



OpenEARTH

Conference on
Climate Change
Adaptation and
Mitigation

12-14 February 2020
Holiday Inn, Thessaloniki Greece

Interreg 
Balkan-Mediterranean
BalkanRoad
Project co-funded by the European Union and National
Funds of the participating countries

OPENEARTH CONFERENCE
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KEYNOTE SPEAKERS

Circular Economy in a Changing World

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Keywords: Green Deal Strategy, UNDPs, Sustainable Development Goals, Circular Economy Strategy

Abstract

It is more than true that world population will continue to increase as well as the daily demands and the pressure to the environment. It is also very well known that, waste (all kinds and anywhere on the planet), is mainly considered an environmental issue and from east to west and north to south will continue to increase, as well as waste has a strong relation with economic and social dimensions. Moreover, taking into account the treaty of Rome (back in 1957) that nothing was indicated related with environmental protection, to the Circular Economy Strategy and the New Green Deal Strategy, we can realize how far we are to reach all the proposed targets. World is changing and move fast and without any doubt could not be able to change our daily routines, as we are demanding more and more products, producing more and more waste and consuming more and more energy, producing more and more greenhouse gasses. At the same time circular economy is gaining increasing attention in Europe and around the world as a potential way for our society to increase prosperity, though reducing dependence on primary materials and energy before 2030, while the main Green Deal Clear Vision is to achieve climate neutralization by 2050 as well as to implement the 2030 the UNDPs and SD Goals.

Beside all those, in the entire EU exists more or less 23 million enterprises in primary, secondary and thirdly sector, offering 90 million job positions (almost 99% of all the EU jibs positions) in more or less 500 million citizens EU(28), which those SMEs affecting the entire value chain. Hence are considered to be the backbone of each local economy with some unique characteristics i.e more than 75% of those SMEs has less than 5 employees (family oriented) and the most important one is responsible for (at least) 60% of the entire pollution.

Green Deal includes the Circular Economy concept as it is a new growth strategy that main purpose is to “transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use”. Additionally, aims to protect, conserve and enhance the EU's natural capital, and protect the health and well-being of citizens from environment-related risks and impacts. Moreover, place citizens first, and pay attention to the provinces, industries and workers who will face the greatest challenges while at the same time targeting that this transition must be just and inclusive.

From 1970 to 2017, the annual global extraction of materials tripled, and it continues to grow¹³, posing a major global risk. About half of total greenhouse gas emissions and more than 90% of biodiversity loss and water stress come from resource extraction and processing of materials, fuels and food. Although the transition to more sustainable systems has started, feeding a fast-growing world population remains a challenge with current production patterns. Food production still results in air, water and soil pollution, contributes to the loss of biodiversity and climate change, and consumes excessive amounts of natural resources, while an important part of food is wasted. FAO indicated that if Food Waste (FW) was a country could be the 3rd biggest CO₂ producer after China and USA with more than 3.5-4.2 billion of t equivalence CO₂. Each citizen in the entire EU produced approximately 179 kg/y FW equal more or less with 600 €/y, while during the Jesus life time (almost 2000 years ago) the production of food waste was estimated at 0.12kg/citizen according to Evangelists Matthew (14, 13021), Mark (6, 30-44), Luke (9, 10-17) and John (6,1-14) in the well know miracle of the multiplication of the 5 loaves.

Hence as it is extremely difficult to take “plastic products” from our daily life (more than 8.3 billion metric tons of plastics in the past six decades were produced – equal with 82200 times the Eifel Tower-, most of which has ended up as waste. In Europe the average plastic consumption is estimated at 31 kg/y/citizen). Europe aim by 2030, to develop a regulatory framework for biodegradable and bio-based plastics and will implement measures on single use plastics.

Finally, European funds, including for rural development, will help rural areas to harness opportunities in the circular and bio-economy but what we really must change is our attitude and behavior related with the products that we used, buy, consume, disposed of as well as the environmental performance. It is true that we must participate in the great debates and be part of the problem otherwise we will not be able to follow and adapt

The increase of soil organic matter reduces global warming, myth or reality?

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Keywords: carbon stock, climate change, humus, soil management, wastes

Abstract

The presence of organic matter in soils is the essence of a soil. Soil carbon storage is a vital ecosystem service, resulting from interactions of ecological processes, of which photosynthesis, respiration, and decomposition are key¹. The role of soils is essential in both global negotiations (CO₂ market) as carbon storage

mechanisms to mitigate climate change and as finite resource required for sustainable development². The contribution of soils to reduce the presence of carbon in the atmosphere, mitigation of global warming, is based on the sequestration and storage.

The global soil carbon (C) pool is about 2500 gigatons (Gt), which includes 1550 Gt of soil organic carbon (SOC) and 950 Gt of soil inorganic carbon (SIC). However, Lal (2004)³ indicates that the conversion of natural to agricultural ecosystems, causes depletion of the SOC pool by as much as 60% in soils of temperate regions and 75% or more in cultivated soils of the tropics, suggesting that human-driven land-use decisions have resulted in substantial reductions in global SOC level. In Europe, soil carbon stocks in the EU-27 are around 75 billion tonnes of carbon; around 50 % of which is located in Ireland, Finland, Sweden and the United Kingdom (because of the large area of peatlands in these countries)⁴.

Under these considerations, the most logical strategy, if we want to reduce the impact of global warming, is to favour the carbon sequestration and storage by soils, increasing the levels of SOM. We should consider that around 45 % of the mineral soils in Europe have low or very low organic carbon content (0–2 %) and 45 % have a medium content (2–6 %). According with this data, soils across Europe are likely to be accumulating carbon⁵. However, the storage depends not only of the amount of SOM presented in the soil, but the environmental conditions that affect the soil and the type of organic matter added. Therefore, we should take into consideration that SOM addition and accumulation do not mean that carbon sequestration and storage occur. Irrespective of the climate debate, the SOC stock must be restored, enhanced, and improved. Even more, soils provide basic ecosystem services and their protection is an essential prerequisite for achieving the Sustainable Development Goals promoted by United Nations². In Europe, the main strategies around agriculture and climate change are focussed to encourage farmers to adopt “simplified cultivation techniques” that enhance agricultural sustainability⁵. Results indicated by researchers addressing that changes in land use resulted in significantly higher SOC stocks in the less intensively used soil⁶.

Regarding to the soil conditions, it is worthy to understand the type of soil, select the adequate organic matter as amendment, choose good management practices to keep SOC, know the effects on carbon sequestration at short, medium and long term. Considering plants as the media for carbon sequestration, it is necessary to take into account the natural vegetation restoration and tree planting on degraded land. Regarding to the question, myth or reality? The answer must be reality but, we should consider more than the simple addition of organic matter to the soil. Soil, environment and socio-economic factors should be integrated to achieve the goal of carbon storage. The addition itself, would be the myth. So, let the soil work!

INTERREG BALKAN-MEDITERRANEAN: European Structural Investments Funds (ESIF) for Climate change mitigation and sustainable development in the Balkan Mediterranean area

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Abstract

Over half of EU funding is channeled through the 5 European structural and investment funds (ESIF). They are jointly managed by the European Commission and the EU countries. The purpose of all these funds is to invest in a sustainable and healthy European economy and environment [ec.europa.eu].

The Transnational Cooperation Programme (TNCP) “**Balkan-Mediterranean 2014-2020**” is co-financed by the European Regional Development Fund (ERDF), as well as by the Instrument of Pre-Accession Assistance (IPA) and has a total budget of approximately 40 million of Euros for the 2014-2020 programming period, while it brings together regions from three (3) different EU countries (Bulgaria, Cyprus, Greece) and two (2) candidate countries (Republic of Albania, Republic of North Macedonia). The Programme supports the sharing of experiences, knowledge and the improvement of public policies between national, regional and local authorities, while the main needs and challenges of the can be grouped in the following headings: socioeconomic development and demography, **environment and climate change**, natural and cultural heritage.

