22 Precision Agriculture

A Potential Tool to Tackle Drought and Water Scarcity in the EU

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Several EU (European Union) Member States, such as Portugal, Spain, Belgium,[1] Cyprus[2] and Poland,[3] have informed the Agriculture and Fisheries (AGRIFISH) Council about the drought they had experiencing lately. In the summer of 2017, Portugal, Spain and Belgium outlined their drought situation and its impact on their agriculture, especially on the cereal and livestock sectors. As a response, some delegations declared that "they were also experiencing severe heat waves with consequent droughts affecting agriculture."[4] Then, roughly a year later, the Cyprus delegation "urged the Commission to propose within the new CAP framework, solutions and means of supporting efforts to combat water shortages and drought conditions."[5] Not surprisingly, in addition to informing the AGRIFISH Council about the drought situation, all of the said countries, most recently Poland, took the opportunity to seek solidarity to support their farmers and several delegations expressed sympathy for their requests.[6] Consequently, in August 2018, Commissioner Phil Hogan announced that the European Commission shall offer further sup-

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1 Outcome of the Council Meeting, 3556th Council meeting, Agriculture and Fisheries, Brussels, 17 and 18 July 2017, p. 10.

2 Outcome of the Council Meeting, 3624th Council meeting, Agriculture and Fisheries, Luxembourg, 18 June 2018, 10200/18 (OR. en) Provisional Version Presse Pr Co, p. 11.

3 Outcome of the Council Meeting, 3632nd Council meeting, Agriculture and Fisheries, Brussels, 16 July 2018, p. 7.

4 Outcome of the Council Meeting, 3556th Council meeting, Agriculture and Fisheries, Brussels, 17 and 18 July 2017, p. 10.

5 Outcome of the Council Meeting, 3624th Council meeting, Agriculture and Fisheries, Luxembourg, 18 June 2018, 10200/18 (OR. en) Provisional Version Presse Pr Co, p. 11.

6 Outcome of the Council Meeting, 3556th Council meeting, Agriculture and Fisheries, Brussels, 17 and 18 July 2017, p. 10; Outcome of the Council Meeting, 3624th Council meeting, Agriculture and Fisheries, Luxembourg, 18 June 2018, 10200/18 (OR. en) Provisional Version Presse Pr Co, p. 11; Outcome of the Council Meeting, 3632nd Council meeting, Agriculture and Fisheries, Brussels, 16 July 2018, p. 7.

port to farmers affected by droughts. This support was in addition to those covered by the existing Common Agricultural Policy (CAP), more specifically, two specific decisions were adopted, namely higher advanced payments and derogations from specific greening requirements.[7] However, this necessarily comes at a very high cost, not to mention the damage to the environment. To this end, we wish to scrutinize EU law and policy concerning water quantity, more specifically drought and water scarcity to ascertaint to what extent they address this situation and what kind of solutions are offered. Special emphasis shall be put on the opportunities provided by precision agriculture as a potential new tool to respond to the current negative trends. Following the introduction, the first part of the paper will focus on water as a natural resource, followed by the analysis of the relationship between water and agriculture. Then, precision agriculture will be introduced. The second part examines EU legal and policy documents concerning drought and water scarcity, namely the Water Framework Directive, the Communication on *Addressing the challenge of water scarcity and droughts in the European Union,* the Blueprint, and the Proposal for a Regulation on minimum requirements for water reuse. Finally, some conclusions will be drawn.

22.1 Water as a Natural Resource

The total amount of water on Earth is constant (about 1.4 billion km3[8]); therefore, it is merely the physical state of the water that is changing continuously between the three phases, namely ice, liquid and water vapour.[9] Although the Earth is called the 'Water Planet' as more than 70% of its surface is covered with water, which practically means that water is by far the most common liquid on the Earth's surface,[10] 97% of this water can be found in the ocean, so the vast majority of water on Earth is unfit for human consumption or other uses due to its high salt content. In addition, two thirds of the

7 "Higher advanced payments: farmers will be able to receive up to 70% of their direct payment and 85% of payments under rural development already as of mid-October 2018 instead of waiting until December to improve their cash flow situation." "Derogations from specific greening requirements, namely crop diversification and ecological focus area rules on land lying fallow, to allow such land to be used for the production of animal feed. Consideration is also being given to the adoption of further derogations to greening to allow farmers more flexibility to produce fodder. These measures will be of particular benefit to livestock farmers." https://ec.europa.eu/info/news/commission-offers-further-support-european-farmers-dealing-droughts-2018-aug-02-0_en; http://europa.eu/rapid/press-release_IP-18-4801_en.htm.

8 http://www.unwater.org/statistics/statistics-detail/en/c/211801/.

9 J. Boberg, *Liquid assets: How Demographic Changes and Water Management Policies Affect Freshwater Resources,* RAND Corporation, Santa Monica, CA, 2005, pp. 15-17.

