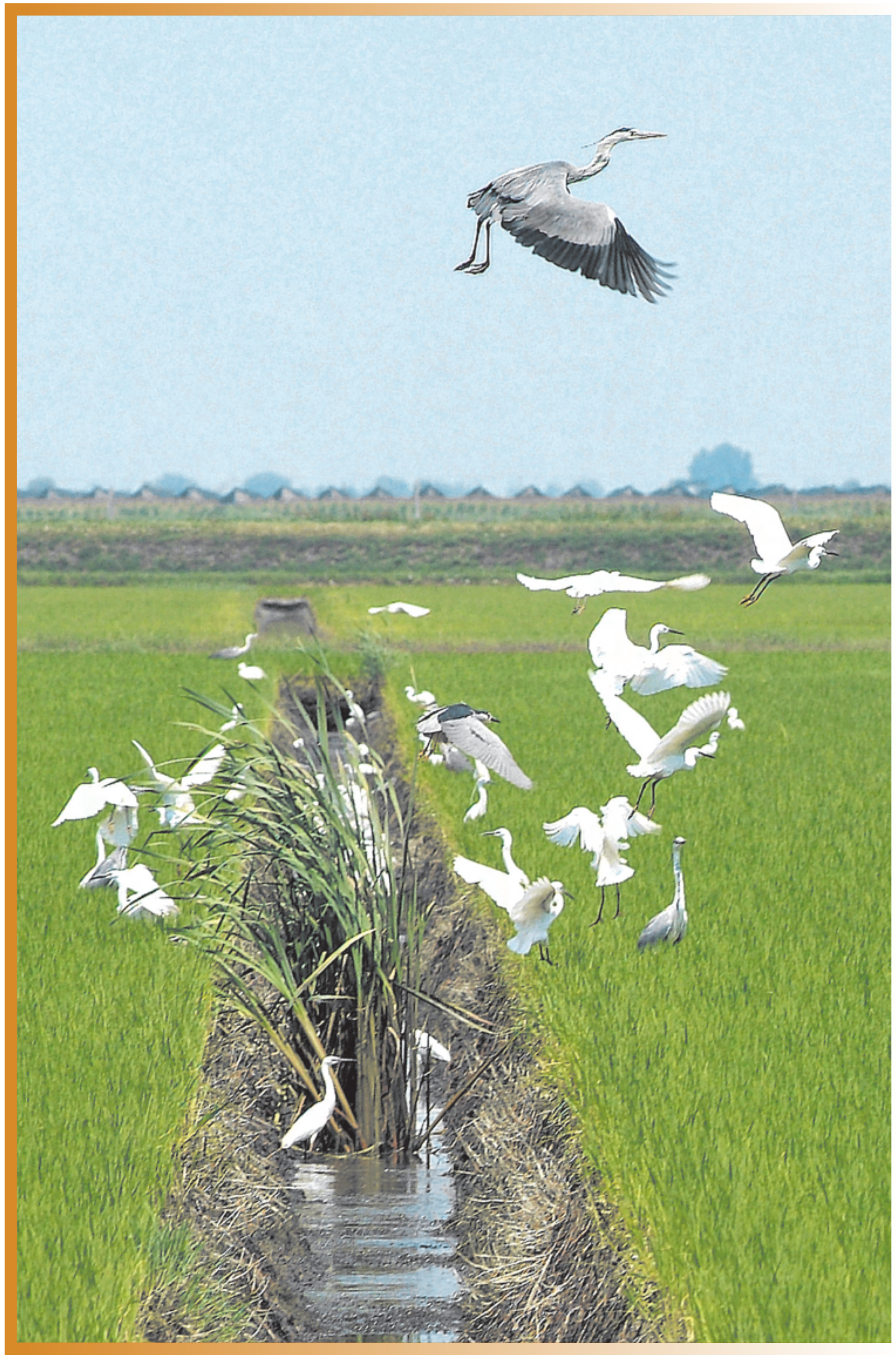
E. Salemi, M. Mastrocicco, N. Colombani. G. Castaldelli (2011) Fertilization management in zones vulnerable to nitrate: a new perspective based on G.I.S. mapping of residual nitrogen availability. HydroEco 2011, Vienna, Austria, 2-5 May 2011.

Colombani N., E. Salemi, M. Mastrocicco, G. Castaldelli (2011). Groundwater nitrogen speciation in intensively cultivated lowland areas. 9th International Hydrological Congress, Kalavrita, Greece, 5-8 October 2011.

Castaldelli G., S. Bolognesi, N. Colombani, E. Tamburini, F. Vincenzi, M. Andreotti, R. Loberti, M. Mastrocicco (2010) La dinamica dell'azoto in diversi tipi di terreno. Terra e vita, 4: 30-31.

Mastrocicco M., N. Colombani, G Castaldelli (2011) Il ruolo della zona insatura nella lisciviazione dei nitrati verso le acque sotterranee in Provincia di Ferrara. DIRETTIVA NITRATI: dalla ricerca alla gestione del territorio, Legnaro (PD), 31/05-01/06 2011: http://www.acquerisorgive.it/public/file/Dese/MASTROCICCO.pdf.

Salemi E., Colombani N., Mastrocicco M., Tesini E., Castaldelli G. (2011) Monitoring and mapping of residual nitrogen in lowlands. the case study of Ferrara province. Geoitalia 2011, VIII Forum italiano di scienze della terra – Torino, 19-23 settembre 2011. Epitome, Vol. 4, 2011, pag. 102.



Sidedress of cattle beef slurry between corn rows with straight tine cultivators in the Province of Rovigo

Gianluca Carraro

In Po Delta flood plain, with the help of the largest agricultural farmers associations, two “pilot farms” have been selected having availability of both cattle beef slurry and land for trials on corn.

The pilot action of Rovigo, in particular, wants to demonstrate that even in nitrate vulnerable zones (like Rovigo province) cattle slurry in not a problem to get rid of quickly but is an asset for the farm mainly if the application is based on sidedress between corn rows. For this purpose a cultivator with straight tines has been developed to apply slurry while corn is growing without damaging the crop and guaranteeing the complete burial of slurry according with EU Nitrate Directive. The first prototype, ever done at least in Italy, is shown in the photo.

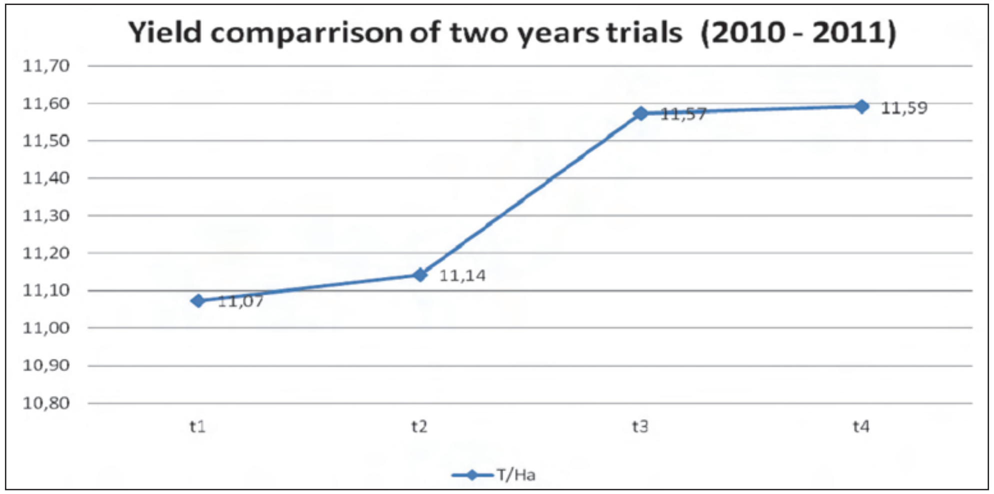
After solving some mechanical aspects, a three-year trial (2010-2012) has been planned to monitor the yield response to different slurry applications.

The treatments are arranged in a randomized block design with three replications in two different sites having different characteristics of soil texture, organic matter content, characteristics of slurry. Each block is 4 rows wide and 200 m long. For each block the yield is weighted and the relative humidity of the grains is measured.

The theses compared are:

- t1: 170 kg / Ha of nitrogen from slurry at the corn growth stage of 5 true leafs (10 cm height),
- t2: 170 kg / Ha of nitrogen from slurry at the corn growth stage of 10 true leafs (70 cm height),
- t3: 170 kg / Ha of nitrogen from slurry in two applications at the corn growth stages of 5 and 10 true leafs (10 cm ÷ 70 cm),
- t4: 170 kg / Ha of nitrogen from urea at the corn growth stage of 5 true leafs (10 cm).

In the photo an application is shown at the growth stage of 10 true leaves (70 cm).



The results of the first two years of trials are very encouraging:

Especially the thesis t3 (*170 kg / Ha of nitrogen from slurry in two applications at the growth stages of 5 and 10 true leafs or 10 cm ÷ 70 cm*) shows results almost identical with thesis t4 (*170 kg / Ha of nitrogen from urea at the growth stage of 5 true leafs or 10 cm*). **In other words this is the demonstration that corn yield is the same either the farmer fertilize with chemical** fertilizer (urea, 170 kg / Hectar of Nitrogen) **either he applies cattle slurry** (170 kg / Hectar of Nitrogen).

Also the thesis t1 (*170 kg / Ha of nitrogen from slurry at the growth stage of 5 true leafs or 10 cm height*) showed an economic interest comparable with chemical fertilization if the cost of inputs (like phosphorus and potassium) carried out with the slurry is considered.

The results of the pilot action may have a positive impact on agricultural and environmental standards because they confirm that the application of cattle slurry during crop season (**corn sidedressing fertilization**) has the following characteristics:

- it is not harmful for the crop,
- it brings to comparable yields, at least in the short period, with chemical fertilization,
- since the distribution of slurry takes place whilst the crop root system is in strong absorption of soil nutrients (including nitrates), it can reduce at highest level the loss of nitrate and consequently this technique **can be considered as the best available technique (BAT)** to apply slurry to soil.

Moreover, with the aid of vulnerability maps, and pending further validation of the two years results, it could be asked the policy makers to permit more flexibility in nitrogen applications (in terms of quantity) when they take place with such sidedressing techniques.

The Pilot Action results obtained so far, have been shared with the Local Implementation Network (LIN) that was involved also in the initial selection of the "pilot farms", then in the collection of technical tips and finally in sharing the comments on the agronomic results (Arquà Polesine meeting 11 November 2010, Taglio di Po meeting 17 November 2011, Rovigo meeting 24 November 2011, Giacciano meeting 6 December 2011).

Finally some links have been set to be visible even in another project on nitrate (Riducareflui) that an agricultural branch of Veneto Region (Veneto Agricoltura) has carried out in 2010-2011.

Efficient use of water resources and reduction of agricultural nitrate pollution in Tisza River basin

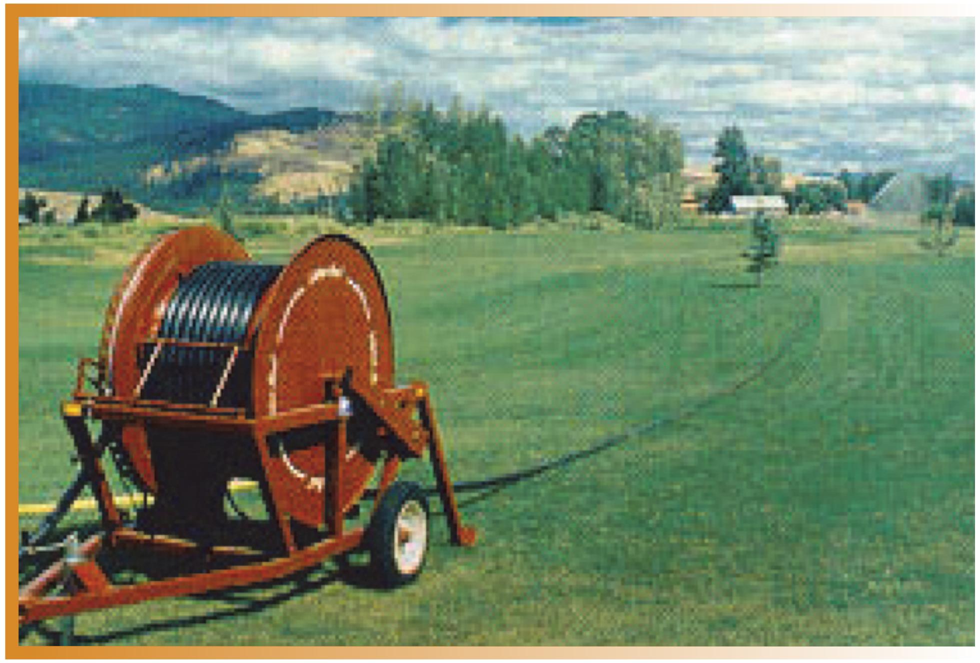
Zoltán Karácsonyi, Béla Kelemen, Tünde Szabó

The aim of the pilot project was to evaluate the use of water resources in irrigation, fish pond culture, natural ecosystem, resilience and responsible use of liquid manure and to develop a widely available free database to support agricultural water consumption and nutrient management.

