MEDWIN PUBLISHERS
Committed to create value for Researchers

Food Science and Nutrition Technology
ISSN: 2574-2701

Soil Science in Face of New Challenges: Quo Vadis Soil Science?

Bašić Ferdo*

Department of Natural Sciences, Croatian Academy of Sciences and Arts, Zagreb, Trg Nikole Šubića Zrinskog 11 – Croatia

Review Article

Volume 2 Issue 3

Received Date: July 25, 2017

Published Date: August 21, 2017

***Corresponding author:** Bašić Ferdo, Department of Natural Sciences, Croatian Academy of Sciences and Arts, Zagreb, Trg Nikole Šubića Zrinskog 11 – Croatia, E-mail: ferdo.basic1@gmail.com

Abstract

Soil is a media of a harmonious flow of matter and energy in terrestrial ecosystems, a condition-ally renewable resource and a unique natural entity. As a "young science" of twentieth century Soil science started and developed dominantly within agricultural and forest sciences. Recently is on crossroads; to stay within agriculture and forestry worrying on soil fertility and other aspects of biomass production in a sustainable way, or orientation on environmental life-sciences, studying of soil-originated terrestrial ecosystem out-puts (SOEE), including of agro ecosystem, as opened and permanent evolution exposed system inspired by needs of ever-higher yields for feeding of increasingly population.

We are witnesses of consequences of omnipresence anthropocentric position resulted by terms like; *(soil) functions and/or (ecosystem) services*, which suggests an unnatural, inferior position of soil/ecosystem, putting them in position "to serve"... or to be "in function" of... We find it is wrong position! If is anybody in these relations in position to be service, it is man – *Homo sapiens*. Output or effect (instead of service) of soil and/or ecosystem, especially agro ecosystem is multiple and based on "input – output" principles.

We are speaking on Soil Originated Ecosystem Effects (SOEE): productive, regulatory; storage; spatial; social and theological effects;

Very impressive: all what we see as bio-richness and biodiversity including of some anthropogenic structures and landscape/anthroscape, our body, as well as what we are eating, drinking, breathing and filling (our soul) is soil-inspired, soil-originated and/or soil related/oriented.

Quo vadis Soil science?

Let us to conclude; the right and correct position of Soil science is within Ecological sciences!

Keywords: Soil Originated Ecosystem Effects (SOEE)

Introduction

Inspirative words bellow of title wrote Francis D Hole [2] "ambassador of soils" and, with his spiritual, soulful, and artistic nature, certainly the undisputed poet-laureate-of-soils". Compared to the Universe, our Galaxy is endlessly small, compared to which is just as small the Solar system of which our Gea - the "Blue Planet", is just a

hundredth of a part ... Its mainland receiving 1 - 2% of the total emitted solar energy in the last quarter of its geological past on its surface formed a thin layer of soil... and that's Life! Soil is the finest "weaving of the life" inheritance and "time link" - a link between a series of past and present generation of soil users with emerging generations... the link that we, the acquaintances and the users of the soil commit... because; soil is the Creator's gift. Therefore; In designing all the actions to the soil the thought of guidance and the source of inspiration should be a relationship with that offering, which must not hinder the view and thought of gratitude to Creator of this unique Gift! Soil is a media of a harmonious flow of matter and energy in terrestrial ecosystems, including agricultural (agro-) as well as forest (silvi-) ecosystems. As a conditionally renewable resource [1] and a unique natural entity, the soil-pedosphere has a decisive influence on sustainable development of global/national economy, especially food production in agriculture as well as environmental protection. As a “young science” of twentieth century Soil science started and developed dominantly within agricultural and forest sciences. Recently is on crossroads; to stay within agriculture and forestry worrying on soil fertility and other aspects of biomass production in a sustainable way, or orientation on environmental life-sciences, studying of multiple soil-originated and related terrestrial ecosystem outputs, including of agro ecosystem, as opened and permanent evolution exposed system inspired by needs of ever-higher yields for feeding of increasingly population.