10 Boberg, 2005, pp. 15-17; P.L. Brezonik & W.A. Arnold, *Water Chemistry: An Introduction to the Chemistry of Natural and Engineered Aquatic Systems*, Oxford University Press, Oxford, 2011, p. 10.

remaining freshwaters are locked up in glaciers and the permanent snow cover, so no more than 0.7% is available as freshwater[11] (0.66% of which is groundwater[12] and just 0.03% is available as surface water[13] in rivers, lakes and streams).[14]

The Earth's freshwaters constitute 276 international river basins shared by 145 countries covering approximately half of the Earth's land surface and 40% of the global population.[15] By international standards, European river catchments are relatively small with short rivers apart from those rivers which arise from deep inside the continent such as Danube.[16] Nonetheless, there are a number of international river districts in the EU encompassing the rivers Danube, Rhine, Elbe, Ems, Meuse, Scheldt/l'Escaut, Odra, Sava as well as the Finnish-Norwegian International River Basin District.[17] Interestingly, the Danube River Basin occupies 10% of Continental Europe, and extends into the territories of 19 countries.[18] In case of these transboundary waters it is particularly obvious that since waters on Earth are linked,[19] any significant change regarding either water quality or water quantity in the upstream country necessarily affects the downstream country.

Besides limited availability and interconnectedness, another feature of freshwater is that it is unevenly distributed across the globe,[20] and Europe is no exception. While some countries have abundance of water such as Sweden, France and Germany, others, particularly in parts of Southern Europe, are facing problems.[21] Based on the press release of the European Commission in May 2018, "a third of the EU's land suffers from water

11 Art. 2(b) of the Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources states that 'freshwater' means "naturally occurring water having a low concentration of salts, which is often acceptable as suitable for abstraction and treatment to produce drinking water."

12 Art. 2(2) of the Directive 2000/60/EC states that 'groundwater' means "all water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil."

13 Art. 2(1) of the Directive 2000/60/EC defines 'surface water' as "inland waters, except groundwater; transitional waters and coastal waters, except in respect of chemical status for which it shall also include territorial waters." In addition, Art. 2(3) of Directive 2000/60/EC states that 'inland water' means "all standing or flowing water on the surface of the land, and all groundwater on the landward side of the baseline from which the breadth of territorial waters is measured."

14 A. K. De & A. K. De, *Environmental Engineering*, New Age International Ltd, New Delhi, 2009, pp. 66-67. Interestingly, *see further*: E. Brown Weiss, *International Law for a Water-Scarce World*, Martinus Nijhoff Publishers, Leiden, Boston, 2013.

15 A. Rieu-Clarke & F. Rocha Loures, 'Introduction', *in*: F. Rocha Loures & A. Rieu-Clarke (eds.), *The UN Watercourses in Force: Strengthening international law for transboundary water management*, Routledge, New York, 2013, p. 5. See: W.C. Walton, *The World of Wate*r, Weidenfeld and Nicolson, London, 1970, pp. 212-213. *See from*: A/CN.4/332 and Corr.1 and Add.1, Second report on the law of the non-navigational uses of international watercourses, by Mr. Stephen M. Schwebel, Special Rapporteur, *Extract from the Yearbook of the International Law Commission*, 1980, Vol. II(1), para. 57.

16 https://www.eea.europa.eu/themes/water/european-waters/rivers/major-european-river-catchments.

17 ec.europa.eu/environment/water/participation/map_mc/map.htm.

18 www.icpdr.org/main/danube-basin.

19 A.C. Kiss & D. Shelton, *International Environmental Law*, 3rd edition, Ardsley: Transnational Publishers, New York, 2004, p. 455.

20 Rieu-Clarke & Rocha Loures 2013, p. 3.

21 https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Water_statistics#Water_as_a_resource.

stress all year round and water scarcity remains an important concern for many EU Member States. Increasingly unpredictable weather patterns, including severe droughts, are also likely to have negative consequences on both the quantity and quality of freshwater resources."[22] In addition to those concerns presented by some Member States at the AGRIFISH Council meetings, this worrying trend obviously proves how vital it is to deal with the issues surrounding drought and water scarcity in the EU.

22.2 The Relationship between Water and Agriculture

Water "is permanently renewed but it is also finite and cannot be made or replaced with other resources."[23] Despite its limited availability, the demand for freshwater is continuously increasing. As a result, beyond genuine water scarcity, which is attributable to the climate or drought, human induced factors are also responsible for the growing demand for freshwater[24] that often results in overexploitation[25] due to, among others, population growth and economic development.[26] If we narrow down the said tendencies to the relationship between agriculture and water globally, we can conclude that, on average, agriculture accounts for 70% of all water withdrawals.[27]

When it comes to the EU's approach to water, as expressed by Vice-President Katainen, Commissioner Hogan and Commissioner Vella in a joint statement of 2017, "Water is the source of life. It is essential for human health, to the natural environment and a precious resource for many sectors of the economy, where output and jobs in areas such as agriculture […] are often strongly water-dependent."[28]

Indeed, a strong interdependency between agriculture and water in Europe is also evident as, on average, agriculture accounts for 44% of total water use. Not to mention, that this proportion can be as high as 80% in some regions.[29] In terms of sustainable water use, these numbers are interpreted by the Eurostat as follows:

> "The overall use of water resources can be considered sustainable in the long-term in most of Europe. However, specific regions may face problems asso-

22 europa.eu/rapid/press-release_IP-18-3929_en.htm.

23 Communication from the Commission to the European Parliament, the Council, The European Economic and Social Committee and the Committee of the Regions, A Blueprint to Safeguard Europe's Water Resources. COM/2012/0673 final, p. 2.