The Hungarian Pilot Area is located in the middle of the Alföld (Hungarian Great Lowland), and it is characterized by intensive agriculture with nature conservation areas (such as Hortobágyi Nemzeti Park / National Park) and with more than 3000 hectare of fish farming in fish ponds.

The area of **irrigated fields** has significantly decreased both at national and pilot area level decreasing from 451.000 ha (in the '70s) to about 80.000 ha nowadays. Its main reason is particularly the increase of irrigation costs that prove almost unbearable. Irrigation in these days is applied for yield enhancement but in most cases as a tool to save yield.

The Hungarian Partner prepared case studies according to water and energy saving aspects as well as economic aspects. In case of field irrigation hard hose reels and



Aerial photo of a typical pond farm

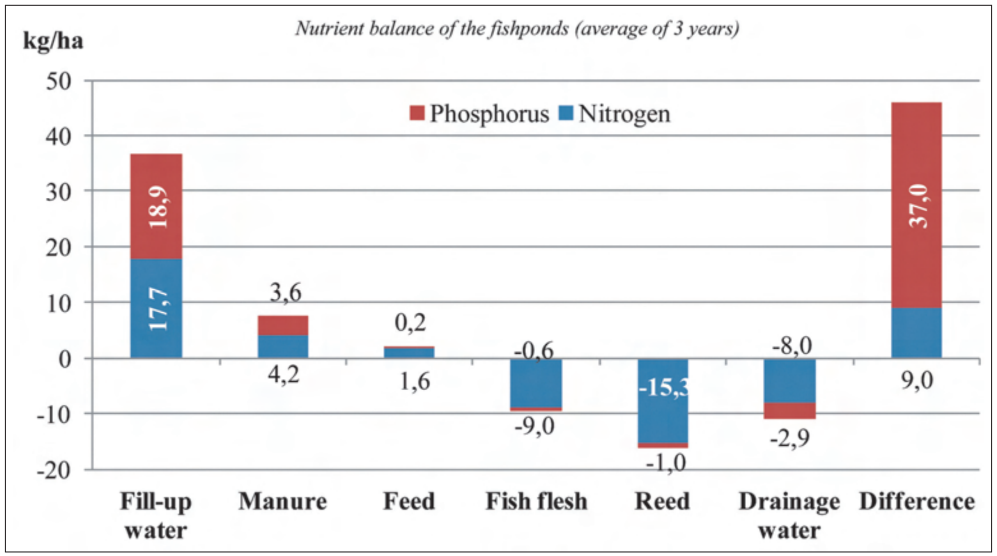
linear machines, in orchards micro irrigation systems for multipurpose use (water supply, frost protection, colouring irrigation, conditioning irrigation) were studied. As a result, it is concluded that due to their energy and water saving character, **linear systems should stay determinant in the development of field irrigation**. **In smaller areas, hard hose reels are recommended**.

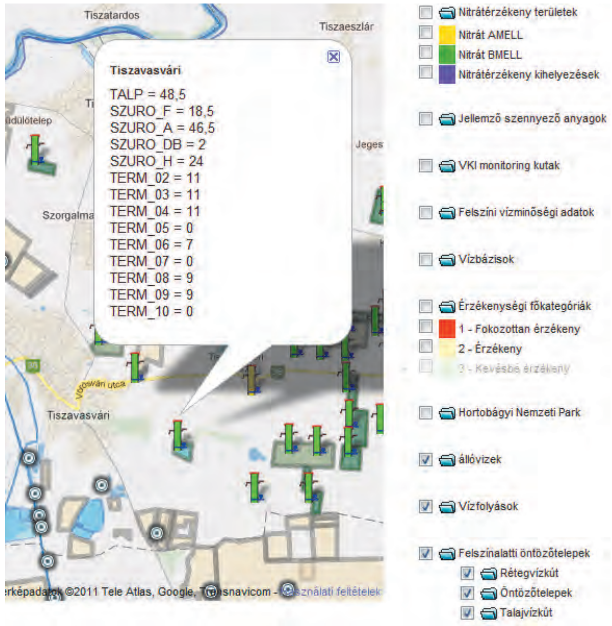
The **efficiency and economic benefit of micro irrigation - meaning huge investment cost - should be increased through multipurpose irrigation**. This provides harmonized water supply, protection against late spring frosts, more marketable products and better plant condition in long hot summer periods.

Typical **fish ponds** are earthen enclosures in which the fish live in a natural-like environment, feeding on the natural food growing in the pond itself from sunlight and nutrients available in the pond water. In order to reach higher yields, farmers introduce nutrients (manure) and additional food (grain).

The study covered the analysis of a large scale Hungarian pond farm. The aim was to determine the impact of the pond fish culture on the water management (water quantity and quality) in a watershed. 3 years data were collected.

Overall data gained show, that the main nutrient (nitrogen and phosphorus) source is the fill-up water and the manure (accounting for 75 and 16%, 17,7 and 4,2 kg/ha of N and 84 and 16%, 18,9 and 3,6 kg/ha of P, respectively). Parallely, the majority of these nutrients are removed via the reeds and fish flesh (accounting for 25 and 47% of N and 14 and 63% of P, respectively). Altogether, 55% and 84% of N and P (that is 9 and 37 kg/ha, respectively) originating from fill-up is removed or retained in the ponds. The significant amount of retention is calculated as the difference between load (form fill-up, manure and feed) and removal (by fish flesh, reed harvested and drainage water) from 55-60 million m³ of fill-up water annually.





data on the screen

Another aim of the study was to evaluate technologies that help saving water during farming. The "*pond water recirculation*" (PwR) system is a unit made up of several small and one large extensive pond. The key concept is that the feed-based production of high value species is carried out in the small ponds under intensive conditions. The effluent water of the ponds are supplied continuously to the extensive pond where the nutrient load is utilised by the natural biological processes. Then, the "purified" water is pumped back to the intensive ponds, thus closing the water recirculation. Due to the controlled environment in the small ponds it is possible to reach the yield of 8-10 tons/hectare, that is about 10 times higher than that of the extensive pond.

The basic concept behind the "*pond-in-pond*" (PiP) system is very similar to the PwR system being also a "combined extensive intensive" system. The main principle is that the effluent water from the intensive unit (floating raceways) rich in nutrients is purified in an extensive large pond utilizing its "biological self-cleaning" capacity. The basic difference between the two systems is that in case of PwR the water bodies of the ponds are separated, but the intensive units of the PiP system are actually situated inside the water body of the extensive pond. Low head pumps are used for supplying water to the raceways. The water of the extensive pond is flowing through the raceways continuously, thus the PiP system can be considered as a flow-through system, having the main advantages of such systems namely the continuous supply of oxygen rich water and continuous removal of fish excreta. The water removed from the system is high in organic matter, which is not wasted but utilized in the extensive pond directly by the fish (unconsumed feed) and as organic fertiliser.

The extensive pond, the pond water recirculation and the pond-in-pond net yield (fish kg/used water m^3) are 0,07, 0,83 and 25,50 kg/m^3 respectively. The pond water recirculation is only 8,4 % of the extensive pond water demand for 1 kg net yield fish respectively. In case of the pond-in-pond system it is 0,3 % of the extensive pond water demand for 1 kg net yield fish respectively.

A great advantage of these ponds beside the high water use efficiency is that they

liquid manure storage

contribute both nature and environmental conservation and can significantly buffer the high organic content of the fill-up water and serve as a quasi biological filter.

The data of **agricultural water consumption and nutriment management** as well as the processes that have a direct impact on them are collected and registered by different authorities in Hungary. This way the persons concerned in the agricultural water consumption often do not even know what data are available for them for making their decisions. In case they have to collect data, information they only find is in different places and not systemized.

Solving this problem the pilot project helps with collecting, systemizing the data in connection with agricultural water consumption and nutriment management in one database and display the data online available for everyone with the help of a geographic information system (WEB-GIS).

The main groups of collected and processed in the pilot project are the followings:

- Hydro meteorological data
- Environmental conditions
- Irrigation from surface and underground waters
- Nutriment management
- Connection with Water Framework Directive (Catch basin – management plan)
- Licensing

On the basis of the above mentioned, anyone who is interested (schools, partner authorities, authorities, social organisations,…) can gather information on, and the farmers can obtain systemized information on the basis of the data of meteorology, water quality, water quantity, water-level, water pollution typical near their territory by making simple analyses with the geographical information. They can gather information on the activities that have an impact on water quality, on the existing, licensed water consumptions in the neighbourhood, on the different nutrient placing areas and data, and on the possible ways of water supply, and the details of the processes of licensing.

The collected data from the practise of nutriment management partly serves for giving information, but the analysis and comparison of data are helpful for the authority in judging the farmer, and in implementing the good agricultural practice and BAT.

WP5 – 5.4: Implementation of pilot action in Greece: Application of a DSS to support water-use and eco-friendly decision process in agricultural production planning

Manos B., Bournaris T., Papathanasiou J., Voudouris K., Kazakis N., Tagarakis A., Zioga D.
(Aristotle University of Thessaloniki, Greece)

SThe pilot action in Greece is an application of a Decision Support System (DSS) to support water-use and eco-friendly decision process in agricultural production planning. The Decision Support System (DSS) is a computerized system, which includes models and a set of relational databases. The EU Water DSS is a simple step by step software based on the related GIS Maps created using LOS Indices developed for EU Water project. The EU Water DSS is an important planning tool enabling the regional authorities and the farmers to design sustainable agricultural policies for the pilot area in Greece. The implementation of the DSS optimizes the farm plan of the pilot area taking into account the available resources (land, labour, capital) and environmental parameters (nitrate reduction, water consumption etc). The DSS is further used to simulate different scenarios and policies due to changes on different social, economic and environmental parameters (e.g. different levels of chemicals or water consumption per crop). The DSS also supports spatial development planning process, facilitates the decision-making process and assists farmers and decision makers in choosing the best alternative solution from the economic, social and environmental point of view.

The model that the DSS uses is an Optimization Multicriteria Mathematical Programming (OMMP) model based on Weighting Goal Programming. The OMMP model achieves optimum crop plans for the pilot area combining different criteria to a utility function under a set of constraints concerning different categories of land, labour, available capital, etc. and taking in account the GIS maps developed for the pilot area. The GIS maps are based on the LOS indices and assess the vulnerability of agricultural land to water and nitrogen losses and the pollution potential of groundwater.

The OMMP model of the DSS **has the following 3 objectives:**

- Profit maximization
- Fertilizer minimization
- Minimization of labor

has a set of constraints concerning:

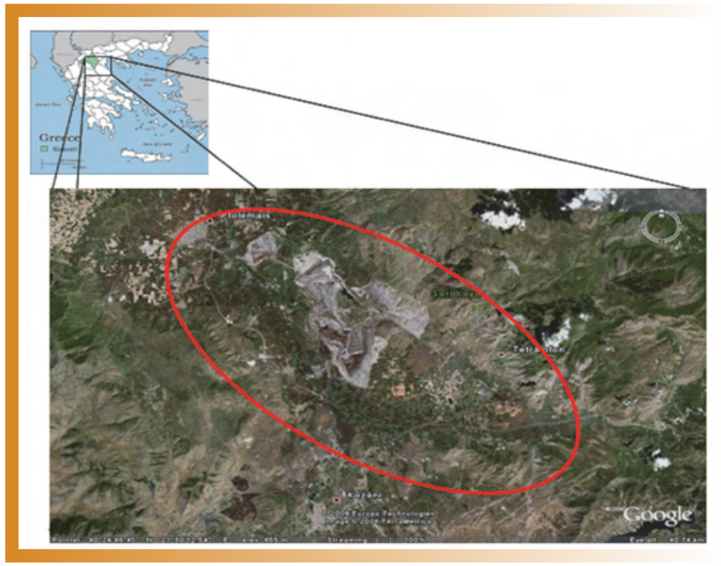
- Total cultivation area
- CAP Constraints (Set Aside, Rights, Quotas, Crop Rotation)
- Market and other constraints
- Rotational and agronomic considerations
- Irrigation Constraints
- LOS Indices Constraints

where the LOS Indices constraints are the following three different types of constraints:

1. LOSW-PR is the sum of total losses of water
2. LOSN-PRN is the sum of total losses of nitrogen
3. Relative Transit Time. The relative transit time is a measure of groundwater vulnerability. The less the transit time, the greater the chances of the pollutant to be transported to the groundwater surface (high vulnerability).

and simulates the 4 following Scenarios:

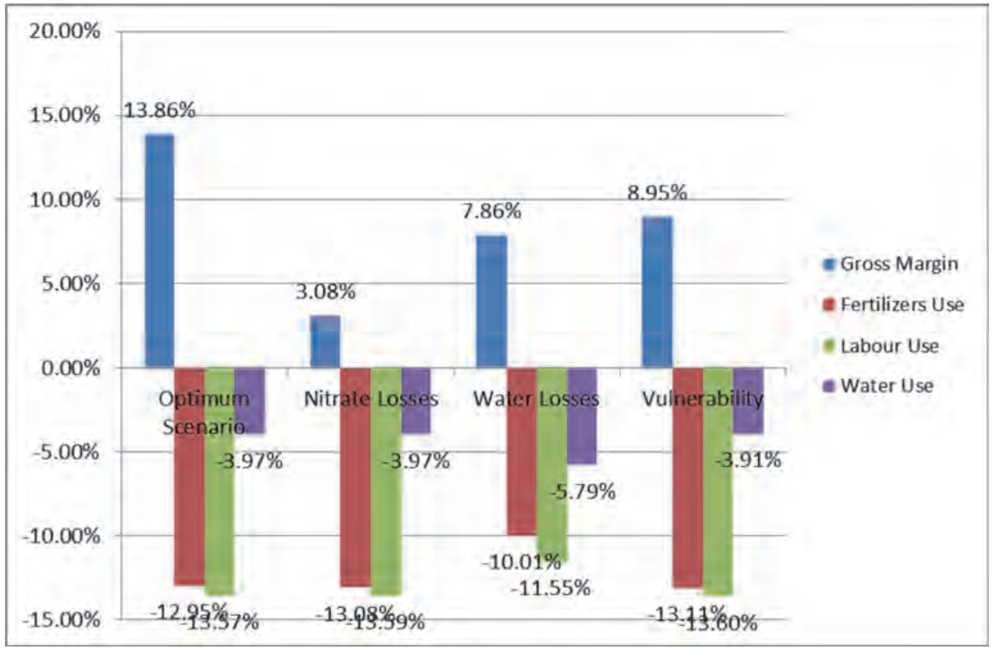
- Optimum Scenario, that gives the optimum production plan (without LOS Indices constraints)
- Vulnerability Scenario, that uses as constraints the data from the Relative Transit Time (TT)
- Water Losses Scenario, that uses as constraints the data from Total Losses of Water (LOSW-PR)
- Nitrates Losses Scenario, that uses as constraints the data from Total Losses of Nitrogen (LOSN-PRN)



The DSS through the OMMP model facilitate and optimize the decision-making process relating to the problems of land use, water management and environmental protection.