The impacts of climate change – already seen through temperature shifts and extreme weather conditions (floods, storms and drought), are certain to have wide-range effects in the territories. Reduced availability of water and energy (as a result of increasing temperatures and more variable precipitation levels) can increase the costs and/or reduce benefits obtained from using these resources. Fighting climate change and growing environmental concerns has become an integral part of main EU policies. On the other hand, the BM territories are particularly vulnerable to climate change and they need to capitalize on the trend towards energy efficiency management and low carbon policies. To reach this objective, considering both, limited financial resources and regulatory requirements on “thematic concentration”, the Programme has directed 25,5 M € (65%) under Priority Axis 2 ‘Environment’, having approved for funding in total 23 projects, under the 1st Call for Project Proposals (2016), out of submitted 209 with a total budget of 241.198.955,29 €.

In this framework, five (5) Good Practices Projects were selected under TNCP BM Programme:

1. BALKAN ROAD (Agriculture / Farming)

The overall objective is to promote technologies that enhance the wide implementation of sustainable management strategies at farm level, in terms of resources management and reduction of carbon, waste and water footprint of agricultural products in the BM area.

2. AIRTHINGS (Air Pollution)

The project will supply and install approx. 100 Internet of Things intelligent air quality measuring sensors in all BM countries - providing real time data through internet - forming a network of interconnected cities, jointly monitoring air quality, alongside with cloud based "Open data" system with predictive analytics and advanced machine learning capabilities.

3. PV ESTIA (Energy Efficiency)

The overall objective of the project is to enhance the penetration of PV's in the built environment, which is endangered due to their volatile nature and the limitations of the electrical distribution grids. The objective is to transform the buildings into a controllable energy source, thus making them grid friendly.

4. HERMES (Coastal Erosion)

HERMES is a network joint action aiming to upgrade the capacity related to coastal erosion mitigation and climate change resilience of local/regional/national authorities involved in the coastal zone management in the BM area.

5. DISARM (Natural Disasters)

The key purpose of DISARM project is developing, validating and demonstrating a set of services that employs state-of-the-art observational and modelling techniques, with the aim to assist interested authorities in better preventing, addressing and mitigating the adverse impacts of droughts and wildland fires, being intensified due to climate change. [TNCP Balkan-Mediterranean 2014-2020, Version 1.3 – approved by EC]

Urbanization, Land-use change and Demographic Transitions: Evidence from Southern Europe

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Abstract

While urbanization has been closely related to economic development and demographic change, heterogeneous patterns and processes of regional growth and change reflect the uneven distribution of urbanization, the subtle impact of demographic dynamics and the consequent implications for land resource management and environmental sustainability. Differences in patterns of urban growth and change in a paradigmatic region such as the Mediterranean basin —often masked by statistics indicating a net increase in urban population—reflect regional divides in socio-demographic, economic and environmental variables. To better understand the impacts of these regional differences, interdisciplinary research should better link socio-demographic and economic patterns from the one side - and environmental dynamics from the other side - to urbanization and regional/local processes of change. Going from regional to local, multi-scale analysis of environmental change gives more opportunities to ascertain the combined effect of

demographic dynamics on urbanization, evidencing the role of social transformations and the latent linkage with 'hegemonic' concepts such as that of land degradation, which is intimately related with both socioeconomic dynamics and environmental sustainability. Reconnecting impacts of regional-scale socioeconomic change with local-scale ecological dynamics definitely contributes to an enriched knowledge of environmental histories, outlining how a study of differences under assumptions of non-linearity and complex system thinking is key to understand future socio-environmental trends in the study region. This contribution finally encourages studies within a multi-disciplinary arena, stimulating further literature reviews aimed at discussing these deserving issues - proposing new theoretical frameworks at the same time, with empirical approaches, comparative works and case studies providing the necessary, informed ground to science and policy.

Agribusinesses under climate pressure

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Keywords: Climate change, agribusinesses, adaptation, international markets, environment friendly products, opportunities, risks

Abstract

Agribusiness is concisely defined as “a generic term that refers to the various businesses involved in food and fiber production (including farming), seed supply, agrichemicals, farm machinery, wholesale and distribution, processing, marketing and retail sales.” Agribusinesses are important part of the economic sector and they contribute to the society development as they increase the added value of raw materials, strengthen local rural economies, food security and nutrition, boost innovation and improve life quality in many areas at risk of exclusion and vulnerability. The challenges that agribusinesses face in the competitive environment of the international markets, and especially when competing with large companies and their clusters, are enormous, Low productivity capacity, limited variety of products, higher operational costs, limited access to the national and international markets, high certification costs, low-skilled personnel, etc., make agribusinesses less competitive than large businesses at national and international level.

In this environment within which agribusinesses are called upon to operate, another aggravating factor, this of climate change, is added.

The effects of climate change on agribusinesses are expected to be significant in the coming years and fall into two categories, (i) impacts on crops conformability to the new climatic conditions and consequently on crops yield, and (ii) the need to adopt and implement alternative practices that will reduce emissions of greenhouse gases

in large proportion, in accordance to the international and European decisions for the reduction in greenhouse gases emissions until 2050.

As regards the first parameter and taking into account the projection models for climate change, significant changes are expected in crops yield, which will be different in the different climatic zones of the planet. For Europe, we expect increase in agricultural productivity in the northern countries due to longer growing season and to an extension of the frost-free period. Warmer temperatures and longer growing seasons might also allow new crops to be cultivated. In southern Europe, however, extreme heat events and reductions in precipitation and water availability are expected to hamper crop productivity. Crop yields are also expected to vary increasingly from year to year due to extreme weather events and other factors such as pests and diseases. In parts of the Mediterranean area, due to extreme heat and water stress in summer months, some summer crops might be cultivated in winter instead. Other areas, such as western France and south-eastern Europe, are expected to face yield reductions due to hot and dry summers without the possibility of shifting crop production into winter. The consequences of these changes could be catastrophic for agribusinesses if they do not adapt in due time, do not consider them seriously and design their future strategy, e.g. shift to crops better adapted to the new conditions, gradual replacement of current plants with more adapted varieties, etc.

The climate strategy of the European Union aims to reduce greenhouse gas emissions by 80% by 2050. This reduction will be achieved by reducing emissions across all sectors of the economy and by promoting clean energy sources, waste exploitation for energy production, use of biofuels etc. Agribusinesses are not expected to be excluded from these changes and therefore timely planning and searching for the most appropriate solutions as well as determining the required investment costs are required.

In any case, the world market is already shifting to more environment friendly and low-emission production processes and products. The survival of agribusinesses depends to a large extent on their ability to adapt to the new market conditions and requirements, as well as their insight into understanding the narrow timeframes for their adaptation in order to gain a place in the market of environment friendly products early.

It is crucial therefore to understand this pressure for change as an opportunity, and not as a crisis or risk. As the consumers have already shifted to environment friendly products, the benefit of this shift will be twofold, environmental and economical.

Water-(Energy)-Food: how confident are we on the health and wealth of this Nexus in the climate change context?

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Abstract

Undoubtedly, water is perhaps the second most important resource after air, that is necessary to sustain most life formats. Every productive anthropogenic activity is directly or indirectly related to water resources availability and management. Its importance and vulnerability have been realized from the ancient times as evidenced by myths, masterpieces of engineering and legislative acts. Nowadays, the European legal framework is offering a wide armory of tools for sufficient protection and restoration of water, in order to ensure its sustainable management. In doing so successfully, the scientific community has developed a very deep understanding of the mechanisms that control water resources' pollution and overall deterioration. As a society we are confident about understanding everything about water, however we do not seem to be as comprehensive with regards to the dependencies of water to major elements that relate or depend upon water, such as food and energy.

Still, food is a crucial element to societal welfare and overall socio-economic stability and improvement. Despite its importance however, elementary yet of primary importance issues are still far from being adequately addressed and resolved; such issues include safety, security and adequacy. Food production requires directly and indirectly the consumption of considerable amounts of energy and presupposes water availability at reasonably quality. Improper management and use of water not only jeopardizes food production but also negatively affects soil resources.