24 J.C. Padowski & J.W. Jawitz, 'The Future of Global Water Scarcity: Policy and Management Challenges and Opportunities', *Whitehead Journal of Diplomacy and International Relations*, Vol. 10, No. 2, 2009, p. 100.

25 G. Kardos, 'A vízhez való jog', *Acta Humana*, Vol. 15, No. 1, 2004, p. 95; Rieu-Clarke & Rocha Loures 2013, p. 3.

26 www.eea.europa.eu/articles/water-in-the-city.

27 www.worldbank.org/en/topic/water-in-agriculture.

28 Joint statement by Vice-President Katainen, Commissioner Hogan and Commissioner Vella on World Water Day, Brussels, 21 March 2017, europa.eu/rapid/press-release_STATEMENT-17-688_en.htm.

29 https://ec.europa.eu/info/news/future-cap-sustainability-water-source_en.

> ciated with water scarcity; this is the case particularly in parts of southern Europe, where it is likely that efficiency gains in agricultural water use (as well as other uses) will need to be achieved in order to prevent seasonal water shortages. Regions associated with low rainfall, high population density, or intensive agricultural or industrial activity may also face sustainability issues in the coming years, which could be exacerbated by climate change impacts on water availability and water management practices."[30]

Given that we have referred both to the significance of water and to the high proportion of water use in agricultural production through irrigation, it is high time to clarify the link between the two. In other words, we have to justify why so much water is used for irrigation. When approaching this issue globally, we can say that "irrigated agriculture represents 20% of the total cultivated land, but contributes 40% of the total food produced worldwide."[31] Furthermore,

> "Given that irrigated agriculture is, on average, at least twice as productive per unit of land, provides an important buffer against increasing climate variability, and allows for more secure crop diversification, it is certain that irrigation will continue to play a key role in ensuring global food and nutrition security."[32]

These

> "projections for both water and food security appear, at first look, to be contradictory. On one hand, there is a need to use less water in agriculture, but on the other hand, more intensive use of water in agriculture is a key element of sustainable intensification of food production. Resolving this apparent quandary requires a thorough reconsideration of how water is managed in the agricultural sector."[33]

Furthermore, interestingly, if we take a look at the production of fruits and vegetables within agri-food production, it is conspicuous that although these are an 'excellent source of water', growing them also requires 'significant quantities of water'.[34] Nonetheless, the increasing demand for food does not make it possible to reduce food production and, consequently, water consumption. However, it cannot be overemphasised that "Reducing the unsustainable amounts of food waste has the potential to significantly reduce the

30 https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Water_statistics#Water_as_a_resource.
31 www.worldbank.org/en/topic/water-in-agriculture.
32 Id.
33 Id.
34 https://ec.europa.eu/info/news/future-cap-sustainability-water-source_en.

amount of water waste, given the dependence of food production on water."[35] In the EU, the numbers speak for themselves. *Around 88 million tonnes of food waste are generated annually. This data is worrying not only because of* ethical and economic considerations (based on the estimations its associated costs are around EUR 143 billion), but also due to its contribution to the depletion of water as well as other natural resources.[36]

Consequently, as the necessity of irrigation to satisfy the growing demand for food cannot be questioned due to the difference in productivity, the issue is how to irrigate in a sustainable manner.

22.3 Precision Agriculture

Precision agriculture (also referred to as precision farming, smart farming, site-specific crop management or satellite farming)[37] is considered to be a potential tool that can contribute to the sustainable management of water resources, used especially for irrigation purposes. It is also often referred to by Commissioner Hogan in his most recent speeches.[38] Nonetheless, as will be demonstrated below, the sustainable use of water resources is only one of the benefits of precision agriculture. After mentioning Commissioner Hogan, it would be appropriate to continue this piece by detailing the activity of the European Commission's Directorate-General Agriculture and Rural Development (DG AGRI). However, the term precision agriculture must be defined first. Interestingly, the only attempt to define precision agriculture was made by the European Parliament and not the European Commission as one would imagine. This is why I shall now continue with the European Parliament and its relevant work.

35 europa.eu/rapid/press-release_STATEMENT-17-688_en.htm.

36 https://ec.europa.eu/food/safety/food_waste_en; See also: Stenmarck et al., *FUSIONS: Reducing food waste through social innovation*, Stockholm, 2016.

37 M. Kritikos, *Precision agriculture in Europe: Legal, social and ethical considerations*, European Parliamentary Research Service, Brussels, 2017, p. 2. PE603.207.