Does the Ecostems Serves... Soil is in Function of...

We are witnesses of consequences of omnipresence anthropocentric position resulted by terms like; *(soil) functions and/or (ecosystem)* services, which suggests an unnatural, inferior position of soil/ecosystem, putting them in position “to serve” ... or to be “in function” of... We find it as wrong position! Because of: soil and ecosystems are neither “in function” of anybody nor in any “service” as the result of requirements of genius *Homo sapiens*. In the new period Anthropocen soil is as always, a self-standing natural entity and specific, perfectly creation of Nature/gift of Creator. If is anybody in these relations in position to be service, it is man – *Homo sapiens*. Out-comes or effect (instead of service) of soil and/or ecosystem, especially agro ecosystem is multiple and based on “input – output” principles. In land management – farming, we “invest” in soil/agro ecosystem (soil “inputs”) fertilizers, tillage, etc., expecting annual (fertilize), 2-3 years (deep loosening), or long-term (drainage system) outputs in the form of food, fibber, fuel, timber, regulation...etc.

Soil Originated Ecosystem Effects (SOEE)

Soil genesis, physical, chemical and biological properties as well as fertility of soil is between others result of multiple cycling and exchange of matter end energy between living and non-leaving, organic and mineral, solid, liquid and gaseous component of ecosystem. Long-term investments – inputs in the soil are driving force of evolution of agro-ecosystem, as opened system in the direction of ever-higher yields of growing crops and livestock, because soil of higher fertility can supply high-yielding varieties of crops, these varieties giving better fodder... or; in recent climatic (agro ecological) conditions some varieties of crops and some farming practices results by one level of yields, in case of change follows evolution... it would be other - again higher yields, because of its an opened system, there is no end!

We are speaking on Multiple Soil-Related Ecosystem Outcomes (MSREO):

Productive Effects: Primary production of biomass – base of agriculture and forestry: Food (bread, meat, milk, vine, beer, juices); Fiber (cotton, line, hemp, wool); Fuel (biodiesel, bioetanol); Wood and other forest products; Medicinal herbs and their products (drugs, biochemical products - antibiotics, test-organisms); Ornamental – decorative plants;

Regulatory

Climate regulation – as source and media of sequestration of greenhouse gases; Receptor, accumulator and transformer of different substances – pollutants emitted from urban, traffic and industrial structures; Regulation of water flow – natural infiltration erosion prevention, drainage water accumulation and drought prevention), universal filter for drinking water; Source of oxygen as the base of aerobiosis; Air quality regulator - capturing the dust and chemical pollutants, emitting some chemicals to the air; Bio–regulator - starting and ending points of numerous bio-cycles;

Storage

Drinking water supply and flood prevention; Organic matter (humus) in different phases of transformation; Plant nutrients - organic or mineral, natural or anthropogenic origin; Pollutants emitted from natural

(volcanic) spheres or anthroposphere; Gene reservoir of micro and macro pedo-flora/fauna, and base of biodiversity;

Spatial

Aesthetic - natural landscape and anthroscape; Spatial conditions for numerous anthropogenic activities: agriculture, forestry, industry, transport, housing, recreation, waste disposal; Sport terrains (football, golf, recreation) and tourism – continental and agro-tourism; Powerful factor influenced spatial planning;

Social

Memorial - geological, paleontological, pedological and archeological heritage; Aesthetic richness - memory - base of patriotism; Inspiration for art, culture, and aesthetic design;

Theological Effects

Source of spiritual impressions; Soil as central topic of Bible and binding legacy of actual generation of soil users;

Very impressive: all what we see as bio-richness, including of some anthropogenic structures and landscape/anthroscape, our body, as well as what we are eating, drinking, breathing and filling (our soul) is soil-inspired, soil-originated and/or soil related/oriented. If so, let us to conclude; the right and correct position of Soil science is within Ecological sciences!