The selected pilot area for implementing the pilot action is a part of Sarigkiol basin in Northern Greece constituted from the irrigated agricultural area (12,593 ha) of two municipalities of Kozani prefecture. The basin has been selected for its ecologic and natural resources exploitation characteristics influencing agricultural and pollution patterns.

The results in the pilot area show that all the scenarios used achieve the three main goals set by the model definition. The alternative production plans resulted from the scenario analysis are different in each scenario. As regards the total gross margin of the pilot area there is an increase from 3.08% in the Nitrate Losses Scenario to 13.86% in Optimum Scenario. On the other hand the reduction in fertilizers use starts from -10.01% in Nitrate Losses Scenario to -13.11% in Optimum Scenario. There is also reduction in irrigation water consumption from 3.91% in Vulnerability Scenario to -5.79% in Water Losses Scenario. Finally, the minimization of labour use goal achieves decrease from -11.55% to -13.60%. The results of the implementation of these scenarios are given in the next figure.



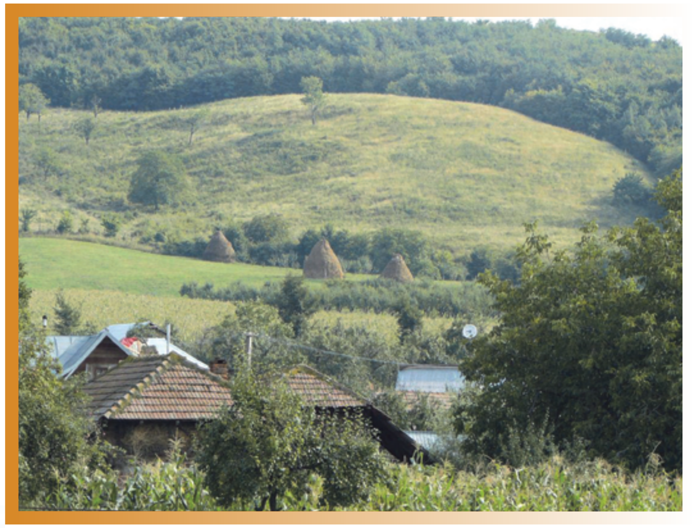
We can conclude from the results that the DSS achieves to increase the total gross margin of the pilot area, and decrease both fertilizers use and irrigation water consumption.

Implementation of a multi-sectoral integrated DSS in Arges-Vedea basin

Danut MARIA, Ion SERBU, Ilie BIOLAN, Animary ARGHIRESCU

In the frame of EU.WATER project, WP5 package of activities – Pilot Action Romania, a series of activities were initiated targeting the stakeholders from the Argeş-Vedea river basin. Project implementation targeted Argeş – Vedea catchment area and for this perimeter one devised and prepared vulnerability maps concerning nitrogen losses through percolation underneath the plants' root system and also through surface run-off, maps illustrating the transit period of fertilisers up to the first underground aquifer, maps which outline those areas where nitrogen based fertilisers may be applied without the risk of polluting the underground waters, etc. County level Directorates for Agriculture and Rural Development from the project targeted Argeş, Teleorman, Călăraşi, Giurgiu and Ilfov counties have designated 20 localities from the above mentioned river basin which are situated inside Nitrates Vulnerable Zones (NVZs).

In July and during the first days of August, in four localities of Argeş County, one organized formal EU.WATER project presentation meetings with local stakeholders. These localities are: Teiu, Leordeni, Topoloveni and Călineşti.In Teleorman county, four such meetings were also organized in the following communes: Zimnicea, Suhaia, Turnu Măgurele and Drăgăneşti-Vlaşca.In Călăraşi county, during August, similar meetings were organized in four communes: Budeşti, Chirnogi, Vasilaţi and Nana.



These meetings have been organized at the town hall locations, during which a number of various project stakeholders attended [farmers, individual agricultural producers, agricultural landlords, family associations, teachers, representatives of water supply and sewerage firms, Mayor's Office civil servants, representatives of the Inspectorate for Emergency Situations (ISU-Romanian abbreviation), members of Water User Organizations and of the territorial branches of National Land Reclamation Administration (ANIF-Romanian abbreviation)].

At the project presentation meetings that have been organized in Zimnicea, Turnu Măgurele and Chirnogi, envoys from local TV stations also attended.

Towards the end of September and beginning of October such meetings have been organized in two of the major towns of Ilfov County: Magurele and Chitila.

Project meetings with local stakeholders culminated in October with the following localities: Călugăreni, Daia, Greaca, Adunatii Copăceni and Colibaşi, all situated within Giurgiu County.

The programme for these meetings consisted of two parts.

• During the first part, one briefly presented the scope of the EU.WATER project and the technical solutions implemented at national/EU level, with the purpose of rationalizing water consumption a of alleviating pollution with nitrates from agricultural sources.

• During its second part, the activity consisted of a number of 5 (five) social survey questionnaires which were distributed among meeting participants to be filled in by these.

The questionnaires referred to irrigation infrastructure, field water management, application of organic and chemical fertilisers, amounts of applied nitrogen based organic and chemical fertilisers, the way in which manure is currently stored (individually or in a collective manner), whether manure storage platforms exist or not, the way in which liquid livestock wastes are deposited, present social and economic plight of the relevant locality/commune, etc.

Project feedback consisting of answers provided to the questionnaires are to be synthesized on counties and further analysed and interpreted for a better understanding of the opinions of those actors which are influenced by the pollution of the water table and also of those which show interest in a quick implementation of the project outcome, as measures have to be prioritized within each designated Nitrate Vulnerable Zone (NVZ).

The project team will subsequently devise the final list of measures and the corresponding indicators to monitor their effectiveness in application.

Pilot Action Romania tackled a well known issue throughout the Arges – Vedea target area, by proposing a series of new solutions designed to achieve the reduction of the amounts of fertilisers applied to agricultural crops, together with new techniques which should ensure irrigation water savings. All such solutions included in the project are the outcome of focused debates and analyses carried out with local stakeholders. These findings were disseminated through several presentations organized in a number of 20 communes with mayors, farmers and other representatives of the local stakeholders.

Thus, in each of the town halls corresponding to the 20 localities designated as vulnerable to nitrates pollution by the Directorates for Agriculture and Rural Development of the 5 counties that correspond to the Arges – Vedea river basin territory, farmers attending these meetings were presented with practical ways and items of equipment which can achieve optimization of the irrigation water consumption, with solutions and equipment that ensure a rational application of fertilisers and maintenance of an appropriate level of soil moisture content; they were also familiarized with the most important provisions within the Code of Good Agricultural Practices, the farm level management plan and the nutrients management plan, all of which, provided they are correctly applied, can decrease the loads of nitrates which reach surface and underground waters.

All participants to these meetings received hard copies of relevant information on the EU.WATER project objectives and progress, on the Code of Good Agricultural Practices and one CD with the Romanian legislation that currently translates at national level, all relevant EU legal framework on water issues, such as the Water Frame Directive and Nitrates Directive.

Some of the farmers were also asked to fill in questionnaires which were further processed and used within the project.

The most relevant outputs of the Pilot Action Romania project activities are:

- An enhancement of the awareness level of local players/stakeholders on the need to save water and to lower the current level of nitrates pollution derived from agricultural activities.
- Dissemination of the provisions of the Romanian "Code of Good Agricultural Practices", 2005 edition.
- More useful knowledge on the collection, storage, transport and use for fertilization purposes, of the domestic sewage and manure, under environment-friendly conditions.

In terms of limitations and drawbacks of the Pilot Action Romania, one can mention:

- Difficulties in mechanization of the nutrients and water management activities
- Hurdles encountered in financing investments designed to significantly decrease the nitrates pollution and the current water consumption level.

Each commune within the Arges – Vedea target area presents particularities on terrain, population structure, traditional agricultural practices, endowment and social and economic conditions.

The extrapolating potential will surely depend on the degree in which the stakeholders comprehend and prioritize the project goals, on the practical incentives which can be made available to them in order to apply suggested new techniques/solutions and of course on their motivation/determination to do so.

Normative instruments which are in effect within the project pilot area comply with provisions of Nitrates Directive 91/676/CEE.Outputs of the pilot action initiative together with the vulnerability maps could be part of a future edition of the Code of Good Agricultural Practices and perhaps of an amendment to the Water Law. Up to the present there have been no requests/applications on supporting the transformation of any of the EU.WATER innovations into regional level practices.

CHAPTER C – COMMUNICATION AND EDUCATION

Promoting a sustainable agriculture in the project areas

Judit Karácsonyi

EU.WATER strategy to reach target groups: local bodies committed in territorial planning and resource management, farmers, their associations and technicians, further concerned by training activities and agricultural technicians (planned within the Mainstreaming Action Plan) is based on a community-led process to improve awareness towards sustainable agriculture patterns, ownership of the problems and solution brought by the application of the project‘s methodologies and by the pilot actions. The involvement of the target groups in each area is formalized through the creation of Local Implementation Networks (LIN), which are permanent forums, coordinated by the project partners, to foster communication and interaction between the stakeholders and the decision makers and facilitate the voluntary use of EU.WATER methodologies.

Challenges creating the LIN network were finding a broadly based membership involving three main categories of key target groups: (1) local bodies committed in territorial planning and resource management (2) farmers, their associations and technicians, further concerned by training activities (3) agricultural technicians.

During the project lifetime, around twenty-four LIN workshops were organized in the eight concerned EU.WATER pilot areas, reaching outstanding results in terms of people involved (among the others, it must be mentioned the 147 attendees at the Ferrara workshop when the results of the pilot action were presented, and the 180 participants at the first cycle of trainings for agronomists and farmers in Pancevo, Ser-

bia) and in terms of capacity to raise awareness across the rural communities and policy-makers on protection of natural resources in agriculture by applying EU.WATER tested practices. In specific, the LIN workshops were organized in each project area upon considering a jointly defined dissemination purposes.

The 1st meetings were organized in the first half of 2010. At this phase of the project the LIN served as an information platform about the project and activities so far.

The 2nd meetings were organized after the GIS maps and databases were ready so the LIN became a interactive meeting where the members and project partners had a chance for a detailed discussion and LIN members were involved in the formulation and use of the database in terms of giving opinion, shared expertise. At the same time the LIN meeting was a great opportunity to spread information concerning the so far results of the project and of the main specific activities carried out and also the scientific conclusions reached on Technical Forums and by technical discussions among the partners.

In beginning of 2012 the 3rd LIN meetings were organized when the project almost reached its end. At this stage, the results were presented to the LIN members who now were partners in the finalization of the project results and common positions (final statements) were adopted by LIN networks to

be used to improve the local intervention plans to multiply the project results at wider pan-regional level.

In addition to Local Implementation Networks EU.WATER also concentrated on the general communication and dissemination activities. Beside those general activities EU-WATER project corresponding to the streamlined multimedia requirements is present in the multimedia also: information on the project and the project meeting in Odessa was broadcasted in prime time in the Ukrainian television

and the 2nd Hungarian LIN meeting was broadcasted in the regional television. To enhance the project diffusion several multimedia material was developed: the project videos uploaded on the project website (www.eu-water.eu) and on YOUTUBE, video on the transnational capacity building seminars organized in Ferrara in July 2011, interviews etc.

The EU.WATER project website - that has been from the beginning the point of reference for all dissemination activities – was awarded as the best website in the South East Europe (SEE) programme and was presented during the 2nd Communication Seminar organized by the SEE programme JTS.