38 Speech by Commissioner Phil Hogan at Opening of Wageningen University Academic Year, on 3 September 2018. https://ec.europa.eu/commission/commissioners/2014-2019/hogan/announcements/speech-commissioner-phil-hogan-opening-wageningen-university-academic-year_en; Speech by Commissioner Phil Hogan at ENRD Seminar on Smart Villages, on 22 May 2018. https://ec.europa.eu/commission/commissioners/2014-2019/hogan/announcements/speech-commissioner-phil-hogan-enrd-seminar-smart-villages_en; Speech by Commissioner Phil Hogan at German Catholic Days, Muenster, Germany, on 15 May 2018. https://ec.europa.eu/commission/commissioners/2014-2019/hogan/announcements/speech-commissioner-phil-hogan-german-catholic-days-muenster-germany_en; Speech by Commissioner Hogan at AgriResearch Conference – Innovating for the future of farming and rural communities, Brussels, on 2 May2018. https://ec.europa.eu/commission/commissioners/2014-2019/hogan/announcements/speech-commissioner-hogan-agriresearch-conference-innovating-future-farming-and-rural-communities_en; Remarks by Commissioner Hogan at launch of an EU Code of Conduct on Agricultural Data, Brussels, on 23 April 2018. https://ec.europa.eu/commission/commissioners/2014-2019/hogan/announcements/remarks-commissioner-hogan-launch-eu-code-conduct-agricultural-data-brussels_en; The role of water in sustainable agriculture, on 24 February 2017. https://ec.europa.eu/commission/commissioners/2014-2019/hogan/blog/role-water-sustainable-agriculture_en.

The European Parliament,[39] more specifically the European Parliamentary Research Service has dealt with precision agriculture in depth.[40] As a result, two studies were "prepared for, and addressed to, the Members and staff of the European Parliament as background material to assist them in their parliamentary work"[41] and published in 2016 and 2017.

The first one, namely *Precision agriculture and the future of farming in Europe: Scientific Foresight Study* published in December 2016, states that

> "Precision agriculture (PA), or precision farming, is a modern farming management concept using digital techniques to monitor and optimise agricultural production processes. For example, rather than applying the same amount of fertilisers over an entire agricultural field, or feeding a large animal population with equal amounts of feed, PA will measure variations in conditions within a field and adapt its fertilising or harvesting strategy accordingly. Likewise, it will assess the needs and conditions of individual animals in larger populations and optimise feeding on a per-animal basis." […] PA methods promise to increase the quantity and quality of agricultural output while using less input (water, energy, fertilisers, pesticides…). The aim is to save costs, reduce environmental impact and produce more and better food. The methods of PA rely mainly upon a combination of new sensor technologies, satellite navigation and positioning technology, and the Internet of Things. It has been making its way into farms across Europe and is increasingly assisting farmers in their work."[42]

Turning our attention to the other study that was published under the title *Precision agriculture in Europe: Legal, social and ethical considerations* in October 2017, it stipulates that

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39 *See also*: Bled Declaration delivered by two MEPs to Commissioner Hogan, Commissioner Bulc and Commissioner Gabriel in relation to the digitalisation of rural areas. The declaration highlights the significance of precision farming by emphasising its "potential to increase productivity while significantly reducing environmental impact and food safety risks." https://ec.europa.eu/info/news/european-commission-supports-call-smarter-future-rural-areas-2018-apr-13_en.

40 See also other documents that were requested by the the European Parliament's Committee on Agriculture and Rural Development: Joint Research Centre (JRC) of the European Commission; Monitoring Agriculture ResourceS (MARS) Unit H04; P. J. Zarco-Tejada, N. Hubbard and P. Loudjani, *Precision agriculture – An opportunity for EU farmers – Potential support with the CAP 2014-2020*, Brussels, 2014. IP/B/AGRI/IC/2013_153, PE 529.049. and Council of Agricultural Research and Economics – Centro Politiche e bioeconomia (CREAPB): A. Zezza et al., Wageningen Economic Research, The Netherlands: B. Smit, R. van der Meer and K., Poppe Leibniz-Zentrum für Agrarlandschaftsforschung (ZALF): M. Lana, M. Weltin and A. Piorr, Research for AGRI Committee Policy support for productivity vs. sustainability in EU agriculture: Towards viable farming and green growth: Study, Brussels, 2017. IP/B/AGRI/IC/2016-56, PE 585.905.

41 Kritikos 2017, p. 2.

42 R. Schrijver, *Precision agriculture and the future of farming in Europe: Scientific Foresight Study*, European Parliamentary Research Service, Brussels, 2016, p. 4. IP/G/STOA/FWC/2013-1/Lot 7/SC5.

> "Precision agriculture (PA) (also referred to as precision farming, smart farming, site-specific crop management or satellite farming) is a data-based management approach that is characterised by the collection and use of field-specific data. This can then be used to adjust the application of inputs to specific characteristics of small units of cropland and grassland to optimise fuel and input use (and to reduce losses that would otherwise cause pollution)."[43]

In addition, it further explained that

> "The main concept of precision agriculture is enabling optimisation, meaning helping precise application of inputs, such as fertilisers, pesticides and irrigation water, which can result in a positive environmental impact (e.g. by reducing losses that would otherwise be lost to the water or air)."[44]

The above are much rather descriptions or explanations of precision agriculture than definitions. However, these approaches should not be underestimated. Thanks to them we have a clear understanding what the term precision agriculture means, even if the meaning of this term has not yet been fully fleshed out by the EU.