To Feed the World – Past, Actual and Expected Problems

As we have seen, feeding of population is based on effects of specific, ecosystem – agro ecosystem, as base of man-settled part of Gea - Anthroposphere. Grandiose population of *Homo sapiens* lived on the Earth in the history from the very beginning (from Adam) till Anthropocen (today) of about 106 billion ($106x10^9$) persons for feeding used about 15 billion ($15x10^9$) hectares of agricultural land - pasture and arable land. Actually, we are using 5 billion ha, of which 3, 5 pasture and 1, 5 arable land. According of Pretty, et al. [3] "one of the most important challenges facing society today is how to feed an expected population of some nine billion to the middle of 21st century. To meet the expected demand for food... we need to produce 70-100% more food in light of the growing impacts of climate changes". It is possible on the way of environmentally sound, sustainable intensification of farming system. Out of any doubt; challenging activities of all agronomy-related sciences!

Soil in Relation with Other Resources

Precondition of an urgent need of efficient and integral soil protection is the precise status and valorization of soil as natural resource. As a unique natural entity, the real place of soil is as member of Ecological trinity; Soil – Water – Air [1]. Comparing of soil with other members of this trio, which is public, soil is private good. Private good in public interest necessary to manage on a sustainable way! Reality is that European (American, global) farmers are practically workers on own private good with land management on the way which have to follow numerous acts, regulation, rules, directions of EU (state) administration. Farmer in twofold position "conflict of interests", because of in the role of producer interest of farmers is high yield and profit, which includes the use of environment risky agrochemicals, but in the role of consumer interest of farmers and public – tax payers is food safety and clean air and water? Who would judge in the case of conflict with heavy consequences?

Position of Soil Science

Soil science is a young natural science, practically the science of twentieth century. The first steps and development to the last decades of century were within agricultural, forestry, or geo-sciences. Data on soil-land management-related environment degradation opened the door of global audit and (re)position of agriculture [4], and Soil science within natural sciences. Starting with The *Future of Soil science* [5], continuing by "global soil inventory" through World Soil Book Series [6], ending with occasional (global) messages of *International Year of Soil (IYS)* – 2015 [7] *(Soil Matters – Solutions Under Foot* – Nortcliff – 2015) [8] ideas on position of Soil science are "on table". Except of numerous soil relations and roles as well as social aspects (environment, soil degradation, soil carbon and bio-diversity, soil and land use, do we value soil?, soil and society, etc.) the first time are described possible extraterrestrial soils on Mars and Titan Blume & Fleige [9]. So, we soil scientists are flaying to Mars/Titan but... starting from position which can be described as "enslaved somewhere in the function of agriculture, forestry, water management...". Solution is really "under foot"!

Soil as "producer" or "environment- oriented" science - origin of ecosystem effects

There are two tendencies in actual positioning of Soil science. One tendency, following tradition of its founder, more or less accept soil (land) as essential resource of economically, socially and environmentally sustainable biomass - food, fiber, fuel – timber (FFFT) production. This concept observes the soil as an essential component of agro- and silvi- ecosystems in the service of agriculture

and forestry and insisting on research of soil focused on properties crucial for ever-higher yields of growing agricultural crops and/or forest trees. Really, changing physical, chemical and/or biological soil properties on the way optimal for plant growth Soil science becomes a powerful factor of agro- and/or silvi- ecosystem evolution to the level of ever-growing yields of biomass per hectare of land [4]. Indeed, the concept of Multifunctional Character of Agriculture and Land (MFCAL), inaugurated 1999th in a sensitive period for effect of all messages - the end of the second and on the threshold of the third millennia, which was the driving force of analyses and looking for other – non-food soil functions and insisting on multifuncionality of soil [10]. Otherwise, in terminology of Croatian Soil scientists instead of "soil functions" in the use is the term "roles of soil" [7], defined as food and non-food one.