The EU.WATER educational package for the South-East Europe

Marco Meggiolaro

Schooling and human capital investments can enhance the technical efficiency at rural production activities. In a changing agricultural environment, where the market economy conditions rapidly evolve and the new technologies are regularly becoming available, skills obtained by formal training and schooling have an advantage over the on-the-job experiences. Most of the new agricultural technologies are geo-climatic, geo-referenced and land-specific and are continuously gathered by the multi-sectorial approach, where the biology, earth and environmental sciences are integral part of the agronomic investigations. For farmers and technicians, the access to new technologies and scientific-based practices currently existing in the European and international specialized networks is a crucial factor to address the integrated and environmental-friendly development of the local rural areas. Merging imported knowledge to the local-based experiences and traditional agricultural codes, especially for those Countries that have been characterized for a long time by a static political and technical feature, could definitely be considered the best way to increase the farm profitability and address ecological patters in agriculture.

In July 2011 the Province of Ferrara, in the frame of the EU.WATER joint activities, organized an intensive transnational capacity building seminar to reinforce the general capacities of administrations and technicians from Serbia, Croatia, Moldova and Ukraine in water and environmental monitoring procedures, with the final aim of addressing know-how to gather the local and regional policy planning for agricultural and water management issues.

After an initial evaluation by a team of Ferrara's experts about the state of achievement of the EU.WATER results obtained so far, the capacity building focused on those critical aspects identified in the use of GIS mapping technology, sampling of aquifers and surface water (on-the- field training was carried out in the Ferrara pilot test rural area) and – finally - chemical and LAB analysis on the main nitrogen analytes with particular reference to the necessary equipment to organize small, relatively low costs but efficient laboratories to analyze the Nitrate dynamic in the fields.

Two partners' delegates (one GIS expert and one water-environmental expert) attended the course to allow the replication of the monitoring and LAB analysis practices in the partners' country. At this regard, one video documentary was produced by the Province of Ferrara specialized TV not only for dissemination purposes but also to be broadcasted in the partners' countries during the seminars with local agricultural technicians to concretely address local replications schemes.

The educational package was completed in the fall 2011, when some agronomist from the Province of Ferrara team visited all partners' regions to get a wider knowledge on the traditional codes of agricultural practices applied in every pilot area to strengthen the scientific consistency of the Transnational Strategy for the Integrated Water Management in Agriculture.

In the long term, the purpose of the schooling is to strengthen the local networks of technical assistance to farmers and support the involved administration in the decision-making process thanks to local human capital and an indigenous stock of knowledge, avoiding the need of foreign skills and the related transaction costs.

The EU.WATER Transnational capacity building, currently recognized as one of the most outstanding results for the South East Programme in terms of potential of replication and knowledge transfer, was coordinated by the CFR (Ferrara Research Centre), a spin-off the University of Ferrara that counts on one of the most experienced team in Europe in the field of water-quality monitoring and nitrate analysis. The immediate follow-up actions looks at new academic cooperation between the concerned universities and research centers, while new project proposals to enhance the impacts of the educational package have already been triggered in other EU Territorial Cooperation Programs.

CHAPTER D – COMMON INTEGRATED STRATEGY FOR WATER MANAGEMENT IN AGRICULTURE / WATER RESOURCES & IRRIGATION

Arampatzis S. (Region of Western Macedonia, Greece)
Tagarakis A., Kazakis N., Zioga D.
(Aristotle University of Thessaloniki, Greece)

Introduction

The aim of the current chapter is to identify alternative irrigation methods in order to save water based on bibliographical references and the use of the codes of good practice for each target area / country. These codes consider many issues, including water consumption which is the main issue considered. Codes of good practices are identified for each country, and critical suggestions are made on what is appropriate for the purposes of the EU.WATER project in relation to water consumption.

In order to study the alternative irrigation methods for better management of the irrigation water are taken under consideration previous experience of local and central services – responsible for water management, the available technology, the international literature, the relevant technical reports of good practices and the results of other related projects in combination with the good practices.

1. Situation in the EU.WATER areas

1.1 Crops cultivated in the EU.WATER areas

The main crops cultivated in the study areas of the EU.WATER project are:

- Arable crops: wheat, barley, oat, rye, maize, sunflower, soybean, alfalfa, rice
- Vegetables: potatoes, green peas
- Industrial crops: sugarbeet
- Fruit trees: pear, grape vines, olive
- Set aside – pastures

1.2 Crop irrigation needs

Wheat. Wheat is not a very demanding crop by means of irrigation. According to FAO the total growing period for wheat crop varies from 120 to 150 days and during this period the seasonal crop water needs are approximately 450 – 650 mm (www.fao.org).

Barley. It is less demanding in water than wheat. It can grow well with only 200 – 250 mm rain per year (Dalianis, 1983).

Oat. Oat is the most demanding cereal in water (Dalianis, 1983). FAO reports that the total growing period for oat crop is the same as for wheat and barley varying from 120 to 150 days and the seasonal crop water needs are approximately 450 – 650 mm (www.fao.org).

Maize. It is a very demanding crop in terms of irrigation. The final yield is highly correlated to availability of water. Increased water needs are presented during blooming season. In general it demands 500 – 600 mm of water during the cultivating period.

Sugarbeet. The total water needs depend on the climate and the growing season of the area where it is cultivated. According to FAO the approximate values of seasonal crop water needs are 550-750 mm (www.fao.org).

Potato. Potatoes tolerance for water stress is limited and it is the main limiting factor for tuber grade, tuber specific gravity and quality. FAO refers to potato water needs to be approximately 500 – 700 mm (www.fao.org).

Green peas: The crop water needs are approximately 350 – 500 mm (www.fao.org). It develops deep root system so it can grow well in dry climates. The needs in water are increased during blooming (Ha, 2007).

2. Irrigation systems

The main irrigation systems in the study areas of the EU.WATER project are:

- Drip irrigation
- Sprinkler irrigation
- Surface irrigation / flood irrigation

3. Codes of Good Agricultural Practices in the EU.WATER countries

European Union has started an effort to introduce or reintroduce good agricultural practices in the modern farm management. Most of them were traditional practices that were abandoned due to intensification of agriculture. These practices were enriched, to result the Codes for Good Agricultural Practices. These codes involve the following agricultural activities:

- Inputs management
- Soil management
- Crop rotation
- Fertilization
- Water management
- Plant Protection
- Management of native vegetation
- Harvest
- Managing of crop residues
- Waste management

Following these practices combined with the use of new techniques and technologies in irrigation and fertilization will lead to optimization of production and minimization of the environmental impacts due to agriculture. Most EU.WATER countries already maintain their own Code of Good Agricultural Practices (for example Italy, Greece, Hungary) according to the country's specific morphology, traditional practices etc. Other countries have not adopted codes of good agricultural practices (for example Croatia, Serbia) but may use alternative guidelines (for example Moldova).

4. Strategic design for water conservation in the SEE area

We collected and reviewed all the available information from:

- Data collected from partners (questionnaires)
- Traditional practices and Good Agricultural Practices in the partner's areas
- International practices found elsewhere
- Literature review

According to partner's answers to questionnaires, reports and additional data gathered within the EUWATER project, the main tasks that need to be focused in order to enhance water conservation and decrease water consumption in the partner's areas are:

- Improvement of Water Balance
- Improvement of irrigation efficiency
- Management and reuse of sewage – wastewater for irrigation

4.1 Improvement of water balance

The term Water Balance corresponds to the predictive methods which consider the plant physiology properties, calculating the real water needs in each crop growth stage, soil properties and climatic conditions in order to advise the farmers about the most appropriate irrigation timing and amount of irrigation water to apply. Water balance is essential for decision making on water management.

An improved water balance in the project areas can be achieved using certain management tools such as Meteorological data monitoring and Soil monitoring.

In certain partners areas (Italy, Greece) small meteorological stations are being installed, mainly in big farms and high value crops that can afford the cost, in order to monitor the weather and microclimatic conditions in the farm. The main attributes that are being monitored using such stations are:

- Precipitation
- Wind direction and speed
- Air humidity
- Air temperature
- Solar radiation

Using these data, irrigation may be customized according to the real needs and conditions in the farm. Recently several sensors that can be used as small meteorological stations have been developed reducing the cost of monitoring in field microclimatic conditions.

Apart from the above private systems, where the farm scale is small and cannot afford the cost of this technology, the weather properties may be monitored in local level by the local authorities (municipality or region).

Soil properties (Field Capacity, Permanent Wilting Point, soil texture, infiltration) are essential in order to perform irrigation programming. Therefore soil sampling and monitoring is very useful. In the cases where soil sampling on farm level is not feasible, several soil properties map have been developed in EUWATER project for the project areas. These maps are available on the EU.WATER website and can be used from the agronomists or the farmers to calculate the irrigation schedule.

Additionally the implementation of an irrigation service, possibly via Web, would manage the water balance on the scientific basis by spreading the costs of a wide range of users.

At this point it should be noted that AUTH used the maps and database developed in WP3 to go one step further by developing a Decision Support System (DSS). The DSS is an important planning tool enabling the regional authorities to design optimal spatial development policies and protect the groundwater from the agricultural land use. It also supports production planning and water and fertilization management. From the results we can summarise that the DSS achieves to decrease both fertilizers use and water consumption. With the use of EU.WATER DSS we can achieve optimum crops plans in the pilot area combining different criteria taking in account the EU.WATER GIS maps of the pilot area. The Decision Support System (DSS) is a Computer system which includes models and a set of relational databases. EU.WATER DSS is simple step by step software which is based on the related GIS Maps created using LOS Indices developed for EU-Water project. The DSS is further used to simulate different scenarios and policies due to changes on different social, economic and environmental parameters (e.g. different levels of chemicals or water consumption per crop).The results from the implementation in Greece show that the DSS achieves the three main goals set by the model definition. An increase in Gross Margin achieved from (3.69% - 13.88%), a reduction of fertilizers use from (8.05% - 12.95%) and finally a reduction in labour use from (11.95% - 13.58%) depending on the scenarios.

The use of simulation models, using software to calculate irrigation programming according to real needs for each crop and each area and Decision Support Systems (DSS) may be vital. Several software programs have been developed to assist on irrigation scheduling. Some are free to be used by anyone providing a friendly and easy to use interface. Farmers and agronomists should be aware of these programs and get informed or trained to use such tools. The local authorities may have an informative or training role on this task.

Also irrigation may be managed according to available soil moisture. Useful tools in order to monitor soil water content are the soil moisture sensors, tensiometers. Automated irrigation has started to be applied according to sensor readings. Possibly, the use of soil moisture sensors in combination with the weather station or weather data from local agencies would lead to optimized water balance.

4.2 Improvement of irrigation efficiency

An efficient irrigation provides water to plants based on the real needs in order to develop and achieve high yield. Additionally soil water content should maintain under field capacity avoiding leaching and preserving the overall water availability.

For a rational use of irrigation water the distribution method is significant. The proper use of irrigation facilities achieves the highest degree of efficiency in relation to the adopted method of distribution.

The parameters that have to be considered to choose the best irrigation method are: soil texture, soil chemical characteristics, slope, crop needs, water quantity and quality, environmental characteristics.

As mentioned in previous chapters, the different irrigation systems show significant differences in irrigation efficiency. The most efficient irrigation system is subsurface drip irrigation because water is applied directly in the root zone while the soil surface remains dry minimizing evapotranspiration. On the other hand it shows high installation costs and difficulties and therefore it may be used only for high value and perennial crops (trees, vines etc.). Drip irrigation is also highly efficient irrigation system; the installation cost is affordable especially in dynamic crops such as maize and it is being extensively used globally. Therefore it is recommended to be used when possible.

In general in order to maximize irrigation efficiency the farmers must:

- Prevent surface runoff or deep percolation
- Do not use surface irrigation (with ditches) in fields with a slope more than 3%
- Do not irrigate in the evening (11:00 – 15:00) due to high solar radiation (high evapotranspiration from soil surface)

Sprinkler irrigation is being extensively used in most of the partner's areas. Also pivot systems are used in many cases. In these systems there are common management tactics that may lead to maximization of irrigation efficiency. Wind affects greatly the uniformity of water distribution minimizing the efficiency. Therefore when it is windy irrigation using these systems should not be performed. Installation of wind meters would assist on this task. Also, irrigation should not be performed in the evening (11:00 – 15:00) especially when temperature is high (summer) due to high evapotranspiration.

It is significant to keep the irrigation network and the equipment in good condition in order to maintain the maximum efficiency. Therefore frequent inspections should be performed for possible leaks or damages and for evaluation of the general performance.

Old machineries for irrigation (especially in sprinkler) should be replaced by new ones (more efficient in water saving and energy saving solutions).

From the above mentioned, in order to minimize water consumption due to agricultural activities, the farmers should be enhanced to:

- Replace irrigation systems with more efficient and less water demanding ones
- Repair or upgrade the existing irrigation systems
- Substitute the old irrigation machinery with new more efficient

4.3 Management and reuse of sewage - wastewater for irrigation

One of the options for developing a 'new water resource is the use of water that would otherwise go to 'waste'. 'Recycling is both technically and economically feasible, and can create significant quantities of useable water from sources such as run-off and treated effluent. Under certain conditions it is feasible to irrigate using treated wastewater. The origin of this water can be either form urban wastes or from livestock effluences (www.npsi.gov.au). The use of treated municipal wastewater is relatively low in Europe. It may become a significant source of water, particularly for the irrigation of crops, provided that guidelines and standards are adhered to. Treated urban wastewater provides a water source which is relatively unaffected by periods of drought or low rainfall. Additionally depending upon the level of treatment, it can be relatively nutrient rich, reducing the fertilization needs.