It is therefore well understood that the relationship between the different elements of the Water Energy Food (WEF) nexus are rather complicated, often misconceived and certainly not addressed in an integrated and hierarchized manner. The complexity of the nexus is further increased during the past years, by the incorporation of climate change, which by itself is a very complicated, multi-parametric element the evolution of which is characterized by an enormous degree of uncertainty. Hence, a broadening of the nexus may be assumed necessary to include climate change, hence creating the WEFC nexus.

In Greece, as an example of the European south, water, energy and food have traditionally been addressed as individual elements, knowing and accepting a degree of inter-correlation, but never exploring the real in-depth dependencies and limitations. The past 2 centuries have marked an enormous development of the country and increase of its per capita income. Public health and sanitary conditions have been spectacularly improved. All these improvements were related to the extensive and often irrational mobilization of water resources and the excessive consumption of energy to produce food.

Irrational use and management of the resources had soon led to excessive reduction of water resources availability and often considerable deterioration of water quality, whilst saline water intrusion often led to coastal aquifers' salinization. In turn this salinization has triggered mobilization of heavy metals that rendered water inappropriate for most uses. The need for intensification of the agricultural production and also lack of knowledge led to excessive fertilization and often excessive use of plant protection products (PPPs). As a result, the bulk products production increased, but natural resources were reaching an alarming state in terms of quality and quantity, products were not necessarily released from agrochemicals, energy consumption for the agricultural production increased disproportionately and on top, ecological functions of dependent to agricultural areas ecosystems, were being seriously compromised.

Inappropriate use of water resources and lack of the nexus understanding and inter-correlation, has led to serious socio-economic anomalies from early to mid-20th century; The generalized decision of farmers to cultivate only cotton in Lemnos island, which is now known of its poor water budget and the vulnerability of existing aquifers to saline water intrusion, led in a few years' time to total destruction of agricultural production that forced local population to what is recorded as one of the largest immigration and emigration waves in the history of the country. Primary appearance of climate change in the form of prolonged droughts in the 1980's further deteriorated aforementioned conditions. Lacking understanding of the inter-connections amongst the elements of the WEFC nexus, pure profit (in the form of increased agricultural production alone) was the sole target. This deepened the water resources crisis which in turn led to water deficiency that several times compromised food security in several parts of the country. In the last few decades the rules of the market call for better qualities in entrepreneurship of farmers. In this framework, viability of farming activities passes through the optimal balance between resources consumption to achieve product yield of high quality.

Despite the SDG targets set by the UN and adopted by the EC, still large parts of the planet are deprived of water based sanitary facilities, access to fresh water, food safety, security and adequacy. On the contrary, the developed parts of the world do enjoy all of the above "commodities", still missing however a golden balance amongst the controlling elements of the WEFC nexus. Establishing a balance amongst the elements of this nexus requires deep understanding of existing inter-relationships and multi-faceted functions. It furthers call for in-depth societal deliberation through systematic sensitization and an honest and wide participatory approach with the inclusion of stakeholders, users and the society. The functions of each of the nexus elements is to be well-understood, along with the impacts in every related sector of the environment and the society. Only when this level of understanding is achieved, and trans-sectoral priorities and rules are set may a viable management of the nexus be designed and applied. We are very close to a non-return threshold with regards to life form sustainability as we know it. Respecting this line will certainly ensure the livelihood of our planet, crossing it will engage a new era for manhood that we are uncertain of its outcome.

The cost of climate change in Greece

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Abstract

The environmental and economic consequences of anthropogenic intervention on climate change are presented. Updated estimates by the Bank of Greece and the Academy of Athens on this issue show that by the end of the 21st century the effects of anthropogenic intervention are significant and lead to additional warming, especially during the summer months in Greece, which exceeds 3 degrees Celsius and overall the year exceeds the targets achieved at the 2015 Paris Conference.. The decline already observed in last century's precipitation in western Greece is expected to continue in the 21st century, and to drop by more than 15% in the same region. The most worrying of all the anthropogenic change is the observed increase in the incidence of extreme weather conditions with significant impact, not only on the increased probability of forest fires, but mainly on agricultural production and especially on the seaside. Some coastal areas are expected to become even more vulnerable due to the penetration of brackish water due to rising sea levels. Taken together, the cost of anthropogenic climate change is expected to exceed 700 billion euro by the end of the 21st century, which drops below 500 billion if the climate change adaptation strategy is implemented.

SESSION: Sustainable Agriculture

Evaluation of cover crop systems for building soil health and for weed suppression in sustainable agriculture

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Keywords: cover crops, legumes, soil fertility, weed suppression

Abstract

Cover crops are used as a tool to preserve agrobiodiversity, to enhance soil chemical and physical properties, increase carbon sequestration, as well as to help in suppressing weeds. Cover crops can be used in both field crops and orchards and can be integrated into a variety of cropping systems. Perennial cover crops are commonly used in cropping systems such as orchards, while annual cover crops are used in annual arable cropping systems. Two multi-species cover crop systems, a two-species and a seven-species mixture, were compared with a single-species cover crop for weed suppression and soil fertility building. The study was conducted at the American Farm School, in a clay-loam soil, for two consecutive years. The two-species cover crop system was a mixture of hairy vetch (*Vicia villosa*) and oats (*Avena sativa*), and the seven-species cover crop system was composed of four species of annual legumes (*Vicia villosa*, *Trifolium incarnatum*, *Vicia faba minor*, *Pisum sativum*) and three species of grasses (*Avena sativa*, *x Triticosecale*, *Lolium multiflorum*). Their effect on soil fertility and quality and their weed suppressing ability was compared to a single-species grass cover crop treatment of triticale (*x Triticosecale*), with a cultivated fallow treatment serving as a control in an RCBD experimental design. The leguminous cover crops were inoculated with the corresponding group of rhizobium inoculum. A UAV with an infrared camera was used to monitor cover crop growth and canopy development. Weed density within experimental plots and their biomass was measured and weed suppression by each cover crop system was estimated. Cover crop biomass and soil total nitrogen (TN) and nitrate-nitrogen (NO₃-N) were measured and soil microbial activity was estimated by measuring soil respiration.

The multi-species cover crop systems were shown to be very adaptable to weather conditions and consistently produced high biomass at both years. The two-species cover crop treatment was found to increase soil total nitrogen (TN) and nitrate-nitrogen (NO₃-N), producing a high legume biomass and contributing significantly greater TN than the other cover crop treatments. All three cover crop treatments resulted in higher soil respiration compared to the cultivated fallow treatment, with the single-species triticale treatment exhibiting the highest soil

respiration rates, followed by the two multi-species cover crops treatments. All cover crop systems exhibited a high weed suppressing ability. This study suggests that multi-species cover crop mixtures have potential to produce a high biomass to suppress weeds, contribute nitrogen to the following cash crop and improve soil health.

Could enhanced efficiency fertilizers mitigate agricultural GHG emissions in a sustainable fashion? Effects of nitrification inhibitor stabilized urea on soil N dynamics, NH₃ and N₂O emission and crop biomass.

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Keywords: nitrification inhibitor, fertilizer, nitrous oxide, agricultural soil

Abstract

Nitrogen (N) fertilization is an essential agronomic practise securing food, feed, fibre and other agricultural product yields for our growing population. However, N losses to the environment, such as emissions of ammonia (NH₃) and nitrous oxide (N₂O), and losses of nitrate-N (NO₃-N) to the environment are risks associated with fertiliser N use that must be better managed to help meet expanding societal expectations. Currently, the efficiency of N fertilization hardly exceeds 50%, which is the ratio of N applied to N used by the crop. The loss of applied N via N₂O emissions is very important in the context of climate change. N₂O is a very potent greenhouse gas that can cause 300x more warming than CO₂ and considering that global soil N₂O emissions are >60%, the link between N fertilization practises and N₂O emissions requires comprehensive investigation. Retaining N in the soil matrix and synchronising crop N needs to N supply is one approach to mitigate N loss in agroecosystems. The increasing adoption of enhanced efficiency fertilizers (EEFs) could mitigate the side-effects of N fertilization. Some EEFs contain nitrification or urease inhibitors (stabilized fertilizers), while others slowly release N components (slow-release fertilizers) or release N at more predictable rates (controlled-release fertilizers). Here, I investigated the effects of urea fertilizer supplemented with a nitrification inhibitor (NI; 2-chloro-6-(trichloromethyl) pyridine), on soil NH₄⁺ and NO₃⁻ dynamics, NH₃ and N₂O gas emissions and crop biomass in a short mesocosm study. Rye grass, *Lolium perenne* cv. Belinda, was grown for 90 days in a typical Mediterranean soil under late-spring ambient conditions. It was demonstrated that the application of NI with urea resulted

in a slower decay of extractable NH_4^+ with a concurrent increase in NH_3 volatilization. Integrated measures of soil NH_4^+ were 3-fold greater when NI was applied. At the same time, there was a 40% reduction in integrated measures of NO_3^- and NO_2^- when NI was applied. Soil N_2O emissions from urea fertilizers were reduced by 50% with NI. There was a small increase in crop biomass for the treatments receiving urea with NI, when compared to those without NI. NIs have the potential to reduce N_2O while retaining NH_4 in the soil, yet further studies are needed to propose new practices and new crop cultivars towards high-yielding agrosystems with lower fertilizer inputs.