After familiarizing ourselves with the term precision agriculture, we should now turn our attention to the farmers' decision-making process to better understand the role and significance of precision agriculture. When making decisions in relation to farm management, farmers have to take into considerations different dimensions of their decisions. Firstly, they decide about the strategic dimension about the future thrust of the farm including but not limited to the crops the farmer wishes to plant, the crop rotation they wish to follow. In addition, the type of farm management also forms part of the decision encompassing the choice between organic, ecological or traditional farming. These strategic decisions reflect the sustainability of the farm as well. Secondly, the tactical decision has to be made about opting for the preferred crop varieties or the level of chemical fertilization. Thirdly, there are optional decisions including the time, the frequency and the quantity of fertilization, or the application of biocides.[45] Precision agriculture is considered to be linked to all three dimensions; however, it plays the most dominant role in operational decisions including the time and intensity of the irrigation of crops.[46]

Finally, without aiming to give an exclusive list, some references to precision agriculture will be mentioned from DG AGRI to reflect their ongoing activities. Firstly, the Agri

43 Kritikos 2017, p. 4.

44 Id.

45 J. Bouma, 'Precision Agriculture: introduction to the spatial and temporal variability of environmental quality', in: J.V. Lake, G.R. Bock and J.A. Goode (eds.), *Precision Agriculture: Spatial and Temporal Variability of Environmental Quality*, John Wiley & Sons Ltd., Chichester, 1997, p. 5.

46 Id., p. 6.

Innovation Summit 2017 in Portugal on 11-12 October must be mentioned, for among others, precision farming was at the centre of attention due to its ability to promote sustainable farming.[47] Secondly, the *European Union funds digital research and innovation for agriculture to tackle societal challenges* was published in the news section DG AGRI on 17 November 2017. It states that

> "Precision farming in particular has become the focus of much of the innovation in sustainable farming, technology's response to the need to produce more with less and in a sustainable manner. In simple terms, precision farming means using technologies such as satellite positioning systems to improve production – for example through monitoring crops and providing data on how best to treat them to increase yields. Monitoring and analysing agricultural data thanks to sensor systems can also improve irrigation management for high water-consumer crops, thus promoting sustainable farming."[48]

Most recently, the *Future of CAP: Sustainability at the water source* on 22 March 2018, briefly mentioned precision agriculture concerning innovation, since it can make water consumption more efficient and this way, more sustainable. This can be achieved through funds including Horizon 2020.[49] In addition, Commissioner Hogan referred to precision agriculture in his recent speeches several times as well as the Communication on *The Future of Food and Farming* published by the Commission in November 2017.[50]

All these references can be considered clear evidence at EU level that the European Commission and the European Parliament count on and evaluate the opportunities offered by precision agriculture.

22.4 EU Law and Policy Concerning Drought and Water Scarcity

This part discusses the relevant EU (binding and non-binding) documents with the aim of following up on the development of water quantity issues, more specifically drought and water scarcity. To this end, the relevant sources will be introduced in a chronological order in the hope that this way we can better understand changes in approaching water quantity. I start my analysis with the Water Framework Directive (2000), on the one

47 https://ec.europa.eu/info/news/future-cap-robots-field_en.

48 https://ec.europa.eu/info/news/european-union-funds-digital-research-and-innovation-agriculture-tackle-societal-challenges_en.

49 https://ec.europa.eu/info/news/future-cap-sustainability-water-source_en.

50 Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions: The Future of Food and Farming, Brussels, 29.11.2017, COM(2017) 713 final. See also: D. Mottershead et al., Research for AGRI Committee – Towards the CAP post 2020 – Appraisal of the EC Communication on 'The Future of Food and Farming' of 29 November 2017, European Parliament, Policy Department for Structural and Cohesion Policies, Brussels, 2018.

hand, because it is the only binding document in force (and the most comprehensive as well) regarding freshwater. On the other hand, it is the first one in the chronological order, followed by the Communication on *Addressing the challenge of water scarcity and droughts in the European Union* (2007), the Blueprint (2012), and the Proposal for a Regulation of on minimum requirements for water reuse (2018).

22.4.1 Water Framework Directive

The Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, generally referred to as the Water Framework Directive (WFD) was adopted in the autumn of 2000.

Firstly, in relation to WFD special attention must be paid to the way water is understood, namely "Water is not a commercial product like any other but, rather, a heritage which must be protected, defended and treated as such."[51] This statement envisages a special protection for water, and urges us to make some observations. On the one hand, it is a completely general statement on water with no reference to certain types of water such as surface water or groundwater. And this, notwithstanding the fact that some tend to consider freshwater to be more valuable from the aspect of the often mentioned decreasing availability of, and growing demand for water. On the other hand, it is worth connecting the words water and heritage to agriculture, as they are inextricably linked to the right to food.[52] This observation follows from the proportion of water withdrawal used for irrigation as well as from the connection between irrigation and food production. Moreover, this paragraph does not differentiate between the quantitative and qualitative aspects of water, even though it is stipulated that

> "This Directive aims at maintaining and improving the aquatic environment in the Community. This purpose is primarily concerned with the quality of the waters concerned. Control of quantity is an ancillary element in securing good water quality and therefore measures on quantity, serving the objective of ensuring good quality, should also be established."[53]

However, as further clarified "The quantitative status of a body of groundwater may have an impact on the ecological quality of surface waters and terrestrial ecosystems associated with that groundwater body."[54] In other words, this paragraph acknowledges the rela-

51 Recital (1) of Directive 2000/60/EC.
52 *See*: E/C.12/1999/5, 12 May 1999.
53 Recital (19) of Directive 2000/60/EC.
54 Recital (20) of Directive 2000/60/EC.