4.4 Enhance the adoption and application of CGAP

From the analysis of Codes of Good Agricultural Practices and traditional practices in the partner's areas several practices were recognized to be commonly accepted in water preservation. These good practices are:

Application of a series of tillage practices that ensure conservation of soil water

- The treated bare soil is vulnerable to erosion by wind or water. Therefore, treatment of soil must be limited as far as possible.
- Soil treatments should take place at the right time with the appropriate equipment. Soil treatments should not be made during dry seasons.
- Avoid deep tillage below 40 cm. Where deep tillage is needed, the soil should not be reversed.
- Where there is flooding risk tillage should be done in a way that ensures field leveling using reversible plows.
- On slopping land plowing must be performed towards the contours to limit water run-off and soil erosion.

Crop rotation - Soil cover

- The field should not be left bare during the winter when it is more vulnerable to erosion due to rain. In light soils it should be covered with vegetation during winter. Crop rotation is a good practice to achieve that.

- Soil cover using different materials is capable of blocking water evaporation.
- The crop residues can offer protection from erosion and enrich the soil with organic matter by covering the soil with the remains.

Protecting water resource

- The uncontrolled use of water like overirrigation, flooding the neighboring fields and roads, the use of unsuitable or defective irrigation systems etc. must end.
- In each irrigation should be applied the appropriate amount of water needed to saturate the soil in such depth as the depth of the root system. Deep infiltration and surface runoff can be reduced by proper control of a number of factors, such as:
  - ✓ irrigation rate (avoid water losses, fix the delivery system)
  - ✓ timing
  - ✓ the soil slope
  - ✓ the length of travel of water in the field
  - ✓ the soil infiltration
  - ✓ the irrigation method

Management of native vegetation

- The native vegetation, the residues of the previous crop or cover crops is best to cover the field surface during the winter especially in sloping fields. The benefits are:
  - ✓ Protection of the soil structure from the rains
  - ✓ Increase the ability of soil to absorb rainwater and reduce runoff
  - ✓ It acts as thermal insulation mean during extreme temperatures
  - ✓ It helps to minimize moisture losses due to evaporation
  - ✓ Reduction of soil erosion and nutrient loss
  - ✓ It assists in the development of soil microorganisms that help in soil fertility

Weed control

Efficient weed control should take place for each cultivated crop, in order to avoid water competition with the crop plants.

Management tactics

Additionally the CGAP provide reduction in annual consumption of irrigation water providing general management tactics:

- Replacement of irrigation systems with more efficient and less water demanding ones
- Reduction of irrigation rate, by measuring and controlling of the consumption of irrigation water (using water flow meters)
- Replacement of irrigated crops by non irrigated
- Replacement of irrigated crops by less water consuming irrigated crops

5. Common strategy for the integrated irrigation and fertilization management

EU.WATER project has identified and developed a total common strategy that will lead to water scarcity deterioration and water quality conservation. In the framework of EU.WATER project a common methodology was developed for all partners areas to assess the vulnerability of each area and propose specific management methods and tools to lead in water resource saving and prevention of water pollution from nitrates due to agriculture.

The total procedure is described in the following flowchart. As shown in the flowchart, the first step for the procedure is the data collection. The information and data needed for the procedure are:

- Elevation
- Climate
- Soil characteristics
- Hydrogeology
- Land uses
- Crops data

After being collected, the data are processed to lead to the models that will be used to assess the vulnerability of the area being studied which is concentrated in several maps containing all the vital information. These maps are:

- Digital boundaries
- Digital data for land uses
- Digital elevation model (altitude above sea level, surface slope %)
- Digital soil type classes
- Digital data for agricultural field-sectors
- Digital data of surface waters (lakes, rivers etc.)
- Digital data for groundwater (waterwells, acquifers, drillings, depth of groundwater table below ground surface)
- Digital data for protected areas
- Digital climatic data (annual rainfall, annual mean temperature, annual potential evapotranspiration)
- Point pollution sources

All the above-mentioned digital models were used to calculate the vulnerability using the LOS indices and Relative Transit Time (TT), to export vulnerability maps which are the final output of the vulnerability assessment providing vital spatial information on which areas are more vulnerable to nitrates pollution and water leaching. The indices that were calculated and provided the vulnerable maps are:

- *LOSW-P*: are the annual losses due to deep percolation beneath the root zone of the 30 cm (mm year^{-1})
- *LOSW-R*: are the annual losses due to surface runoff (mm year^{-1})
- *LOSN-PN*: are the annual nitrogen losses due to deep percolation beneath the root zone of the 30 cm (kg ha^{-1}year^{-1})
- *LOSN-RN*: are the annual nitrogen losses due to surface runoff (kg ha^{-1}year^{-1})

The sum of total losses of water and nitrogen are given by the following:

(LOSW-PR) = (LOSW-P) + (LOSW-R) (LOSN-PRN) = (LOSN-PN) + (LOSN-RN)

- *Relative Transit Time (TT)*: is the minimum relative transit time of losses from the soil surface to reach the groundwater table (days)

The results provide important information, with the vulnerability map suitable for use by local authorities and decision makers responsible for groundwater resource management and protection zoning. Vulnerability and sensitivity maps could be used for planning, policy, management and contamination assessment.

Further elaboration of the data can be performed to develop a Decision Support System (DSS) which will support the farmers and the decision makers on optimization of irrigation and fertilization, leading to a more sustainable and friendly to the environment agriculture.

Apart from the technical oriented tasks, the application of policy decisions in the areas must be reviewed. These tools are:

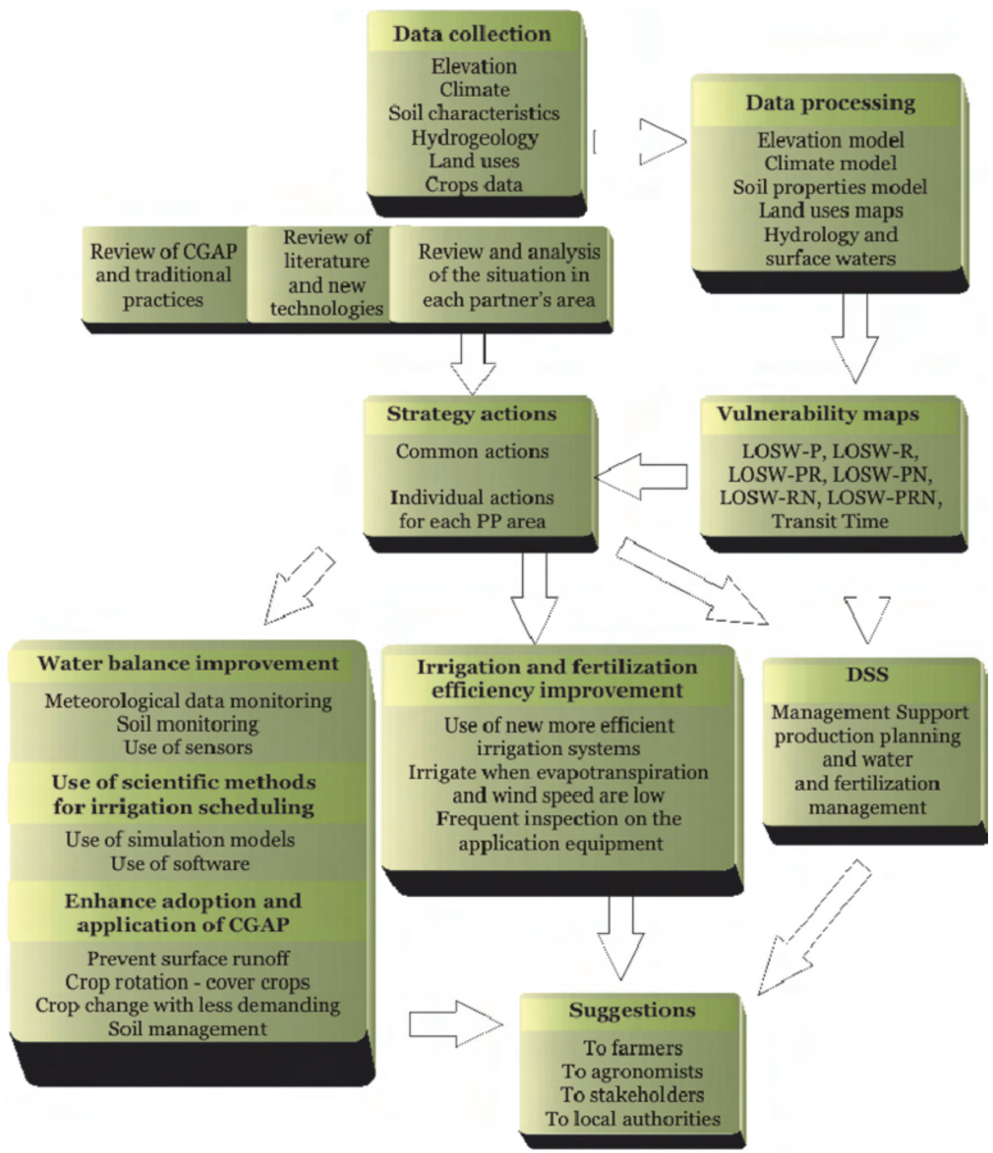
- The Codes of Good Agricultural Practices
- The traditional practices
- The Water Framework Directive
- The Nitrates Directive

Therefore a review and analysis of the situation in each partner's area was performed on the policy and technical tasks. Additionally a detailed literature review was presented in an effort to identify new efficient technologies and international practices.

All the above information was analyzed to end up to the strategy actions which are divided in two main categories: The common actions which can be adopted from all the partners and the Individual actions adapted according to each partners areas situation and needs. A summary of the common actions for water resource savings is given below.

5.1 Common actions for water resource saving

The reduction of water consumption in agriculture is a crucial issue. The following measures and recommendations could be efficient for sustainable water management in the SEE agricultural areas:



General flowchart of the common strategy for irrigation and fertilization management.

Technical aspects:

Soil management

- Enforcing a minimum tillage system to cut water losses from the soil. Avoid deep tillage below 40 cm. Where deep tillage is needed, the soil should not be reversed.
- Performing combined mechanical tillage (combo system) to be able to preserve soil moisture content.
- Performing specialized tillage, able to preserve moisture and block water losing from the soil (compartmented and continuous furrows, chisel and para-plough works that do not turn the soil furrows, etc.).
- Adopting agricultural techniques that achieve a protection of the soil in terms of preventing its settlement, the degradation of its structure and performing an efficient erosion control for the case of sloped and arable terrains.
- On slopping land plowing must be performed towards the contours to limit water run-off and soil erosion. Where there is flooding risk tillage should be done in a way that ensures field leveling using reversible plows.

Irrigation

- Water-saving techniques such as spray irrigation and drip irrigation should be preferred in order to decrease the groundwater quantities used for agriculture.
- New more efficient irrigation systems and management tactics (subsurface drip irrigation, variable rate irrigation, deficit irrigation, sensor irrigation etc.) should be tested and enhanced to be used.
- The use of simulation models and irrigation programming software must be introduced and applied on farm level by the farmers or the region (developing agencies to manage irrigation according to real needs on local level).
- Enhance farmers to introduce meteorological stations and perform soil monitoring to efficiently calculate the real irrigation needs. This may be performed on regional level supported by each region.
- Developing a decision support system (DSS) providing valuable management decisions to the farmers.
- Applying micro-spray irrigation by means of mechanized installations, fitted with low pressure water spraying devices that apply water close to the soil surface.
- Do not irrigate in the evening (11:00 – 15:00) due to high solar radiation (high evapotranspiration from soil surface).
- Keep the irrigation network and the equipment in good condition in order to maintain the maximum efficiency. Frequent inspections should be performed for possible leaks or damages and for evaluation of the general performance. Replace irrigation systems with more efficient and less water demanding ones, repair or upgrade the existing irrigation systems and substitute the old irrigation machinery with new more efficient
- Utilization of the treated wastewater for irrigation purposes in order to decrease the groundwater abstraction. The use of reclaimed or recycled waste water for various non-potable uses has proved to be the most reliable of sources, like in most South East Europe (SEE) countries.
- Construction of small interception dams in the main torrents of the hilly region, aiming at the retardation of wintertime torrential flows and the in-

creasing of the groundwater recharge. In addition, these dams would improve the water supplies for the agriculture requirements.

- Construction of water reservoirs and tanks to collect the rain water. This will reduce rainwater surface runoff, leaching and percolation and will provide water resources.

Crop management

- Selecting crop varieties that are able to make good use of the area's climate potential and applying the crop rotation practice.
- The field should not be left bare during the winter when it is more vulnerable to erosion due to rain. In light soils it should be covered with vegetation during winter. Crop rotation is a good practice to achieve that. Also soil cover using different materials is capable of blocking water evaporation. The crop residues can offer protection from erosion and enrich the soil with organic matter by covering the soil with the remains.
- Integrated weed, pest and disease control must be performed by employing prophylactic means (soil's solarization) as well as biological and mechanical means.