Climate change effects on soil and groundwater

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Keywords: Climate change, Groundwater, Soil

Abstract

Climate change is a periodic modification which occurs when Earth's climate system change, giving new weather conditions that remains in place for a long period of time. As geological history of Earth is showing, climate change phenomena are happening almost from planets' Origin (National Research Council, 2010). Ice ages or global warming periods sometimes can be as short as a few decades, but sometimes can last for an extended period of time, like millions of years. In scientists research, like Warrens' et Johns' on 2006 and Lockwood et Zinderen-Bakker on 1979, are indicated more than five major ice ages during geological history, rotating with greenhouse periods which sometimes were ice free even in high latitudes. Since the industrial revolution, climate has increasingly affected propulsive as to climate change (Shaftel, 2016). Climate change can be attributed to natural processes and also to human activity. Natural factors include Earth's internal processes, such as volcanic eruptions, as well as external parameters, such as solar luminosity and Earth's orbital pattern around the Sun. Anthropogenic activity includes aerosol emission, changes in land use (Pan et Zaitao, 2019). Climate change phenomena impacts the earth's water and soil in multiple ways, those elements can also reflect impacts back, driving to climate change.

In our planet there are four types of water (Surface water, Ground water, Wastewater, Storm water), and three forms of it (Solid, Liquid, Gas). Water held underground in soil or between rocks is a big part of ecosystem, is responsible for

fresh water, human health, for all food, feed, fiber and fuel production, providing a raw of materials for any activity. As Taylor, R. G. et al (2013) said groundwater represent the larger available store of global freshwater. Variability of climate and climate change influences groundwater systems, both directly through replenishment by recharge and indirectly through changes in groundwater use (R.G. Taylor et al, 2012). Natural replenishment of groundwater, from both rain and surface water, is highly dependent of climate, land use, geology, and geomorphology. Long periods of droughts directly affect availability and dependency on groundwater, in those periods there is higher risk of depletion of aquifers.

As José Luis Rubio said, “Soil is a crucial link between global environmental problems such as climate change, water management and biodiversity loss”. Soil is crucial for ecosystem health due of its purifying properties at water; it’s also the engine for water and nutrient cycles. Soil is essential for biodiversity, constitutes the biggest reservoir of genes and species on earth and it represents the biggest global carbon sink (E.C.,2008). Soil could be destroyed, degraded, lost in every activity, change of it use· from industries and human use to climate changes, while it takes thousands of years to regenerate. Its degradation affects its ability to produce and provide services in various ways to the ecosystem. Different processes affect negatively soil’s composition, by including soil erosion, soil contamination, soil sealing, all results of climate change and human activities. Groundwater capacity and flow depends from soil’s characteristics that indicates how much water is actually available for use and how much water remains bound in it (Wang S. et Zhang Z., 2011). Main potential changes in soil forming factors from global warming are both direct, like the organic matter supply from biomass, soil temperature, moisture, as well as indirect though CO₂ cycle, like sea level change and land cover (Brinkman and Sombroek, 1996).

To mitigate adverse effects caused by climate variability and changes in water resources, we have to implement a lot of strategies to insurance low carbon emissions, greenhouse gas emissions, soil erosion, salinization, soil sealing etc.

Small scale farmer’s attitude and perception of climate change: an exploratory study

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Keywords: climate change, small scale farming

Abstract

Climate change and variability are as much of a reality as the very air we breathe yet most people do not acknowledge it as so, in spite of the fact that it is

rocking the very foundations of African society as subsistence agriculture is not only the main economic activity but it is the very essence of livelihoods. Slight disruptions in climate then become a major cause for concern, much pain, and suffering and even in some circumstance's death due to hunger and starvation as farming is a climate sensitive activity. These slight changes in climate affect rural populations the most yet they are least able to take them in their stride, adapt, adjust and move on. Even though this is a major concern this side of the planet, there is a dearth of information on climate smart practices that have been undertaken in this region, that can be embraced by farmers, or any indication that farmers are actually aware of the changing climate and are mitigating to it. To address this gap, this study looked at the perceptions of small-scale farmers of climate change, the factors influencing adaptation and the adaptation strategies they implemented. The study was exploratory in nature hence had a leaning toward qualitative paradigm, hence the data was collected using interviews, and was analyzed for thematic content using the NVivo statistical package for qualitative data analysis. The data was collected at Nswazi village in Matabeleland south, a semi-arid region that is prone to semi drought conditions and is no stranger to the scourging sun, One of the major findings of this study was noted when the respondents were quizzed on climate change and immediately launched into along anecdotes about the position of the "gods" in their culture, which is indicative of the fact that to the African, everything is viewed through religious lens, the climate notwithstanding .

Agricultural practices Countering Climate Change

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Keywords: Climate change, plant protection products, fertilizers, mitigation, adaptation

Abstract

Agriculture is particularly susceptible to climate changes due to changes in precipitation patterns and to unusual weather conditions which directly affect farming activities. On the other hand, agriculture also contributes to climate change through the release of greenhouse gases (GHGs) into the atmosphere. Agriculture is a great contributor to climate change and it has been estimated that about 30% of global

emissions which leads to climate change are attributed to agricultural activities, including the use of Plant Protection Products (PPPs), chemical fertilizers, livestock, biomass and empty pesticide containers burning. For example, methane emitted from livestock digestion processes and stored animal manure, nitrous oxide emitted from the use organic and mineral nitrogen fertilizers.

Additionally, climate change has a dramatic effect on the abundance and activity of seasonal pests, the duration of cropping season and consequently a conceivable increase on chemicals used. Any significant climate change on a global scale should influence local agriculture, and indirectly may affect the world's pesticide use.

Agricultural production strongly depends on crop protection measures. For that reason, in the production of field crops, PPPs and chemical fertilizers are applied to control pests and promote crop yields respectively. The use of Plant Protection Products (PPPs) has become the most common approach to pest control. Although the use of chemicals increases food safety and standard of living, their production and use contribute in several ways in increased levels of carbon dioxide. It has been reported that in due course carbon included in the active ingredient of a PPP could be broken down and consequently emitted in the atmosphere as carbon dioxide. It could be assumed that also other break down products such as methane and nitrous oxide could possibly be produced but in a lesser extent. Additionally, the use of machinery for field operations also contributes to the increased levels of carbon dioxide. Although burning of empty plastic pesticide containers is prohibited by law, this is a common approach in many developing countries which could also lead to increased carbon dioxide levels.

Regarding chemical fertilizers which are used in agriculture and are essential for crop production as they provide elements such as nitrogen, potassium and phosphorous which are essential for plant growth, their production requires intensive energy to be produced, create vast amounts of waste, and in that way contribute to greenhouse gas emissions.

Agriculture sector is among the most sensitive areas to climate change, though it holds a large potential to reduce greenhouse emissions. Although, it is part of the problem of climate change; it could be part of the solution.

As regards the future of agriculture sector under climate change, a number of measures could be undertaken for farming practices, whereas crop rotation, reduced the quantities of PPPs and chemical fertilizers, using different varieties could be considered as the most important.