The other tendency is *environment-oriented* Soil science. Instead of soil functions environmentalists inaugurate the term soil-related ecosystem services. Really, soil is for itself the living system and inseparable component of all terrestrial ecosystems. List of functions/roles of soil is stepwise growing. Reading of *Soil Matters* [8] number and importance of soil-related environment regulatory ("non–food") terrestrial ecosystem services are powerful argument for *declaring of Soil science as ecological/environment-regulatory science* [11]. We can add; Life science in real sense! If so, it is important to precise definition of soil as a living system and radical orientation on new methods of soil analyses, we suppose more *in situ oriented*, than it was in the past and is today. For example; redox potential of soil as marginalized method but integral indicator of physical, chemical and biological properties of soils and its facility for plant growing more reliable than individual indicators such as texture, pH, CEC etc.

Recent Processes in Croatia

Croatian soil scientists are in specific position; awareness of public on importance of soil out of its roles in food production is far below of requirements necessary for remarkable changes. Both tendencies promised permanent increasing of anthropogenic pressure on soil, which means in-creasing of all processes of land degradation. These processes are additionally stimulated by recent chaotic climate changes.

It is truth that always in history soil (land) was in the root of radical historical changes, from forming the first civilization, Moses coming back in Promised Holy land, following Slave-holder system, Feudalism, till Capitalism with market economy which recent "fruit" are "yellow colored European fields" from oil rape and/or sunflower growing for bio-fuels. Increasing of pressure on soil the mankind cut the branch on which seat. Somebody can say; nothing new on "The blue Planet"! It is to expect one of consequences that the main occupation of Soil science in next generation will be Soil-protection - oriented! But, for difference with previous generation "maneuver space" for action is going to be more and more reduced.

In this situation we believe that but International decade of soil 2015-2024 is an excellent opportunity for to think out new changes, at first in land tenure relation [7]. It is truth that private ownership of land is the base of recent society and market economy. But, there is already numerous interventions of society in this relation; from incentives in agriculture as absolutely "contra-market economy" intervention from global level (as declarations on protection of some sites, protection of biodiversity), continental level (directives and strategies of EU) and national level (acts and regulations on; protection of protected natural area, water protecting area, good agricultural practices, etc.). So, land owner have to accept all regulations in spite of the fact that it reduces his private property rights. Soil (land) is private but almost all practices on his land are regulated by society! Mechanism of incentives is compensation, or paying enjoyment of farmers – land owners, but at the same time disclaims market relation on global market of agricultural products. As we see, because of life-importance of soil functions it is unquestionable fact that land management is very responsible job, which needs an efficient use of complex of knowledge's, at first on soil.

Agricultural soils in the Croatian historical area developed since the Neolithic; more than six thousand years now, lasts a story of cooperation and joint action between Man and Nature in these areas. Soil is the heritage and the important time - link a series of past and present generations on the Croatian part of anthropo sphere, with generations yet to come ... that link us, and knowledgeable users of the soil shall be binding, because; Soil is a gift of the Creator. Therefore; in the design of interventions in the soil guiding principle and source of inspiration should be the attitude toward the Endowment, which must not obstruct the view and thought of gratitude facing the Giver!

The minimal demand of society is to look for a clear and from point of view of soil protection an efficient (sustainable) land management. For driving bicycle it is necessary to have license but for land (soil) management not! The solution is to change land tenure relations – land

property rights. Just as air and water as members of "ecological triad" soil need to be public good and property! Land management including of farming system – crop rotation for all soil (land) users have to be "soil friendly", means responsible to society. But products of soil (land) – food, fuel, timber etc., are in every case private property for competition on free market. Precondition for correct land use would be some qualification, which includes clear defined minimum of knowledge on soil for land users. By other words: as a standard have to be the rule that every square meter of land (soil) – agricultural, forest, urban... has to be under professional supervision of owner (society). It includes obvious monitoring of soil and changes in land management practices according of its result [12,13].