Policy aspects:

- Training courses should be organized in order to educate people in using methods to optimize water use.
- Reduction of groundwater abstraction should be applied in the areas that are affected by aquifer depletion.
- The low price of water, results in people not saving water; thus, effective measures must be taken to prevent the unconsiderable use of water, e.g. incentives for efficient water use.

5.2 Individual actions according to each partners areas needs

Apart from the common actions that can be applied in all the partners' areas according to the analysis of the situation there are additional individual actions or some of the common actions are more essential according to each partners areas needs and specifications.

Individual actions for water resource saving in Italy

Both Rovigo and Ferrara are focusing on water balance improvement by monitoring meteorological and soil attribute and using pivot irrigation systems and lateral moves. On fertilization management, a very important task is the efficient use of manure to fertilize the fields.

Individual actions for water resource saving in Greece

The DSS has already been developed and is being applied for Sarigkiol basin in the context of the EU. WATER project in WP5 (pilot actions). According to preliminary results, it provides support to the farmers on production planning and water

and fertilization management. The DSS will be free to use from the farmers via the EU.WATER website. The DSS can potentially be used by any other region / area that can provide the necessary information for production planning and water/fertilization management.

For the Region of Western Macedonia, the most important issues proved to be the clear understanding and the improvement of water balance on the regional level as well as the improvement of irrigation and fertilization efficiency on the farm level.

In relation to the improvement of the water balance in the regional level, a study was conducted to record water drillings in the Sarigkiol area, and to monitor water flows. Planning for the continuation of the study at the regional level also took place, so that the Regional Authority acquires the necessary information to manage water balance on the regional level.

In relation to the farm level, assistance from the local agronomists was found to be especially important. This is because of the small size of individual farms in the region which does not allow individual small farmers to have a good understanding of the general conditions in the area. Hence, EU.WATER actions will focus on training the local agronomists in relation to the results of the project, aiming at having agronomists supporting the farmers afterwards. Nevertheless, material for the support of farmers will also be produced, containing simplified and shorter guidelines, and focusing on production planning issues.

Individual actions for water resource saving in Croatia

Improvement of water balance, in the case of Serbia, performed and released by the Region, using data from meteorological and soil monitoring (especially in big farms) is important management issue. Additionally implementation of water caption and distribution network improvement is vital.

Individual actions for water resource saving in Hungary

In Hungary as stated, better use of natural/rain water resources might be the key to a more sustainable agriculture.

Land preparation to favor retention at farm level and substitution of old machineries for sprinkler irrigation replaced by new ones (which are more efficient in water saving and energy saving solutions)

In orchards and fruit crops micro irrigation should be enhanced for using multipurpose irrigation (not only for water supply, but also for frost protection, colorization, as for apples, and conditioning).

Also, new fish ponds techniques need to perform for water saving.

Individual actions for water resource saving in Serbia

Improvement of water balance, in the case of Serbia, performed and released by the Region, using data from meteorological and soil monitoring (especially in big farms) is important management issue. Additionally implementation of water caption and distribution network improvement is vital.

Individual actions for water resource saving in Romania

In Romania, it is essential to perform public works and constructions concerning the irrigation water supply system network. Improvement of water balance is the key aspect which will be enhanced by agronomists and other specialists at pilot area and country level. The following measures are essential for the Romanian case: Meteorological monitoring at regional level; checking soil moisture content by gravimetric or other methods; use of liquid animal wastes from farms to fertilize crops; application of a series of tillage practices that ensure conservation of rainfall water.

Pivots and lateral moves with low pressure water application systems are used, sprinkler irrigation is still most feasible for Romanian conditions; short furrows can be applied on limited surfaces.

Individual actions for water resource saving in Hungary and Moldova

In Moldova, management and reuse of sewage from households in agricultural areas was stated to be priority. The utilization of drip irrigation systems using the ideal irrigation scheduling (irrigation timing, water inputs etc.) is expected to improve the overall situation.

All the above solutions should be implemented as suggestions to the farmers and the local authorities responsible. All the involved parts have to be aware about the economical and ecological benefits from the adoption of the implementation of the strategy and therefore be persuaded to adopt it.

Therefore seminars and schools need to take place in order to inform and train all the involved parts. In the framework of EU.WATER project, several Local Implementation Networks (LINs) were developed as an effort to inform the parts involved with the agricultural sector in each partner's areas. Additionally the local authorities should organize seminars to inform new farmers and agronomists and to follow the improvements and the new technologies.

Considerations on fertilization methods in order to reduce nitrates pollution

Gianluca Carraro
Sandro Bolognesi

Premises and methodological approach

The second thematic part of the EU.WATER Transnational Strategy for the Integrated Water Management in Agriculture addresses the identification of alternative fertilization methods in order to reduce nitrates pollution. This survey starts from the analysis of the traditional codes of agricultural practices implemented in every partners' areas and it considers many issues to identify some recommendations for a more sustainable and environmental friendly fertilization. Although these recommendations do not consist in radical changes in the local practices, they highlight feasible alternative fertilization methods that could be implemented with a relative affordable budget.

The Province of Ferrara – leader of this activity - has initially merged the geological and environmental informative part (in specific, the nitrate vulnerability benchmarking and the results gained from the Pilot Actions) with the local-based agronomic information and the codes of traditional agricultural practices, collected on site through interviews with the homeland agronomists. Then, in a second stage, Ferrara has developed a set of alternative fertilization methods devoted to prevent nitrates losses. Therefore, this analytic process consists of an integrated evaluative approach, structured on the most peculiar local characteristics and to be connected to the decision support system and the relative financial and normative packages. The expectation is the development of an integrated strategy to manage nitrogen fertilization in the application of the WFD and Nitrate Directive that fits not only the EU provisions but also the local agricultural practices, allowing the effective ownership of green-solutions by farmers.

Regarding the methodological approach, the present survey has been developed upon the following phases:

1. redefinition of the questionnaire for collecting data on the management of nitrogen fertilization of field crops in areas involved in the project and technical coordination of eight agronomists appointed by the partners for the eight concerned areas;
2. examination of data previously collected by the partners by means of questionnaires and analyses. The objective is to compare the codes of good practices available in each of the eight countries (and regions) involved in EU.WATER

against the EU commitments reported in specific Directives and Regulations;
3. sharing and discussion of previously collected information between partners' agronomists through e-mail and Skype to refine the analysis and define the aspects of nitrogen fertilization management.
4. "dedicated" site-visits in each partner's area in order to tackle specific aspects directly with the agronomists and stakeholders (technicians and farmers). This allows speeding up the composition of the knowledge framework (related to codes of agricultural practices) and having an overall view of the main agronomic characteristics in the eight selected areas. These areas are very much representative of the different environmental and social contexts of the South Europe space, as they range from alluvial highly intensive agriculture, continental and extensive agriculture, up to Mediterranean agriculture.
5. data processing of the information collected in the project areas, highlighting the peculiarities and common aspects, with the aim to define a shared evaluative approach and a common strategy to manage nitrogen fertilization in the application of the Directive and in combination with the results achieved during the nitrate benchmarking and the results obtained by the pilot actions;

1. The agronomic survey

The main issues investigated by the EU.WATER project is the rationalization of water use in agriculture and the reduction of nitrogen loads and other pollutants, in line with the Water Framework Directive (Dir 2000/60/EC) and the European Directive on Nitrates (Dir 91/676/EEC). This has made necessary an agronomic survey among the project partners.

The differences in terms of climate, with particular reference to rainfall, temperature, soil, livestock and its consequent management of effluents, determine differences in the cultivation techniques, such as processing, fertilization and irrigation. Agronomic aspects more directly related to the risk of water pollution by nitrates from agricultural sources are summarized as follows: **soil characteristics**, **land use** (rotation and cover crops), **soil processing**, **nitrogen fertilization** and **irrigation**.

These issues are examined by each partner on the base of specific questionnaires related to each target areas. Besides the aspects mentioned, there was a study on the application of codes of good agricultural practice and the impact of individual pilot projects (where they were made).

Finally, it was tried to outline a range of good agricultural practices and their applicability and transferability in the target area.

2. Common strategies to reduce water consumption and nitrate pollution

Starting from the prescriptions contained in some Codes of Good Agricultural Practice (mainly the Italian one) and the experiences coming from the Nitrate Project carried out in the Province of Ferrara since 2007, it can be said that there are some agronomic choices that have a direct impact on the degree of risk of water pollution by nitrates from agricultural sources. The most critical cultivation phases are: **crop rotations, tillage, nitrogen fertilization, cover crops, irrigation.**

2.1 – Crop rotations

The crop rotation in the partners' countries does not seem a critical factor in water pollution. The range of crops generally investigated and their seasonality seem to agree with this thesis. However, the crop rotation should be finalized to avoid mono-successions or succession of spring-summer crops that leave the soil devoid of vegetation cover during autumn and winter months when, due to the more abundant rains than in other periods of the year, it is reasonable to expect more intense phenomena of leaching of nitrogen present in the soil.

The possible landfill of residues of the previous crop is directly connected both to the type of crop rotation and the type of soil tillage. The landfill of cereal straw and other similar residues (i.e. stalks of maize, stems of rape, etc..) with low nitrogen content, as a result of degradation and humification processes occurring in these materials, determines a nitrogen removal from the soil solution. The nitrogen is then used by microorganisms that drive these processes and it is subtracted from any leaching processes.

2.2. Tillage

The application of plowing is common, but in many cases the minimum tillage is made: for instance in drought climate patterns, loose textures or in preparation of the soil for the sowing of autumn-winter cereals.

The use of specific equipment for minimum tillage has been noted in several countries. Generally, the tillage has to take into account the priorities in order to be properly pursued. In general, a not-processed soil or a soil subjected to minimum tillage is characterized by a slower mineralization of organic matter and preserves, if properly structured, an abundant microporosity that ensures a more dynamic equilibrium of the water contained in it. Both factors play a positive action towards the reduction of nitrate leaching from soil to groundwater. Moreover, without vegetation cover the no-tillage favors the phenomena of surface runoff, which increases with the slope of the soil. Therefore, it would be appropriate to limit the traditional land preparation processes (especially plowing) to those situations of real need such as landfill of solid manures, such as need to re-establish a proper structure in difficult terrain, such as burying plant residues which are potential sources of pathogens (for example the *Fusarium* of wheat). Where slope is more than 30%, the most recent Italian action plans allow a maximum distribution of 50 kg N /ha and, if applied, a maximum of 35 tons/ha of livestock manure. If the slope concerns superficial water bodies, transverse bands of crops have to be seeded or other measures to reduce run-off of fertilizers have to be taken. Finally, the protection of water bodies is completed by buffer zones of at least 20 m, with crops planted across the slope (in this context the sowing are allowed in no-processed soil) with vegetation cover during the winter (Art. 5 PA 1150 / 11).

2.3. Fertilizers and fertilization techniques

With regard to the role played by the type of fertilizer used, the pilot action of the Province of Ferrara has shown that more or less stabilized organic matrices limit the risk of nitrate pollution thanks to the following two features: (1) the nitrogen contained in the matrices is gradually released into the environment and it responds better than synthetic fertilizers to the nutritional requirements of crops and, consequently, to their capacity to absorb nitrogen present in the soil; (2) the excess of nitrate nitrogen is reduced or canceled in the presence of high amounts of organic matter (especially in conditions of low oxygen).

The pilot action of the Province of Rovigo also has demonstrated that through the subsurface distribution of cattle sewage on corn it is possible to obtain crop yields very similar to those obtained with the chemical fertilization. With the added advantage that the "source" of the same nitrate (the manure) is applied to the soil when the root systems, in active absorption, provide the best possible retention.

With regard to synthetic nitrogen fertilizers, should be noted that they are often used among Partners without strict relation to their readiness: nitrate is much more "ready" for root absorption than ammonium nitrate than urea; so it is important to underline that in fertilization plans must be considered both the intrinsic characteristics of the fertilizer both the moment of its distribution which is directly related to its potential leaching: the more the distribution is done ahead of time when the plant starts to absorb the nitrogen present in the soil, the greater the risk that this nitrogen can be transported to the level of groundwater.

In this context, the pre-plant fertilization (occurring before sowing) with nitrogen fertilizers should be limited as much as possible or should be avoided specially with nitrate-based fertilizers.

Finally, it highlights the need to evenly distribute the fertilizer, whether organic or chemical, on the whole cultivated area respecting the existing water bodies and keeping a proper distance from them. The only exception may be the localized fertilization between the rows which, then, will be carried out at lower doses than those generally applied to the entire surface. In all cases, it is required to draw appropriate fertilization plans that consider at least the following aspects:

needs N = crop needs - (natural supplies of N) + (fixed assets and losses of N)

2.4 – Irrigation

The role of irrigation is fundamental in determining the dynamics of nitrogen in the soil. The distribution of high volume of water can quickly determine the drag of nitrate from the upper layers to the aquifers, as a result of vertical movements, and to surface water, due to movements in the horizontal direction. The water distribution method is a top priority for a rational use and for achieving three objectives: to give water to plants based on their real needs, to maintain the water content of the soil under field capacity avoiding leaching and to preserve the overall water availability.