Mitigation measures have the potential to reduce climate change impacts, and adaptation can reduce the damage of those impacts. Both approaches could contribute to the development of agriculture that is more resilient to the threat of climate change. Increasing energy efficiency and reducing greenhouse gas (GHG) emissions to mitigate climate change could be the two most important goals for agriculture.

Regarding adaptation plans in agriculture, there is a range of them that have to be taken at farm and sectorial level, from technological solutions to adjustments in farm management or structures. Adaptation measures that have to be considered at farm level, could be for example the selection of crops and varieties that better adapted to the expected length of the growing season and water availability,

improving the effectiveness of pest and disease control through better monitoring, diversified crop rotations, or integrated pest management methods.

Adaptation measures have to be taken at sectorial level and could be the following:

- identification of vulnerable areas and assessment of needs and opportunities for changing crops and varieties in response to climate trends
- support to agricultural research and to experimental production aiming at crop selection and development of varieties best suited to new conditions

Diagnosis of the agro-food value chain studies in Fieri Region

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Keywords; Agro-food value chain, integrated diagnosis, cluster.

Abstract

A study was conducted on an integrated diagnosis of the Agro-food value chain in Fieri region in Albania, this is necessary in order to map the local production and the people involved, identify problems, collect data that can be used as tools for solutions, describe potential alternatives and achieve knowledge exchange. The municipality of Fier is located in the western part of Albania, south of the Myzeqe area, is bordered by two main rivers, Semani in the north and Vjosa in the south. The Municipality of Fier is 43580 ha, where 35850 ha is agricultural land cultivated from which 33212 ha arable land and 2621 ha uncultivated. Over 70% of the territory of Fier Municipality is made up of agricultural land. Around 37% of the population live in areas where dominate the agricultural economy. The Municipality have 25 919 farmer families or 86 210 farmers working in the agro-food sector. Registered farms are 16 235 and 9684 are unregistered. The study aimed to determine (i) the identification of the local production of agro-foods and understand its contribution to the local and national economy as per its volume as well as its financial aspects, (ii) to find, approach and interact with all the involved parties in the agro-food chain, including producers, cooperatives, processors and traders as well as authorities, (iii) to address the problems concerning the agro-food sector in Fieri region. The methodology is based on the findings of existing data from secondary sources and data collected from interviews of 667 producers, 24 packers, processors and logistics and 29 authorities or policy makers as well as discussions held during the meetings with different stakeholders. The survey was conducted between March and August 2018 and the target group was consisted the producers (TG-1), the packers, processors and logistics (TG-2) the authorities or policy makers (TG-3). The results showed that the agro-food sector in

Fier is part of the tradition, the family business or one personal choice. About 32.8% of the producers have 11-20 years of experience and more than 30% have 6-10 years working in agro-food sector. The 54% of TG2 people interviewed are processors and 17% of them are packers working in private sector. The producers and processors are oriented towards the market, and they need the implementation of contemporary techniques. The processors evaluated as common problem the technical problems, the trading problems, the financing and products price. The processors think that the employees' experience and knowledge can influence the quality of the products by 92% of them. Today's ambitions of producers and processors are oriented towards the market, and therefore the need for implementing contemporary techniques of processing processes is needed Food Safety Management System (FSMS). The authorities have a very good knowledge of situation of the agro- food sector in Fieri municipality. The interviewed are involved in sector issues, and they have received or participate in agro-food programs implemented. The difficulties of agro-food sector are related to infrastructure, inputs, storage conditions and product processing. It is estimated that knowledge is limited in terms of Good Agricultural Practices, legislation, marketing and trade issues.

Sustainable management of irrigation water under climate change

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Keywords: Irrigation; Water efficiency; Water reuse; Innovation; Precision irrigation; Capacity building

Abstract

Water is considered as the most critical resource for sustainable development worldwide. It is essential not only for agriculture, industry and economic growth, but it is also the most important component of the environment, with significant impact on health and nature conservation. The agriculture worldwide today accounts for on average more than 70% of water used. Irrigated areas will increase in coming years due to climate change, while fresh water supplies will be diverted from agriculture to meet the increasing demand of domestic use and industry. Furthermore, the efficiency of irrigation is very low, since less than 65 % of the applied water is used by the crops. To overcome water shortage in agriculture it is essential to increase the water use efficiency and to use marginal waters (reclaimed, saline, drainage) for irrigation. The sustainable use of water is a priority for agriculture in arid and semi-arid areas. Imbalances between availability and demand, degradation of surface and groundwater quality, inter-sectorial competition and inter-regional conflicts often

occur in these regions. So, under scarcity conditions and climate change, considerable effort has been devoted over time to introduce policies aiming to increase water efficiency based on the assertion that more can be achieved with less water through better management. Better management usually refers to improvement of allocative and/or irrigation water efficiency. The former is closely related to adequate pricing, while the latter depends on the type of irrigation technology, environmental conditions and the scheduling of water application. Precision irrigation, which takes into account climatic, soil and plant parameters to estimate crop water requirements, is related with the sustainable water management in agriculture and protection of the environment. It not only provides the optimum soil moisture and nutrients necessary for plant growth, but it also contributes to control erosion, soil and groundwater degradation. Socio-economic pressures and climate change impose restrictions to water allocated to agriculture. The adoption of sustainable water management is not only a technological problem but involves many other considerations relative to social behavior of rural communities, the economic constrains, or the legal and institutional framework that may favor the adoption of some measures and not others. Sustainable water management in agriculture can be achieved by adopting improvements in irrigation application, soil and plant practices, water pricing, reuse of treated wastewater, farmers' participation in water management and capacity building.

Dynamics of litterfall production and its correlation with soil greenhouse gases in a peri-urban forest after thinning implementation and their climate change mitigation potential

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Keywords: Greenhouse gases, litterfall production, thinning implementations, global warming potential, climate change mitigation

Abstract

The implementation of different forest management practices, such as thinning, can affect the budget of GHG through the alteration of soil characteristics and biochemical procedures. However, the knowledge of the response of thinning implementation on forest soil-atmospheric greenhouse gas (GHG) (CO₂, CH₄ and N₂O) fluxes exchange system especially in Mediterranean ecosystems is limited due to the high heterogeneity of both soil properties and forest biomass. Litterfall production

also plays a primary role on both a forest's ecosystem's sustainability and on the GHG exchange system occurring between soil and the atmosphere. Any alteration of litter layer of the soil can influence the soil GHG fluxes dynamic. In this study we assessed the response in medium term of GHG fluxes and litterfall dynamic to three thinning treatments (traditional thinning; a medium-heavy intensity thinning - 21% basal area removal, selective thinning; more intense 40% basal area removal, control; no thinning) two years after thinning implementation.

The study site is located in the peri-urban forest of Xanthi (41° 09' 27.3' N – 24° 54' 09.8' E, Greece). GHG fluxes were measured twice per month intervals for two years (Oct-16 until Sep-18) after thinning operation (Sep-16) using the closed static chamber method. Global Warming Potential (GWP) of GHG emissions for each treatment was also quantified in order to estimate the mitigation potential of thinning practices in global climate change forest sector. Within the plots, there were two traps (50 x 50 x 30 cm) widely used for the estimation and evaluation of the litter decomposition they were placed in each plot at 1m height from ground, near the collars used for the measurement of soil GHG fluxes. The trapped litter was collected in numbered of paper bags once at the end of each season during the study period. Each litterfall sample was sorted at eight different fractions: pine needles, deciduous leaves, twigs and branches < 4.5 cm, reproductive structures and bark from both conifers and broadleaves.