Conclusion

As a "young science" of twentieth century Soil science started and developed dominantly within agricultural and forest sciences. We are witnesses of consequences of omnipresence anthropocentric position resulted by terms like; *(soil) functions* and/or *(ecosystem) services*, which suggests an inferior position of soil/ecosystem, putting them in position "to serve"... or to be "in function" of... We find it as wrong anthropocentric position! If is anybody in these relations in position to be service, it is his majesty man – *Homo sapiens*. Effect (instead of service) of soil and/or ecosystem, especially agro-ecosystem is multiple and based on "input – output" principles.

Recently is on crossroads; to stay within agriculture and forestry, or orientation on environmental life-sciences, studying of soil-originated terrestrial ecosystem effects, including of agro ecosystem, as opened and permanent evolution exposed system inspired by needs of ever-higher yields for feeding of increasingly population. We are speaking on Soil-originated ecosystem effects SOEE: productive effects-primary production of biomass – base of agriculture and forestry; regulatory; storage; spatial; social and theological outputs. All what we see as bio-richness, including of some anthropogenic structures and land-scape/anthroscape, our body, as well as what we are eating, drinking, breathing and filling (our soul) is soil-inspired, soil-originated and/or soil related. *Soil is a gift, temptation and duty that the Creator intended man!* The correct answer on the question; Quo Vadis Soil science is [4]: the right position of Soil science is within Ecological- life sciences!

References

1. Varallyay G (2005) Role of Soil Multifunctionality in future sustainable agricultural development, Special issue: Contribution to solution, University of Zagreb, Faculty of Chemical Engineering and Technology, Zagreb: 29-39.

2. Hole FD (1989) Popularizing the subject of soil, Department of Soil Science, University of Wisconsin-Madison, Madison, Wisconsin, U.S.A.

3. Pretty J (2010) The top 100 questions of importance to the future of global agriculture, International Journal of Agricultural Sustainability 8(4): 219-236.

4. Smith C, Semedo MH, Schmitz N, Fotabong EL, Holden P, et al. (1997) Quo Vadis agriculture, BOKU, Wien:120

5. Hartemink AE (2006) the Future of Soil Science, International Union of Soil sc, Wageningen p: 165.

6. Bašić F (2013) The Soils of Croatia, World Soil Book Series, International Union of Soil Sciences, editor Alfred E. Hartemink, Springer Verlag, Dordrecht, Heidelberg, New York, London: 179.

7. Bašić F, Jones A (2015) Soils of Croatia in the strategy of soil protection of EU, Regarding of International year of soils, 50th Croatian and 10th International symposium of Agronomists, Plenary session, Opatija, Pp: 9-20,

8. Nortcliff S (2015) Task Force: *Soil Matters* Solutions under foot, On behalf of the International Union of Soil Sciences, Geo Ecology Essays, Catena Verlag, GMBH, Reiskirchen 154.

9. Blume HP, Fleige H (2015) Extraterrestrial Soils, in; *Soil Matters* Solutions under foot, On behalf of the International Union of Soil Sciences, GeoEcology Essays, Catena Verlag, Reiskirchen 22-28.

10. Maastricht (1999) Cultivating our futures, Background papers, FAO/Netherlands Conference on the MFCAL, Maastricht:189

11. Poulsen L, Abraham EM, Bašić F, Dascal G, Davies J, et al. (2013) Economic assessment of desertification, sustainable land management, and resilience of arid, semi-arid, and dry sub-humid areas, costs and benefits of policies and practices addressing land degradation and drought in the drylands, White paper of 2. scentific conference of UNCCD, final draft, Davos: 142.

12. Lowdermilk W C (1994) Conquest of the land through seven thousand years, Agriculture Information Bulletin No. 99, US Department of Agriculture, Soil Conservation service, Washington: 30.

13. Hole FD Wisconsin Soils Study and Expedition Fund, Department of Soil Science, College of Agricultural & Life sciences, University of Wisconsin-Madison.