The achievement of these objectives may be in conflict with requirements of some agronomical techniques, such as for example, the defense of the grasslands from frost in some livestock districts, or pedological features, such as the efficacy and relative easiness of application of lateral infiltration for irrigation in sandy soils. Apart from the exceptions, wherever there was a possibility it would be desirable:

- the use of predictive methods (water balance) which, considering the crop phases, soil and climatic conditions, advise the farmer about the most appropriate timing and amounts of water; the implementation of an irrigation service, possibly via Web, would manage the water balance on the scientific basis by spreading the costs of a wide range of users;
- where the service already exists (Italy), it would be useful to promote the use of small farm weather stations to correctly detect climate data at farm scale and correctly plan the moments and the volumes of irrigation; possibly, the weather station should be supplemented with the use of piezometers with a manual / digital reading for monitoring the subsurface aquifer; the use of detectors of the nitrate content in the soil would complement the information to set and better manage irrigation taking into account the needs of crops and reducing the nitrogen washout to a minimum;
- use of irrigation facilities able to achieve the highest degree of efficiency in relation to the adopted method of distribution; moreover a good irrigation practice has to pursue a high distribution efficiency which is strictly related to irrigation methods; the parameters that have to be considered to choose the best irrigation method are: soil texture, soil chemical characteristics, slope, crop needs, water quantity and quality, environmental characteristics;
- abandonment of techniques and equipment to determine wastage of water resources or, if it is not possible, adoption of some important measures: for example flood irrigation should be allowed only in deep soils, mainly clay soils, for crops with deep roots that require frequent irrigations. Moreover, when furrow irrigation is adopted the farmer has to be aware that the risk of nitrate percolation decreases: from the beginning of the furrow to the end, from sandy soils to clay soils, from shallow soils to deep soils, from superficial root crops to deep root crops, in very clay soils. In addition, long irrigation rounds are not advised because they can facilitate the formation of cracks, an great losses of water and nutrients (becoming pollutants). In case of rain (sprinkler) irrigation, a very strict control has to be put on how to distribute sprinkler on the field, on rain intensity related to soil permeability, considering wind effect on sprinklers distribution diagram, to the effect of the crop on water soil distribution. In case of drip irrigation with fertilizers, the fertilizer injection has to be done not right at the beginning of the irrigation but only after having distributed at least 20-25% of the planned water amount; in the meantime it has to be considered that the fertilizer application must end when reaching the 80-90% of the planned water amount.

3 - Conclusions

Once having evidenced common characteristics among partners is not easy and therefore the search for common strategies has in itself the risk of defining very general techniques or procedures with limited or absent impact on the major aims of the project EU.WATER, which are water saving and restraining nitrate pollution from agricultural sources.

With this premise, the first conclusions of the work done are summarized based on three phases:

- Knowledge (technical and technology): regarding all processes and experiences developed within the project EU.WATER; they have identified critical points and provided possible solutions;
- Policies: once the most stringent problems and related solutions are identified, each partner can act at local/regional/national level on the existing policies to better adapt them to the EU.WATER results;
- Incentives: the technical solutions provided in the first point, supported by the policy makers by adequate legislative measures, must be supported by appropriate financial incentives of local/regional/national and, above all, European origin like the Rural Development Plan.

3.1 - Knowledge (technical and technology)

3.1.1 - Vulnerability maps

The vulnerability maps drawn up by all partners for their own Target Areas have allowed to divide the study territory in further and more significant gradients of vulnerability. The flat and sometimes insignificant limit of 170 kg/Ha of nitrogen applicable in Vulnerable Zones can be overcome permitting differentiated amount of application of nitrogen. Where maps show some areas with relative lower vulnerability, than some other areas, in the previous areas it will be asked to apply more than 170 kg/ha of nitrogen. On the opposite, in the areas of higher vulnerability, the limit of 170 kg/ha could be even decreased or just respected only if some techniques of leaching reduction (like sidedressing of sewage in corn) are put in place.

3.1.2. – Partners' Pilot actions

The pilot actions drawn up by EU.WATER partners are summarized as follows:

- **Ferrara**: the leaching of nitrates in soils fertilized with manure (especially chicken manure) is lower than the one occurring in the same soil without organic fertilization. So fertilization with manure, especially in light soils, is useful to decrease nitrate pollution;
- **Rovigo**: a prototype of coulter has been developed to localize cattle slurry between rows of corn (corn sidedressing), and agronomic trials were carried out showing that crop yields are quite comparable to chemical fertilization that brings the same amount of nitrogen;
- **Hungary**: the fertilization, in particular organic, is always preceded by appropriate fertilization plans, here simulated in a DSS (Decision Support System) created both for vulnerable and non-vulnerable areas;
- **Greece**: irrigation is led by a DSS that allows to save or at least has a greater efficiency of irrigation water also including considerations on leaching of nutrients towards the subsurface aquifer;
- **Romania**: usage of a multi-sectoral integrated DSS capturing end-users and stakeholder opinions for planning the appropriate measures at municipal level for protecting surface water and groundwater against pollution with nitrates from agricultural sources. The system will use pairwise comparison method in ranking the measures according with the local stakeholders opinions from each vulnerable zone in the area.

3.1.3 – Agronomic Considerations

Examining the results of the pilot actions and considering the different agricultural realities of project partners, it can be concluded that:

- the use of livestock manure properly matured and stored in appropriate containers is a resource that cannot and should not be dispersed, for several reasons:
  - it allows better capturing function of soil towards nitrates inducing minor leaching losses,
  - liquid cattle effluents (slurry), especially in corn sidedressing applications, show runoff and leaching almost close to zero, considering not only the absorption capacity of soil organic molecules but also plant uptake,
  - it permits a cost savings for the farmer;
- the use of chemical fertilizer must be made by considering not only the needs of the crop but also the intrinsic characteristics of the fertilizer, in particular the speed of his transformations in the soil, in order to limit the amount of nitrate therein contained and subjected to leaching;
- the techniques and means of distribution play an important role in enabling a uniform distribution of fertilizer (organic or chemical) that will be applied to the soil/crop with adequate separation bands from surface water bodies;
- the distribution must be restricted or prohibited on soils saturated with water, ice, snow, before significant rainfall events, in the absence of cover crops;
- in certain situations, see the European authorization to Italy to raise the amount of nitrogen from 170 to 250 kg per hectare, the removal of the residues of the main crop (corn) is recommended;
- the use of fertilizer plans is a prerequisite needed to best calibrate the inputs of fertilizers in relation both to the needs of the crops and the pedo-climatic characteristics of the area;
- given the significant variability in the manure and slurry depending on storage time, animal diet, temperature and rainfall, etc., chemical analysis of livestock effluent are required at least once per year before land application;

- a common partners' procedure is required both during the sampling of the effluent mass and in the chemical analysis in order to have comparable data;
- for the same concepts of efficiency and greater respect of the environment, the use of water balance is a prerequisite if it is not existing already; where an irrigation service already operates, it is essential to replace the large-scale weather data with the farm scale data using farm weather stations that can be furthermore integrated with piezometers to monitor the water table level, which is often a not investigated variable in water balances;
- the use of instruments that detect the content of nitrate in the soil and that, coupled to the abovementioned instruments, can provide an additional element of assessment of actual nitrate concentration in the preparation of the water balance;
- some more useful devices could be remote control of irrigation equipments including anemometers that can stop the machine in case of wind drift; finally the apparatus for *ferti-irrigation* could complete the best use of irrigating equipment keeping strong attention to nitrogen problems.

3.2 – Policies and related future actions

Once each Partner has focused on the major issues in the context of nitrate pollution from agriculture and irrigation management, with scientific data in its own possession and with operative proposals listed above, each partner can act on local/regional/national policy makers to propose the necessary adjustments that must be understood not as a rejection of existing rules, but as a specific further scientific implementation.

In this sense, it might be useful to allow each administrative area (province, for example) to be more flexible about the limit of 170 kg/Ha of nitrogen.

This will be possible according to the knowledge acquired in the preparatory phase of EUW project dealing with techniques and procedures.

3.3 – Incentives

Talking about incentives it is necessary to distinguish between Partner already members of the European Union and partner non-members yet. For the former it will be possible to allow the inclusion of a number of initiatives developed by EU.WATER (corn sidedressing of the effluent, water balance management, construction of farm weather stations with dedicated software) into the Rural Development Plans especially in the next implementation period (2014-2021). In the meantime, it is possible to test large-scale validity of EU.WATER postulates. For the other partners it would be possible to indicate the specific sources of funding already available by the European Union or indicate hypothesis regarding new ones. Following this approach it will be possible not only to increase the spreading of techniques and technologies more environmental friendly but also, with the controls that follow the European funding, to monitor the exact extent of their application.

Common set of recommendations supporting the eco-environmental benefits

Danut Maria
Animary Arghirescu

Nitrogen based fertilisers recommended application periods

The following paragraphs comprise recommendations on the fertilization periods and techniques employing nitrogen based fertilisers that are suitable to a wide range of crops:

Crops sown during autumn

Due to higher amounts of mineral nitrogen coming from mineralization of organic matter content, which are present in the soil during autumn months and also as a result of abundant precipitations occurring within the autumn-winter season, there will be an increased risk of water contamination with nitric nitrogen through leaching and surface run-off. When applying fertilisers to autumn sown crops, one should take into account such soil reserves i.e. applied quantities should amount to 1/4 of the annual nitrogen dose which has been set on the basis of previously mentioned principles. Nitrogen is recommended to be applied only under the form of ammonia or amide.

By observing such rules, one can make sure that crops consume residual amounts of nitrogen from the soil during the first stages of vegetative growth, thus contributing to the lowering of the nitrates loads that reach surface and underground waters. The remainder nitrogen amounts will be applied in the spring (minus the amount of mineral nitrogen). For heavy textured soils, the recommendation calls for fractioning application of the above mentioned dose.

Spring-summer crops

The basic fertilization is recommended to be made by using 1/4 up to 1/3 of the dose amount in order to prevent losses through leaching, especially during such periods as those with heavier than usual forecasted rainfall. The remainder quantity of fertilisers is to be applied during the period when crop plants have maximum consumption, simultaneously with normal crop husbandry.

Perennial crops

For the case of vine and orchard perennial crops no nitrogen based fertilization shall be made during the vegetative growth pause periods, as otherwise the risk of leaching with surface run-off might be significant as the majority of such plantations are located on sloped terrains. Fertilization is to be practiced during active vegetative growth periods, when nitrogen consumption is at its peak.

General rules that must be observed before committing to a chemical fertilization campaign:

- avoiding application of nitrogen based fertilisers during autumn months;
- spring application of nitrogen based fertilisers must be preceded by tests aimed at determining the soil nitrates reserve, with the purpose of being able to apply the strictly needed quantity of nitrogen needed to complete the requirement of the cultivated crop type.
- adopting maximum caution when the agricultural land is affected by surface run-off; the risk is at its maximum in the case of waterlogged or frozen terrains;
- adopting maximum safety precautions for the case of storing, handling and applying liquid chemical fertilisers; thus, the storage tanks must be manufactured of corrosion resistant materials and must have sufficient storage capacity; when distributing such fertilizing substances into the field one must employ special spraying devices, capable of avoiding wind triggered dispersion when working in the proximity of water bodies;
- fertilization application must be avoided on deeply tilled soils (scarified, deep ploughed, etc.), for the purpose of blocking the nitrates from reaching underground waters;
- on sloped land, for fruit trees and vines where soil erosion occurs frequently and the risk of nutrients leaching through surface run-off is significant, one needs to ensure correct application of fertilisers;
- only fertilisers which are in dry condition and having optimum specified granulation are to be used for fertilization purposes;
- no fertilisers will be applied when air humidity is high or during occurrence of such phenomena as fog, drizzle or rain.

Organic fertilisers

Manure is usually applied in the field during autumn months, when performing the main tillage work (ploughing which ensures turning of the furrow), under favourable meteorological conditions, with overcast skies and slow wind. As manure is being spread, the relevant land is being ploughed, thus ensuring adequate mixing and incorporation of the manure. Manure incorporation has to be performed deeper (up to 30 cm) on light textured soils (sandy soils) and within drought affected areas and less deep (up to 18-25 cm) on heavy textured soils, in cold and wet areas. In wetter areas organic fertilisers can also be applied during spring months.

Environment and agriculture

- Disposing of and storing of manure in the proximity of water bodies is strictly forbidden and is punishable by applicable law;
- Emptying or washing of fertilisers' storage tanks and spreading machinery into surface waters or in their vicinity is deemed as an environment polluting action and is also punishable by law;
- When committing to a fertilization campaign, one should carefully study the weather conditions and the soil's condition; therefore, one has to avoid application of fertilisers during windy or very sunny days, during rainfall, snowing or on frozen and snow covered terrains;
- One has to enforce such measures that can ensure avoidance of intentional or accidental spilling of liquid fertilisers (from tankers or storage tanks) in the proximity of water bodies or directly into these.