The results obtained showed that thinning can affect significantly CO₂ fluxes variation, two years after thinning implementation, although the effect size is low. The mean annual CO₂ emission was significantly lower in selective compared to both traditional and control sites. CH₄ uptake observed throughout the study period in all treatments, that increased significantly with increasing thinning intensity. No significant changes occurred in N₂O fluxes variations. Thinning was able to decrease significantly litterfall production in both thinned sites. Conifer fractions (pine needles and pine bark) reduced significantly in the most thinned plots, in contrast with broadleaved were increased in the most intense thinning site, favoring the broadleaved native species. In medium-term, there was no correlation between CO₂ and N₂O fluxes with litterfall in contrast with CH₄ uptake that was significant and positively correlated with broadleaved fractions in all treatments. Reduction in Global Warming Potential (GWP) was observed in both thinning treatments, markedly in selective, giving an initial picture that high intensity thinning in this degraded forest, presents a high potential for global climate change mitigation in forest sector.

In conclusion, the results presented here show that silvicultural practices, such as thinning, can affect the litterfall production which in turn, control and influence the soil GHG exchange system in relation to the atmosphere in the mitigation content in a degraded coniferous ecosystem in Greece. However, a long-term in situ research is essential in order to extract definite conclusions regarding the response of silvicultural practices in the global change mitigation targets.

Innovative solutions for maintaining and improving soil fertility protecting the environment and mitigating climate change

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Keywords: sludge, composting, decontamination, gypsum

Abstract

Climate change is caused by the release of greenhouse gases into the atmosphere. These gases are accumulated in the atmosphere, leading to global warming. Research has focused on protecting the environment and limiting the negative effects of climate change. The report addresses issues related to the characterization and evaluation of sewage sludge and the possibilities for their use in agricultural practice as a soil improver, for the rehabilitation of disturbed and poorly productive terrains, in forestry and others. Methods for decontamination of sludge before their utilization have been developed and put into practice. Soil changes have been identified as a result of the use of sludge as a soil improver. By-products of bio-sludge obtained from biogas production as an organic reserve are conducted. New soil improvers are presented, such as industrial gypsum obtained from the desulphurization installations /SOEs/ of Maritza-East 1, composting as an alternative to organic fertilization and environmental protection.

In conclusion, it is noted that in Bulgaria a number of problems with various organic wastes are being worked on in order to find the most efficient and rational technological solutions for their utilization and environmental protection. New technologies limit carbon emissions in the atmosphere and limit negative climate change.

Estimation of the above ground biomass and carbon stock in the restored mines of the Western Macedonia Lignite Center

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Keywords: climate change mitigation, forest restoration, forest biomass estimation, geostatistics, kriging regression

Abstract

Forest plantations have immense potential to store carbon, playing a substantial role in climate change mitigation. The assimilated carbon is stored in the above and below ground parts of the trees, in dead wood, in litter and in soil. The Lignite Center of Western Macedonia having the obligation to rehabilitate the restored areas after the end of the mining activity, started to create tree plantations in the 80s. Today some of these plantations are almost forty years old and occupy more than 2,000 ha in total. The dominant planted species is the black locust (*Robinia pseudoacacia* L.), a fast-growing pioneer species, covering 95% of the planted area. Other planted species are *Spartium junceum*, and *Cupressus arizonica*, covering 2.45% and 1.44%, respectively.

The aim of this study is the estimation of the above ground biomass and the carbon stock and its distribution across the planted areas of the Lignite Center of Western Macedonia. 215 sample plots of 100 m² each were set up through systematic sampling in a grid dimension of 500 x 500 m. In each sample plot the tree species, breast height diameter (cm), tree height and the height to the base of live crown (m) were tallied. The standing and laying dead wood were also recorded. The above ground biomass was estimated using an exponential allometric model for black locust of the form $M=a \cdot dbh^b$ and its distribution along the planted areas was calculated using geostatistics and kriging regression. The results have shown that in the Amyntaio mine field the above ground biomass ranges from 20,1 to 90,2 tn ha⁻¹ with a mean value of 55.3 tn ha⁻¹ or 36,9 to 165,2 tn ha⁻¹ in terms of CO₂ equivalent. In the Ptolemaida mine field from 11,6 to 75,8 tn ha⁻¹ with a mean value of 36.3 tn ha⁻¹ or 21,2 to 138,8 tn ha⁻¹ in terms of CO₂ equivalent. The biomass distribution in Ptolemaida mine field seems to show a spacial orientation (anisotropy) from Southeast to Northwest. This might be due to the course and direction of the excavations and their corresponding plantation restorations. This spatial anisotropy occurs to a lesser extent in the Amyntaio mine field to west and north where these parts are close to the active mining areas and have therefore been recently restored by planting. The black locust shows a remarkable ability to survive and grow on disturbed sites such as the restored mines of the Lignite Center of Western Macedonia. It is very competitive compared to other planted species and has created the necessary forest environment for the natural regeneration of other, more shade and soil demanding species such as oaks and maples.

Acknowledgements

This research was funded by Single RTDI state Aid Action Research –Create – Innovation with the co-financial of Greece and the European Union (European Regional Development Fund) in context with Operational Program Competitiveness, Entrepreneurship and Innovation (ΕΠΑΝΕΚ) of the NSRF 2014-2020 (project Contribution of the tree planted land of West Macedonia lignite center to protection of environment and to mitigation of climate change T1EDK-02521).

Conversion of coppice oak forests in the service of multifunctional forestry towards climate change challenges (region of Karditsa, Greece).

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Keywords: coppice oak forests, conversion, carbon storage, multifunctionality

Abstract

Greece is a predominantly oak forest country. The majority of these oak forests are coppice managed, combined with the intense relief and additionally, influenced by climatic change, often exceeding their resilience, resulting in their continuous deterioration. The importance of conversion of oak forests in Greece is a major environmental goal, particularly necessary to restore degraded and overexploited lands, balance regional water cycle by reducing run-off, flooding and by increasing the control of groundwater recharge and watersheds protection, reduce soil erosion and eventually desertification, but also to settle the significant multifunctionality of forest ecosystems, consisting also in soil protection from wind and alluvial erosion, microclimate regulation, CO₂ sequestration, biodiversity conservation, wood production, as well as aesthetic and recreational function.

The aim of this research is to investigate the conversion capability of degraded coppice oak forests in the region of Karditsa into high, valuable, multifunctional forests, defining an appropriate model of conversion, based on primary forest functions. The spatial representation and analysis of forest functions can constitute the base of forest planning. An effort of mapping the basic forest types according to their appointed primary function was made using GIS.

Thus, coppice oak stands were classified as protective (forests of general protective role, forests that protect infrastructure, riparian forests with hydronomic function), estimated that they should occupy 37% and aesthetic, estimated that they should occupy 56% of the total area covered by coppice oak forests (2.543,45 ha).

The mapping of forest types did not lead to completely different management models, since the general framework of conversion is proposed in each category, but in some limited degree modification of individual actions, depending on each appointed primary function. The general framework of the proposed conversion is the extension of the rotation length to 120 years, with the prerequisite of lifting deterioration factors, such as illegal logging and grazing. The conversion is proposed to be implemented primarily in stands of good site qualities, by conducting positive selection cutting, to favour the prospective individual logs, removing their most acute competitor. The conversion is proposed to start at age 10 or earlier or at age 20 at the latest. The thinning is proposed to be applied up to 20% in good site qualities and up to 15% in bad, favouring Fir and deciduous species, as Hornbeam, Ash and Chestnut, already occurring in the area. In stands of worst site quality, the natural method of conversion is mainly proposed. Regarding the silvicultural treatments of protective

forests, particular attention should be given in the reduction of disruptions and soil compaction, and in the handling of logging residues, by placing them alongside the contours to prevent erosion. In the treatment of aesthetic forests, particular attention should be given in potential artificial introduction of Fir, which in this particular case is proposed to be of a very limited scope, to avoid disturbance of the ecological niches, which would cause unpredictable consequences in the biodiversity, in non-removal of logging residues, which contribute to the increase of complexity and in creating and maintaining forest gaps.

The method of conversion combines many of the management practices that contribute to climate change mitigation and adaptation. Increasing complexity of forest structure, using extended rotation length, selective logging, creating uneven aged mixed stands are proposed methods to increase carbon storage, deteriorate climate change effects, while highlighting other forest functions.