tionship between groundwater quantity and surface water quality. Nonetheless, it is well-known that this relationship is much more complicated. This interrelationship between surface water and groundwater is relevant for both water quantity and quality, as water withdrawals affect both surface and groundwater, while pollution in either source will in turn also contaminate the other source.[55]

Following these observations regarding the way water is understood under the WFD, we now turn our attention to the goals of this directive. As stipulated in Article 1 of the Water Framework Directive, it was adopted, among others, with the aim

> "to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater which: […] (b) promotes sustainable water use based on a long-term protection of available water resources; […] (e) contributes to mitigating the effects of floods and droughts and thereby contributes to: – the provision of the sufficient supply of good quality surface water and groundwater as needed for sustainable, balanced and equitable water use, […]."

First and foremost, it has to be noted that we opted for those elements from the said article that bear a relevance to our research, namely that are related to water quantity, more specifically to the lack of a sufficient amount of water. The analysis of these elements brings us back to recital (19) of the WFD, namely, that the directive is primarily concerned with water quality and water quantity is an ancillary element. Without questioning this provision as well as the dominance of the water quality provisions in the directive, we cannot disregard that quantitative aspects necessarily form part of the WFD either explicitly or implicitly. Starting with the explicit references to drought, the said Article 1 obviously concentrates on the two extremes of insufficient water quantity, such as drought and flood. Further, recital (41) stipulates that "For water quantity, overall principles should be laid down for control on abstraction and impoundment in order to ensure the environmental sustainability of the affected water systems." Lastly, pursuant to recital (32), drought forms part of the "exemptions from the requirement to prevent further deterioration or to achieve good status under specific conditions."

Moving on to the implicit references, firstly, we have to make mention of sustainable development that is inconceivable without covering both water quantity and quality. Besides this provision, other references to sustainability can be also found such as "basic principles of sustainable water policy"[56] or "sustainable water use."[57] Moreover, we can-

55 S.C. McCaffrey, 'The UN Convention on the Law of the Non-Navigational Uses of International Watercourses: Prospects and Pitfalls', in: S.M.A. Salman & L. Boisson de Chazournes (eds.), *International Watercourses, Enhancing Cooperation and Managing Conflict*, World Bank Technical Paper No. 414, 1997, p. 18.

56 Recital (5) of Directive 2000/60/EC.

57 Recital (23) of Directive 2000/60/EC.

not overemphasise that the three pillars of sustainable development, that is the social, economic and environmental pillars,[58] encompass not only environmental considerations. Hence, when this principle of EU environmental law is mentioned it necessarily refers to water as a whole without any separation of its different aspects. Secondly, the same approach can be applied in relation to the reference to "integration of protection and sustainable management of water into other Community policy"[59] including agriculture where both qualitative and quantitative considerations are vital. Not to mention recital (34) of the WFD, which states that "For the purposes of environmental protection there is a need for a greater integration of qualitative and quantitative aspects of both surface waters and groundwaters, taking into account the natural flow conditions of water within the hydrological cycle."

In conclusion, it can be summarised that in spite of the generally water quality oriented approach of the WFD, water quantity, more specifically drought also plays a role in it both explicitly and implicitly.

22.4.2 Communication on Addressing the Challenge of Water Scarcity and Droughts in the EU

The Communication on *Addressing the challenge of water scarcity and droughts in the European Union*[60] was published by the European Commission in 2007.

Importantly, the communication defines the terms drought and scarcity, stating

> "While 'drought' means a temporary decrease in water availability due for instance to rainfall deficiency, 'water scarcity' means that water demand exceeds the water resources exploitable under sustainable conditions."

When analysing this source, we can rely on our findings under the WFD. Thanks to this communication, we can get valuable insight into the EU's water quantity concerns due to its focus on drought and water scarcity. The seriousness of the situation was underlined, on the one hand, by referring to the dramatic increase in the number and intensity of droughts in the EU in the past three decades. Meanwhile, the year 2003 was highlighted when over 100 million people and a third of the EU territory were affected by droughts. In addition, contrary to the approach of the WFD, this communication treats the quan-

58 T. Strange & A. Bayle, *Sustainable Development: Linking economy, society, environment*, OECD, 2008, p. 27; *Mainstreaming of the three dimensions of sustainable development throughout the United Nations system*: Report of the Secretary-General, A/70/75–E/2015/55.

59 Recital (16) of Directive 2000/60/EC.

60 Communication from the Commission to the European Parliament and the Council, Addressing the challenge of water scarcity and droughts in the European Union, Brussels, 18.7.2007, COM(2007) 414 final.

titative and qualitative aspect of water the same way by stating "Access to good quality water in sufficient quantity is fundamental to the daily lives of every human being and to most economic activities."[61] In other words, water quality cannot be considered without considering sufficient water quantity which means that availability of freshwater is not taken for granted anymore.