Additional to the above, fertilisers' application is not recommended in the circumstances listed below:

- on deep frozen soils;
- on soils which have in-depth cracks (fissures) or which have been excavated for tile drains installation or for the storage of backfill spoils;
- on terrain which during the past 12 months has underwent drainage or subsoiling works;.
- when applying fertilisers in the field, one must maintain buffer strips towards neighbouring watercourses, of minimum 5 - 6 m width;
- for the case of fertilization that employs the use of liquid animal wastes, the width of the buffer strip must be of at least 30 m in the case of watercourses and of 100 m in the case of drinking water wells;
- on periodically waterlogged or flooded terrains, the moment for fertilisers' application has to be carefully selected in terms of finding the optimum soil moisture content, in order to avoid leaching of nitric nitrogen as well as denitrification losses under the form of nitrogen or nitrogen oxides;
- whenever possible, nitrogen based fertilisers must not be applied on sloped land, on frozen or snow covered terrains, as in these cases the risk of nitrates being leached once the weather warms is significant;
- special precautions need to be enforced when applying fertilisers on land situated in the proximity of water bodies, lakes, ponds, drinking water wells, as these are exposed to the risk of being polluted with nitrates (and in certain instances also with phosphates) which are conveyed by drainage effluents and surface run-off water.

Fertilization plans and records attesting the use of fertilisers within agricultural exploitations

A fertilization plan is a must for each agricultural exploitation that encompasses more than 10 hectares; such plan has to consider as first priority all organic products and by-products available at the relevant farm level and which have fertilising potential (such as manure, animal waste slurry, swine sludge, vegetable by-products, etc.) and as second choice, with a completion role, chemical, organic or organic-mineral fertilisers.

Each agricultural producer must comprehend the need for a correct evaluation and periodical monitoring of the crop plants' nutrient requirement based on realistic forecasting and on data on local conditions, soils, climate, projected yield levels; in this way, one can effectively avoid over-fertilization and nutrient pollution.

Special attention has to be paid to fertilization which employs nitrogen-based fertilisers, as these manifest complex behaviour in the soil and can easily be lost under the form of nitrates through infiltration water and surface run-off.

Formal records that have to be kept for each farm that has more than 8 AU (animal unit equivalent) livestock must include the following information:

a) farm total area;
b) for each land plot/parcel inside the farm:
- type and quantity of any chemical fertilizer distributed in the field, the amount of nitrogen contained and dates of application;
- type and quantity of any organic fertiliser distributed in the field (other than the faeces produced directly by livestock) and dates of application (these may contain toxic compounds, such as heavy metals which can accumulate within the soil);
- for each type of applied organic fertiliser (other than the faeces produced directly by livestock) records have to specify their nature (manure, urine, fermented manure, liquid animal wastes, semi-fluid with paste-like consistency livestock wastes, fermented organic fertilisers, sewerage sludge) and the type of animals which generated such fertilising substances;
- type of any agricultural crop, date of its sowing and date of harvesting;

c) farm level livestock numbers, broke down on breeds and yielding categories, as well as the duration for which different animals are being kept inside the farm;
d) amount of any type of fertiliser of animal origin and its type (manure, urine, fermented manure, liquid animal wastes, semi-fluid with paste-like consistency livestock wastes, fermented organic fertilisers, sewerage/water treatment sludge) exported from the relevant farm, date of forwarding and name and address of the recipient.

The overall amount of mineral and organic fertilisers that is applied per unit of surface must not exceed **170 - 210 kg N/ha/year**. This limit value also includes the amount of nitrogen from the liquid animal faeces that ends up directly onto the soil during grazing. Especially for those agricultural exploitations situated within nitrate vulnerable zones, any exceeding of the aforementioned values is forbidden.

Keeping a log with the history of fertilization applications

Aside of the fertilization plan, every agricultural exploitation must keep a log detailing the history of fertilization applications, corresponding to each individual parcel or plot; this log should contain yearly entries referring to:

- Cultivated crops,
- Types and doses of applied fertilisers,
- Fertilisers' nutrient concentrations,
- Application periods,
- Achieved yields.

Such information are particularly useful for the constant updating of the fertilization plan as well as for a sound management of the relevant farm/exploitation.

Other practices aimed at reducing the loads of nitrate pollutants coming from agricultural activities that reach surface waters

In designing storage facilities for organic fertilizers, one should always keep in mind:

- Location should enable construction of a flat, horizontal platform or of a very slightly inclined one;
- Capacity of any storage facility designed for organic animal wastes has to ensure accommodation of an amount of such fertilizers, corresponding to an extra month of consumption;
- The storage facility has to be an adequate structure, complying with every applicable safety and protection standard;
- Location of such a storage platform has to be surrounded by tree/hedgerow windbreaks, to act as buffers for the environment protection;
- Safe operation of such facilities assumes: easy access to, convenient distance to the livestock stables/sheds and to the household, available handling tools, etc., all for an efficient transport and handling of manure/liquid animal wastes;
- Adequate service roads;
- Available fire fighting facilities;
- Protection against possible leaks from irrigation hydrants.

The storage capacity of such facilities depends upon:

- Type and number of the existing livestock, also taking into account the relevant farm management system and its quality;
- Duration of the storage period;
- Type of storage;
- Method for handling and storing of the liquid animal waste;
- Dilution degree of liquid wastes, due to rainfall water or to any other contaminating waters.

One recommends a storage period of up to 6 months (23 - 24 weeks), as any longer storing of animal wastes *is not* beneficial to areas with/without drainage infrastructure, to sloped surfaces, to wet areas with abundant rainfall and also to areas situated in the vicinity of watercourses.

Storage of animal wastes inside pits (basins), directly dug into the ground is totally forbidden.

Any proper animal wastes storage basin has to have a completely lined bottom, by using a special plastic sheet, manufactured to specifications.

Storage of liquid wastes must be performed in watertight tanks, built of adequate material, totally resistant to leaks and to corrosion.

Location of such storage facilities must not be in the proximity of surface waters, neither on land where the water table is close to the ground surface.

Their location will be selected depending on the neighboring hydrographic network and on the presence of nearby forests/wooded areas.

Such storage spaces/facilities must be situated relatively close to the relevant agricultural land surfaces.

CONCLUSIONS

Marco Meggiolaro

The European Council of 20th June 2008 pointed to the "*need to pursue innovation, research and development of agricultural production, notably to enhance its energy efficiency, productivity growth and ability to adapt to climate change*".

Similar conclusions have been addressed by the European Commission in the recent initiative launched at the beginning of 2012 "European Innovation Partnership - Agricultural Productivity and Sustainability" that underlines the role of research and innovation as key elements in preparing the European Union for future challenges and, with particular reference to the agricultural sector, expresses the need to bridging the gap between farming practice and science through smart networking.

Coherently, the orientations for "the CAP towards 2020" highlight innovation as being indispensable to preparing EU agriculture for the future. Increased and sustainable agricultural output will be achievable only with major research and innovation efforts at all levels. At the same time, increased productivity and competitiveness of agriculture calls, first of all, for improved resource efficiency in order to produce with less water, energy, nitrogen fertilisers and pesticides.

In this sense, a distinctive, sustainable rural development must be outstanding for a multi-systemic and multi-functional approach to identify new agricultural paradigm between the necessity to increase crop yields and the need to protect the environment. This is becoming a crucial factor in the political agendas of the administrations located in the EU rural areas.

In the EU-Project perspective this is not to limit fertilizer use, *per se*, but to define site specific guidelines to minimize the risk of leakage of nitrogen and its effects on water resources. EU.WATER, after having investigated the challenges related to nitrate pollution and optimization of irrigation in eight high representative rural communities of the South East Europe area, has proposed hypotheses of improvement shared among Partners and adapted regionally The transnational strategy presented in this publication, together with the implementation of five pilot actions - characterized by a strong scientific and agronomic background - give a common set of recommendations and a potential roadmap for a water-friendly agriculture in this part of Europe and to strengthen the regional policymaking process in line with the EU provisions.

To do this, EU.WATER has covered multiple stages: from research to dissemination of the results across the local farmers associations and various stakeholders to the development of products and techniques and their integration in the rural production process. A meaningful example of knowledge-transfer, performed during EU-WATER,is given by the definition of a scientific methodology to assess the vulnerability to water and nitrogen losses (Aschonitis et all., 2011) and the education and training process which has allowed its application in each partner's area. Moreover, the censuses made regarding the use of water and fertilization practices have provided a general framework and highlighted a series of joint measures on the importance of the adoption of a water balance for water saving and several actions to improve fertilization, both with manure and synthetic fertilizers. The pilot actions have further contributed to provide useful elements for a more accurate understanding of the real vulnerability to nitrates and for a detailed definition of related mitigation measures that can be taken in each partner's area.

Thus, the results achieved by EU.WATER have inspired a successful bridging between research, new technologies, bottom-up dialogue among farmers and their corporations, administrations, advisory services and academics. This kind of approach should help translating research results into innovation, quicker mainstreaming of innovation into practice, giving a systematic feedback from practice to science concerning research needs, enhancing knowledge exchange at all levels, and finally raising awareness on the need for joint efforts to invest in sustainable innovation in agriculture.

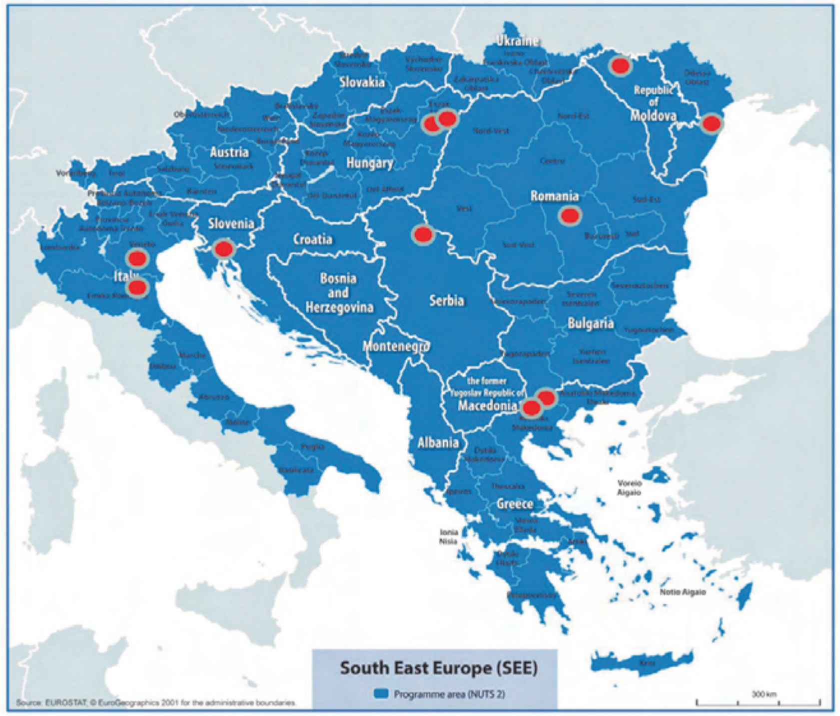
About the upcoming implementation, local policies must necessarily be tailored to the typical characteristics of each partner's area and, in order to pursue this objective, the most promising strategy recognized by EU.WATER is to implement the EU policies and legal provisions through scientific and technical experimentations *on site*.

Furthermore, the inclusion of a series of initiatives already developed during EU.WATER in the forthcoming plans for rural development, especially in the next implementation period of 2014-2021, has been recognized by the partnership as a crucial step to contribute to higher effectiveness of policy instruments to increase agricultural outputs while ensuring the efficient and sustainable use of the natural resources.

EU.WATER has encouraged partners at different institutional and geographical levels and in different sectors to collaborate and take advantage of the potential of cooperation. This is the roadmap for the future: achieve synergies through enhancing exchange schemes among partners from different policy fields, sectors, initiatives and projects, thus contributing to shape or improve the existing policy instruments address rural growth and agricultural competitiveness in the South East Europe, and complementing them with new actions. As stresses by the "European Innovation Partnership - Agricultural Productivity and Sustainability", at transnational and cross-border level, dynamic platforms linking farmers, public and private stakeholders and researchers, as well as cluster initiatives, pilot and demonstration projects could be fuelled by making use of the opportunities provided by different policy fields, in particular the Common Agricultural Policy, Union Research and Innovation Policy, Cohesion Policy, Environmental and Climate Change Policy etc..

In this frame, EU.WATER represents a common macro-regional answer to increase agricultural output based on water-wise approach and scientific-oriented patterns rooted on traditional agricultural practices. Additionally, it represents a starting point to govern the transformations in the rural sectors, by providing advices and guidance to reconcile crops production with environmental preservations, paving the way towards a broader South East Europe partnership for agricultural innovation.

EU.WATER partners at the project meeting in Odessa, Ukraine, 2011



Provincia di Ferrara, Italy • Province of Rovigo, Italy • Trans-Tisza Region Environmental, Nature Protection and Water Inspectorate, Hungary • University of Debrecen Centre for Environmental Management and Policy, Hungary • Region of Western Macedonia, Greece • Aristotle University of Thessaloniki, Greece • National Institute of Research-Development for Land Reclamation I.N.C.D.I.F. - Ispif, Romania • Agency for rural development of Istria Ltd. Pazin, Croatia • Institute of Agricultural Economics, Serbia • Odessa National Polytechnic University, Ukraine • Ialoveni Rayon Council, Moldova

Jointly for our common future