Technological solutions for high salinity irrigation water use of max grow – an electronic treatment device - for sustainable vegetable growing

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Key words: saline irrigation water, electronic water treatment, salinity, productivity

ABSTRACT

One of the major emerging issues in irrigation water is the increase in salinity levels worldwide. This is expected to negatively affect and reduce crop productivity and sustainable food production. Most crop species are sensitive to certain levels of electrical conductivity of soils (ECs) and irrigation water (ECi) and the management choices are very limited to face this problem. Efforts and technologies to reduce the salinity of water exist but are rather expensive and their overall efficiency is considered relatively low. Desalinization is the main solution but the return on investment (ROI) from these technologies is very low. New technologies emerge using other principles such as water dissolution with low range radiation and have been proven quite effective. A long term goal of many studies conducted at Perrotis College is to evaluate the effectiveness of an electronic water treatment system, the MAX GROW device, under harsh conditions of water salinity levels to their effects in growth and productivity of vegetables grown in greenhouse substrates in pots and under floating systems.

MAX GROW is an electronic water treatment system using multiple transmissions of radio frequencies in three different frequency bands simultaneously (ULF/LW/MW) to tackle the problems caused by saline water and water with high concentration of calcium carbonate ions commonly known as limescale. The cutting

edge electronics ensemble generates up to two million pulses per second in a constantly altering transmission bandwidth, enabling MAX GROW to dissolve all the ions of the metallic salts, particularly the ions of calcium, carbonate, nitrate and sodium, altering their given by nature, electrochemical charge (www.maxgrow.tech). This device was tested under a number of hydroponic substrates in pots and soils as well as under floating disk production systems, using irrigation water qualities in very high levels of ECi (at 8, 12 and 20 dS/m). The crop species included leafy and other vegetables sensitive to low and medium levels of ECi. Results have shown that the device was very effective in treating the highly saline water, as indicated by the higher yields and in some cases statistically significant increases, at all measured levels. More studies are in progress in greenhouse and field conditions. The device can potentially be used in all irrigation systems, independent of the size (diameter) of the irrigation lines and the level of water's electrical conductivity.

Drainage water characterization to determine the possibilities of desalination for irrigation reuse

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Keywords: agriculture, electrical conductivity, drainage channels, salinity

Abstract

Water scarcity is one of the major problems in the world and Climate Change impacts are secondary drivers of agricultural water demand (FAO, 2011). Under this scenery, the reuse of water for agricultural purposes is a necessary target for land sustainability and food supply (Hallack-Alegría and Watkins, 2006). Among the options for augmenting freshwater resources is the desalination of salty groundwater, brackish drainage water and seawater (FAO, 2006).

In this sense, the drainage channels that recover excess of water from agricultural irrigation and subsurface waters can be an adequate source after treatment. This is the frame of the traditional irrigation systems of the South of the province of Alicante (Spain), which has more than thousand kilometres of drainage channels. Water of low quality is commonly used for irrigation several times (two or three times). However, water is becoming more saline after each use. Desalination treatments can help to improve the water quality of drainage water to be reused for irrigation, reducing the salinity. The demand for desalination plants continues to

increase dramatically, and one of the key measurements critical in desalination is conductivity (Hashimoto, 2015). Increasing salinity, the service life of the membranes becomes shorter and the cost increases accordingly (Guler et al., 2015).

The main objective of this work was to study the water quality of the drainage system in the counties of *La Vega Baja* and the *Baix Vinalopó* (Alicante, Spain), in order to determine which of channels has water that can be easily desalinated. Salt content was analysed (electrical conductivity and the major anions and cations). Additionally, the mean flow of the channels was determined to know which of them could provide more water.

The channels analysed were divided into two groups, depending on the mouth of the two main rivers where they finally flow: Vinalopó River and Segura River. A total amount of 13 main channels and the two rivers were analysed during the period 2016-2018, at the end of the drainage channel but far enough from the coast to avoid influences of seawater.

The results showed that waters associated to Segura River are generally less saline than those associated to Vinalopó River. However, the water flow was very different in the drainage channels. Mean electrical conductivity range between 3.1-15.5 mS/cm while the water flow result in a wider range between 0.01-4.18 m³/s. The effectiveness of a desalination plant would be associated to a compromise between salinity and availability of water. For instance, the *Dulce* channel gave the minimum salinity (3.1 mS/cm); however, the mean water flow was 0.01 m³/s. In the other side, *El Convenio* channel gave a mean electrical conductivity of 10.8 mS/cm with a water flow of 4.18 m³/s.

To implement a desalination treatment, both parameters should be considered for the optimization of the process, salinity and availability of enough water. In this line, the *La Reina* channel has a 3.7 mS/cm and 2.18 m³/s, which could be the best option to install a desalination plant. This research was supported by the Conselleria de Agricultura, Medio Ambiente, Cambio Climático y Desarrollo Rural of the Valencian Government (Spain).

SESSION: Modern Technologies-Decision Support Tools

Modern technology machinery in agricultural operations and environmental protection

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Key words: rice combine harvester, precision agriculture, GPS, natural resources

Abstract

In this study is being investigated the efficiency and economic performance of combine harvesters by using stalk choppers to avoid the burning of residues that causes atmospheric contamination. Combustion of residues from rice harvesting eliminates harmful insect outbreaks, controls weeds and crop diseases. However, combustion actually causes atmospheric pollution emitting CO₂. In addition, incomplete combustion of residues produces carbon monoxide and non-combustible hydrocarbons that cause cancer. On the contrary, the incorporation of residues into the soil, returns most of the nutrients and contributes in the long term to maintaining nutrient stocks in the soil. For the purposes of the research, was applied the time method on a plot of 40 acres, which is used for rice cultivation, in Nea Malgara, Thessaloniki. Fixed and variable times and delays were calculated to evaluate the performance of the combine harvester. Fixed and variable costs, as well as operator costs, were also calculated. All basic parameters and functions of the machine are being analyzed on the IntelliVIEW™ IV screen. The combine harvester uses the Dual-Chop™ system for rice harvesting and ensures optimum dispersal of residues, so no combustion is applied to the plot. The research has shown that in the rice harvest, with the help of modern technology, the labor speeds are higher, thus saving time, improving yield crop and increasing productivity, reducing labor hours and fuel consumption and in general reducing operating costs of the harvester as hours of work increase. This technology conserves natural resources – soil, water and air – and reduces greenhouse gas emissions. These measures are aimed at reducing waste while increasing recycling and reuse on farms.

Calibration procedure for remote sensing of atmospheric CO₂ using differential absorption continuous-wave laser device

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Abstract

An established method applied for range-resolved gas assessment is the differential absorption lidar (DIAL) technique [1]. DIAL is based on the retrieval of the atmospheric backscattered light from a pulsed laser that is transmitted into the atmosphere. The laser wavelength is sequentially alternated between two wavelengths, one coinciding with an absorption line of the gas of interest (λ_{on}), the other in the close vicinity, but off the absorption line (λ_{off}). A critical term to calculate the concentration of the selected molecular species in the ambient air using DIAL equation is the distance z of the laser beam propagated in the atmosphere.

During CLIMAMED project a compact, robust and reliable device was developed that is capable to measure greenhouse gases concentrations in the atmosphere based on continuous-wave lasers (cw lasers). The system that was developed is not able to determine the distance z through the laser pulse since it is equipped with a cw laser. However, the distance can be determined based on the characteristics of the detection system (telescope and detector) and in particular from the depth of field. Therefore, the DIAL equation can be applied for concentration measurements of greenhouse gases. In the present work preliminary results of CO₂ concentration measurements in the atmosphere will be presented based on the proposed approach.

