Preliminary note: Since 2015, water scarcity and droughts have been rapidly increasing in the EU[1] [2]. Given the particular impact of agriculture on soil, a soil directive must address the impacts of agriculture. Conventional agriculture is one of the main drivers of multiple current crises, but at the same time agriculture is very much needed as one of the most promising keys for many solutions (EASAC[3]).

State-backed Transformation of Conventional Agriculture as Key to Water Protection and Elementary Soil Functions

Conventional agriculture is associated with various pressures to water quantity as well as water quality which are subdivided into types below. Extending technology in waterworks to improve water quality is contradicting the Water Framework Directive[4]. The target must be to systematically reduce pressures on water resources. For this purpose, remedial measures are given:

1) Water quantity

a) Cleared agricultural landscapes without plants (esp. trees) and (tree) transpiration interrupt the so-called small water cycles on continents, causing increased lack of precipitation, reduced water availability and intensified droughts[5] [6] [7].

b) Drained agricultural landscapes lack water retention in soil and groundwater.[8]
c) Organically managed soils show an infiltration rate which is 137% higher compared to conventionally managed ones[9] and a water storage which is 100 % higher (UBA[10]). Soil damage is caused by humus depletion in conventional agriculture: With the humus, the water absorption and water storage capacities ("soil water holding capacity") of the soil are degraded: 1% less humus means water loss of 52,000 liters per hectare[11].
In the same way, a decrease in soil life[12] and biopores[13]reduces the water absorption and storage capacity of the soil[14].
Soil compaction[15] due to decline of soil life, humus depletion and use of heavy machinery inhibits water infiltration into soils (EEA[16]).

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[1] See recital 20 of the Commission Proposal for a Directive on Soil Monitoring and Resilience
[2] EEA (2023): Water scarcity conditions in Europe (Water exploitation index plus) (8th EAP).
[3] European Academies Science Advisory Council (EASAC) (2022): EASAC Report on "Regenerative Agriculture"; press release 05.04.2022: Regenerative Agriculture – Healthy Soils Best Bet for Carbon Storage.
[4] See Art. 7.3 of the Water Framework Directive, 2000/60/EC.
[5] FAO news 15.07.2019: Flying Rivers – how forests affect water availability downwind and not just downstream.
[6] See Scheub & Schwarzer (2023): Aufbäumen gegen die Dürre. Oekom.
[7] Vgl. Ellison et al. (2017): Trees, forests and water: Cool insights for a hot world.
[8] Reinhart et al. (2016): Drainage Water Storage for Improved Resiliency and Environmental Performance of Agricultural Landscapes.
[9] See Thünen Report 65 (2019), summary p.xi.
[10] Cf. Umweltbundesamt (2016) – Böden als Wasserspeicher.
[11] Scheub & Schwarzer (2023): Aufbäumen gegen die Dürre (p. 166) and (2017: Humusrevolution. Oekom.
[12] Cf. EU research project SOILSERVICE (2012).
[13] Beste, A., Lorentz, N. (2022): Ecosystem Soil – Bringing nature-based solutions on climate change and biodiversity conservation down to earth. (Ed.): GIZ/BMUV.
[14] A. Beste (2005): Landwirtschaftlicher Bodenschutz in der Praxis. Grundlagen, Analyse, Management.
[15] About 23 % of all soils in Europe have critically high densities in subsoils indicating subsoil compaction (Montanarella & Panagos 2021). Soil compaction can lower crop yields by 2.5-15 % (cf. Proposal).
[16] Cf. EEA Report 08/2022 – Soil monitoring in Europe.

→ On conventionally cultivated soils, precipitation can no longer infiltrate, plant-available water and groundwater recharge decrease, water (incl. valuable humus) is quickly discharged via rivers into the sea (increase in flooding)[17] [18]. In dry periods, rivers are fed by groundwater, the so called baseflow. Reduced groundwater leads to reduced river water discharge. If the discharge is reduced (e.g. to one third) and the pollutant input remains constant, the pollutant concentration in the river multiplies (triples).
d) Dried out soils can no longer absorb water, which then even more runs off superficially into the sea.

e) Groundwater extraction for agricultural irrigation (often furthermore by inefficient circular sprinklers) further reduces the amount of water (ECA[19]).

2) Water quality

a) Area-wide spreading of artificial fertilizers and pesticides which enter groundwater as original or degradation substances (metabolites, often poorly degradable PMT/vPvM substances[20]) degrades water quality[21].
b) Excess manure from conventional animal husbandry forms nitrate hotspots in groundwater.
c) Soil life is damaged mainly by pesticides, nitrate, monocultures, soil compaction. Soil life is crucial for the degradation of pollutants[22]. "*The physical and chemical purification capacity of the soil is clearly surpassed by the biological one. A decline in the biological activity of the soil decisively reduces its ability to purify water. Soil compaction and humus depletion reduce both water absorption and purification capacity and, moreover, habitat and air and water supply for soil organisms - a cycle that is reinforced.*"[23]

3) Remedy requires state-backed transformation schemes to future-proof agriculture

The following elements are promising: An ambitious soil directive in coherence with pesticide reduction and Integrated Pest Management (IPM), organic farming[24] [25](including elements like humus build-up, phasing out of chemically synthesized pesticides/artificial fertilizers, intercropping, mixed crops, undersowing, green manuring) on 25 % of agricultural land by 2030, agroforestry[26] and other agroecological practices, CAP restructuring. Along with setting incentives, the transformation must be state-backed financially for farmers. When including the above-mentioned water management needs regarding water quantity and water quality, precision farming can also be part of the solution.

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[17] See also recital 20 of the Commission Proposal for a Directive on Soil Monitoring and Resilience.
[18] Cf. Umweltbundesamt (2016) – Böden als Wasserspeicher.
[19] European Court of Auditors - Special Report 20/2021: Sustainable water use in agriculture: CAP funds more likely to promote greater rather than more efficient water use.
[20] See UBA press release 05.09.2023: Water resources must be better protected - UBA warns against slow-to-degrade and mobile chemicals
[21] See Thünen Report 65 (2019), English Summary.
[22] Cf. recital 21 of the Commission Proposal for a Directive on Soil Monitoring and Resilience.
[23] Cf. A. Beste (2005): Landwirtschaftlicher Bodenschutz in der Praxis. Grundlagen, Analyse, Management
[24] Cf. DVGW Arbeitsblatt W 1003 (2022-06); EurEau comments on the Farm-to-Fork Strategy (09/2020).
[25] According to the EU Organic Action Plan (2021), organic farming is for now the only system which has been recognised by a robust certification method. In this way, the risk of greenwashing can be controlled.
[26] European Commission (2021): EU Soil Strategy for 2030. Reaping the benefits of healthy soils for people, food, nature and climate.

Nature-based solutions (elements of IPM, organic farming, agroforestry, NWRM[27] etc.) offer multi-solutions per measure (1:X) for multiple crisis situations: Climate (protection, adaptation), biodiversity/nature loss, (water) pollution, water scarcity, public health, field yield security (EEA[28]). Simplicity and being low-cost are further advantages of such nature-based solutions.

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[27] Natural Water Retention Measures, see the European NWRM platform.
[28] See EEA Report No 17/2020: Water and agriculture: towards sustainable solutions.