Nonetheless, the most important novelty of this communication is the identification of a number of challenges which need to be addressed including pricing, land-use planning, and water efficient technologies and practices. Firstly, when it comes to pricing, attention is paid to those abstractions that are not metered or registered by the authority. As correctly observed, even a well-designed water policy proves to be ineffective without these basic requirements.[62] However, at the same time, pricing cannot handle all challenges concerning water abstraction in general, and irrigation in particular, as it has to reflect the sensitivity of water resources as well. Moreover, in compliance with the 'user pays' principle[63] and similarly to the 'polluter pays principle', it cannot result in the overexploitation of water or in unsustainable water withdrawal even if one or more users are able to pay a high price for water thanks to their economic power. Secondly, regarding land-use planning, the negative impacts of the farms on water resources due to irrigation are at the centre of attention. The communication considers that the further adjustment of the CAP and the 2008 'Health check' could reveal opportunities in the further integration of water quantity issues. Nonetheless, most importantly, "All production including irrigated […] and all economic activities should be adapted to the amount of water available locally."[64] Thirdly, water efficient technologies and practices are briefly mentioned. The communication draws attention to the weaknesses, improvements and opportunities in improving water performance including irrigation where similarly to other sectors wastage of water is also significant. However, as stated further "In addition to improving technologies, the upgrading of water management practices is a necessary instrument in all sectors where huge quantities of water are used […]."[65]

22.4.3 A Blueprint to Safeguard Europe's Water Resources

The Communication of the European Commission under the title *A Blueprint to Safeguard Europe's Water Resources* (Blueprint) was published in 2012.[66] "Its long-term aim is to ensure the sustainability of all activities that impact on water, thereby securing the

61 Id., p. 2.
62 Id., p. 5.
63 Id., p. 3.
64 Id., p. 6.
65 Id., p. 11.
66 Communication from the Commission to the European Parliament, the Council, The European Economic and Social Committee and the Committee of the Regions, A Blueprint to Safeguard Europe's Water Resources. COM/2012/0673 final.

availability of good-quality water for sustainable and equitable water use."[67] As it follows from the goal of the Blueprint, both aspects of water are addressed; even though, all in all, the dominance of the water quantity can be observed. This approach can be justified, on the one hand, by the fact that we already have comprehensive and binding legislation relating to water quality issues thanks to the WFD and its daughter directives. On the other hand, the seriousness of water quantity issues globally can also be an explanation, namely, the growing demand for water may result in an estimated 40% global water supply shortage by 2030.[68]

Firstly, regarding the analysis of the problems and solutions in relation to land use and the ecological status of EU waters, two findings must be mentioned. On the one hand, the impact of agriculture and floods can be mitigated and prevented by using, among others, buffer strips and where possible, green infrastructure instead of the classical grey one.[69] On the other hand, since the ecological status of EU waters is attributable to the over-abstraction of water, the Blueprint provides us with the clarification of the terms over-allocation and over-abstraction of water, as follows:

> "Over-allocating water to users in a river basin due to an overestimation of the available amounts, or to economic or political pressure, should be distinguished from water abstraction, which is illegal because it is conducted without a permit or in breach of a given permit."[70]

In order to address the over-allocation of water, the identification of ecological flow is necessary that is "the amount of water required for the aquatic ecosystem to continue to thrive and provide the services we rely upon. Fundamental to this is the recognition that water quality and quantity are intimately related within the concept of 'good status'." When it comes to illegal abstraction, satellite imagery and derived information, such as the one provided by the Global Monitoring for Environment and Security programme are named as tools that may help Member States identify those areas where the level of irrigation far exceeds what was allowed under the national permits or where irrigation is carried out without permits.[71]

Secondly, the challenges relating to the quantitative aspects of the sustainable use of Europe's waters must be stressed, given that we are talking about global phenomena. The current trends are showing the increase and wider spread of water scarcity and stress. As predicted by the European Environment Agency (EEA) State of Water report, by 2030 about half of the EU river basins may be affected. To this end, the significance of pricing

67 Id., p. 3.
68 Id., p. 2.
69 Id., p. 5.
70 Id., p. 6.
71 Id.

is reaffirmed once again as it "combines environmental with economic benefits, while stimulating innovation." In other words, "Not putting a price on a scarce resource like water can be regarded as an environmentally-harmful subsidy."[72] Meanwhile, metering as a precondition of pricing is stressed, too.

The Blueprint, furthermore, refers to a number of additional actions that have the potential to improve quantitative water management and water efficiency in the EU including but not limited to water accounts, water efficiency targets, and CAP reform.

Starting with water accounts, these were developed by the European Commission, together with the EEA, at river basin and sub-catchment level. While these accounts have to be further refined, they provide valuable information on "how much water flows in and out of a river basin and how much water can realistically be expected to be available before allocation takes place." Moreover, as observed correctly,

> "Water accounts are closely linked to the identification of ecological flow as they should ensure that the needs of nature are respected and that water balances within a river basin stay within sustainable limits. But water accounts alone are not enough as the information they provide is only the basis for action."

Moving on to water efficiency targets, these are necessary for the improvement of the efficiency of water use and should be developed for all river basins under water stress, based on water stress indicators that were developed in the CIS process. Such targets should deal with all the main water using sectors including agriculture.[73]

Thirdly, the European Commission's proposals for reforming the CAP provides an opportunity for funding to improve irrigation efficiency in harmony with the WFD objectives and to prevent the rebound effect ("improvements in water efficiency increase rather than decrease water use and consumption"). Importantly, although agriculture accounts for 24% of water abstraction in Europe compared to the 44% abstracted for cooling water in energy production," its impact on reserves is much greater." This can be explained by the fact that "In energy production, almost all cooling water is returned to a water body, but for agriculture the figure is often just a third."[74]

22.4.4 Proposal for a Regulation on Minimum Requirements for Water Reuse

During the stakeholder consultations resulting in the Blueprint, one alternative supply option emerged that grabbed the EU's attention, namely water re-use for irrigation or

72 Id., p. 10.
73 Id., p. 11.
74 Id., p. 12.

industrial purposes.[75] While the Proposal for a Regulation on minimum requirements for water reuse[76] submitted by the European Commission in May 2018, necessarily focuses on water quality requirements as well as on procedural rules, it provides us with useful information on water quantity thanks to its explanatory memorandum. However, before putting the explanatory memorandum of the said proposal under the microscope, two things must be noted. On the one hand,

> "The new rules aim to ensure that we make the best use out of treated water from urban waste water treatment plants, providing a reliable alternative water supply. By making non-potable wastewater useful, the new rules will also contribute to saving the economic and environmental costs related to establishing new water supplies."[77]

On the other hand, "Water reuse in the EU today is far below its potential despite the fact that the environmental impact and the energy required to extract and transport freshwater is much higher."[78]

Moving on to the explanatory memorandum, first, the contradiction between the limited availability of freshwater and the growing demand is reconfirmed. Not surprisingly, water abstraction for agricultural irrigation is identified as the main threat to EU water resources. Even though, water is inextricably linked to growth when it comes to water dependant sectors and the society. Then, it focuses on the economic aspects of droughts such as the damage to agriculture. Besides the above mentioned example of the drought in 2003, the summer of 2017 is also highlighted through the example of the Italian farming sector. Their loss was estimated to reach EUR 2 billion.[79] Not to mention,

> "This trend is expected to continue with water scarcity no longer confined to a few corners of Europe, but already a concern across the EU with significant environmental and economic consequences. This may in turn affect competitiveness and the efficient functioning of the internal market."[80]

We referred to the integrated approach when discussing certain provisions of the WFD. The significance of integration is at the centre of attention, too. As stated by the proposal

75 Id., p. 14.
76 Proposal for a Regulation of the European Parliament and of the Council on minimum requirements for water reuse, Brussels, 28.5.2018, COM(2018) 337 final.
77 http://europa.eu/rapid/press-release_IP-18-3929_en.htm.
78 Id.
79 Proposal for a Regulation of the European Parliament and of the Council on minimum requirements for water reuse, Brussels, 28.5.2018, COM(2018) 337 final, p. 1.
80 Id.

> "As part of an integrated water management approach, in addition to water savings, treated waste water from urban waste water treatment plants provides a reliable alternative water supply for various purposes. Of these, agricultural irrigation has the highest potential for an increased uptake of water reuse and a contribution to the alleviation of water scarcity in Europe."[81]

22.5 Conclusions

The necessity of irrigation to satisfy the growing demand for food cannot be questioned due to the far greater productivity of irrigated land. At the same time, the European Commission has paid more and more attention to drought and water scarcity over the years. The question arises how can we satisfy the water needs of the agricultural sector while taking into consideration drought and water scarcity. In other words, how can sustainable irrigation be achieved?

Starting with the approach adopted by the Water Framework Directive in 2000, it can be summarized that in spite of the references both explicitly and implicitly to drought, the WFD is dominated by the water quality aspect. In addition, it lacks that level of concern relating to drought that was reflected in the Communication on Addressing the challenge of water scarcity and droughts in the EU in 2007. This latter document is entirely dedicated to challenges relating to drought and water scarcity. Nonetheless, the significance of both water quantity and water quality is obvious by referring to "access to good quality water in sufficient quantity." In 2012, when the Blueprint was published, in addition to emphasising the necessity of both the quantitative and qualitative aspect of water, sustainability as a requirement was also added to them, namely "securing the availability of good-quality water for sustainable and equitable water use." Most recently, in 2018, the European Commission's Proposal for a Regulation on minimum requirements for water reuse can generate opportunities for agriculture. While the significance of the water quantity aspect is increasing, combined with the acknowledgement of the importance of good water quality, sustainability poses limitations.

Moving on to the opportunities inherent in precision agriculture used in irrigation and taking into consideration the aspects listed above, it can be concluded, that precision agriculture can support the EU's goals in the field of water law and policy in many ways. In simple terms, firstly, it makes it possible to restrict water withdrawal to the absolute necessary. Thanks to digitisation, the water quantity used for irrigation can be measured, and may be influenced by pricing (once withdrawal is registered at the authority). These can encourage and result in resource efficient water use. This may preserve water resources in general and ensure future agricultural uses in particular. Moreover, it is worth considering opportunities offered by the Proposal for a Regulation on minimum require-

81 Id.

ments for water reuse, namely whether it is feasible to opt for using reused water for irrigation, benefiting from the technological achievements of precision agriculture. My analysis of relevant EU legal and preparatory documents has shown that precision agriculture has the potential to contribute to the protection and preservation of water resources and thereby mitigate vulnerability to drought and water scarcity.