[1] Vladimir A. Kovalev, William E. Eichinger, Elastic Lidar: Theory, Practice, and Analysis Methods, John Wiley & Sons, New York, Apr 27, 2004, pp. 333. ISBN 0-471-20171-5

Sustainable Management of crop protection using spraying drones (UAVs)

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Key words: spraying drones, crop protection, sustainable crop management

ABSTRACT

In the new decade coming, applications in sustainable crop management, as a means to further mitigate the climate change effects, will focus on more precise management practices. New technologies and methodologies, under the umbrella of Precision Agriculture, will provide sustainable solutions to farmer's level and measurable results to small- and large-scale farming, in contrast to the so far achieved minimal results. Changes in legislation, mainly in the new Common Agricultural Policy (CAP) in EU will further facilitate these developments. Conventional means of spraying various materials to crops, such as pesticides, foliar fertilizers and biostimulant will be enhanced with the use of aerial means, using spraying drones. There is a significant lack in literature on studies conducted to evaluate spraying characteristics and potential of various systems including aerial spraying types. Long term research projects conducted and in progress at Perrotis College/American Farm School, provide concrete evidence of advantages and evaluation of spraying drones (Unmanned Aerial Vehicles, UAV's) compared with the most common ground systems used by farmers. Results from studies in high density olive production systems will be presented and major spraying characteristics and comparisons will be provided. The location of the study is in the American Farm School is a long-term study olive grove, where new production systems adapted for mechanical harvesting are practiced since 2011. The experimental design includes three planting densities (1670, 100 and 500 olive trees/ha), two of the most popular worldwide used varieties in high density systems (Koroneiki and Arbequina), two levels of irrigation are applied (conventional and deficit corresponding to 30-50% less than the conventional) two levels of ground applied fertilizers (conventional and 50% less) and also a foliar application of a biostimulant system, composed of three elements. One line from the super-high-density configuration was selected for the evaluation of the most commonly used ground spraying systems and type of two types of spraying drones. Measurements were taken using Water Sensitive Papers (WSP) placed in four trees and 6 positions within each tree for all systems evaluated. Duration of application, amount of solution used were recorded and the 24 WSP were scanned and analyzed with two software to measure spraying characteristics, such as spraying coverage %, number of droplets and size distribution. The results from two years provided a database for initial comparison of the mode of spraying for each type and indicated some advantages of the aerial. The drones used the least amount of solution, lowest spraying time and better droplet distribution. The two types of nozzles used in some systems, provided different distribution patterns, with the electrostatic ones exhibiting improved droplet uniformity in size and in space.

The study is under progress with additional crop species and setting of the aerial systems under evaluation, to include the final efficiency in crop protection issues during the 2020 growing season, in application in farmers of olives, grapes and field crops species. The main issue is that the technologies in spraying drones are fast developing and provide better technical characteristics, while the prices of the systems are reduced, something that does not happen with the ground systems and the costs of agrochemical inputs, which represent the highest cost of all agricultural inputs. Therefore, the potential benefits of aerial spraying are expected to be more than those reported in this study in the near future. Initial costs estimations further verified the benefits of aerial spraying. Environmental implications are indirectly concluded and are significant in the context of climate change mitigation.

Development of an innovative cotton production support system using satellite remote sensing, sensors and advanced agronomic models

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Keywords: Precision Agriculture, Satellite Remote Sensing, Decision Support Systems, Agronomic Models, Irrigation, Cotton

Abstract

Agriculture and Climate change is one of the key issues nowadays as climate change influences greatly agriculture and agriculture has a great environmental impact.

This paper presents the structure and key features of a decision support information system that will cover the two largest, most time and money consuming problems in cotton cultivation, which are irrigation and pest control of *Helicoverpa armigera* (green worm). These two issues (water consumption and green worm pest control), have great environmental footprint. Both issues require integrated management, both in terms of environmental protection and economical sustainability. The creation and usage of a decision support system for cotton cultivations, based on remote sensing and in-situ data is an urgent need for cotton

cultivation, but also for modern agriculture in general, as it will save natural resources and at the same time reduce costs. With the proposed system it is estimated that the use of irrigation water will be significantly reduced, reducing the aquatic footprint.

In addition, timely and targeted interventions for the green worm will reduce production costs by up to 25%, increasing the viability and sustainability of cotton cultivation in Greece. The common agricultural practice in order to minimize the problem of the green worm, is exaggerated usage of chemicals, with a direct environmental impact.

The main objective of this Information System is to provide a valuable consulting tool for the agronomist and farmer, and will support his daily activities, having in mind the minimization of the environmental footprint of the cultivation of cotton. The presented information system will combine the use of innovative means of data recovery from IoT sensors, remote sensing data, as well as agricultural models predicting phenological stages and other parameters related to the quality and risks of cotton cultivation. Farmers have access from their personal computers and from their mobile devices, through a user-friendly web application.

Ecological mapping of the impacts derived from the construction and operation of Egnatia highway at Xanthi prefecture after the analysis and processing of vector and raster data of the area through Geographic Information Systems, as well as with the preparation of the environmental impact study of the project.

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Keywords: Road infrastructure, biodiversity, geographic information systems, environmental impact assessment, descriptive checklists.

Abstract

Road infrastructure plays a significant key-role of development policies that are directly related to social, economic and territorial cohesion of states, but also the European Union as a whole.

Given the need for road infrastructure, as it is noted also at the White Paper of European Community (Commission of the European Communities, 2001), a parallel ecological vision of road projects, can seriously raise issues of changes and alterations these projects may bring at the natural environment. Besides loss of habitat, those projects can cause disturbance and changes in the amount and the balanced physical

connectivity. It is important to note the alteration of hydrological processes of areas susceptible to these projects. These infrastructures impact in a negative way on ecological processes, creating species extinction conditions, migration and a total modification of genetic material, with a significant impact on food chains and the overall biodiversity of areas which hold those projects.

In Greece one of the largest road construction projects is that of the Highway Egnatia, which has even been included in the Trans-European Road Transport Networks priority. The highway of 670 km crosses the entirety of Northern Greece by connecting urban centers, ports and airports succeeding in reducing of time travel and so providing better access to remote areas and populations closer to large urban centers.

In this study, with the help of geographic information systems, an analysis of spatial data of the study area is carried out, as an effort to record and assess the ecological footprint of the construction and the operation of the Egnatia highway, the changes, the rearrangements and the risks that may cause in both the human environment and the wider natural environment of such a rich ecological area.

Supplementary tool for final conclusions and decisions in the current study, is the preparation of the Environmental Impact Study (EIS) of the project, identifying the different types of ecosystems in the region affected by the Egnatia highway. Then follows an assessment of the expected losses and pressures on the ecology of the area, using the technique of descriptive lists.

Part of the results in this present study, document the low level of burden and deterioration of environmental and anthropogenic variables, which are in connection with the construction and operation of the Egnatia highway in the study area county. It appears that the most likely negative effects of the project, concern the area of Nestos river, with habitats cut-off phenomena, transforming landscape and the disturbance of wildlife.

The climate exposome: a new tool for addressing the health impacts of climate change

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Abstract

The current state of play in the climate policy debate internationally focuses on two key aspects: the relevance and proper extent of mitigation measures in order to avoid crossing the point of no return; and the necessity for adaptation measures

considering the very different socio-economic state and dynamics across the globe. For this, assessing properly the health benefits of policy measures geared towards adapting to the incumbent climate change is a key requirement for accurate impact assessment of the measures envisaged. In this context, reliable quantification of direct and indirect impacts related to both climate change and to climate mitigation policies and measures is a sine qua non for further climate action. Lack of reliable data and comprehensive integrated assessment models hampers decision-making in government, industry and the financial sector.

The exposome concept accounts for the totality of exposures over an individual's life course, focusing inevitably on age windows of increased susceptibility. Rendering it operational requires development and adaptation of novel tools for exposure assessment (both external and internal). Making use of the exposome for comprehensive health risk assessment on the population scale requires development of advanced statistical and biochemical/pathology models based on a combination of environmental and high dimensional biological data, enhanced by machine learning and big data analytics. In addition, agent-based models help capture the changing socioeconomic dynamics that influence societal vulnerability to climate-induced health stress. Considering the change in environmental pressure and human exposure to health stressors linked to climate change would allow us to construct the climate exposome: namely, the exposome of human population subgroups considering the climate change aspects relevant to the ca. 80 years of the human life course.

In this talk, the methodological framework for unraveling the climate exposome is presented and examples demonstrating its applicability and usefulness in climate decision-making are given. The ultimate objective at this point is to start the scientific discussion on the new generation of integrated assessment models. This entails a model scheme based on enhanced data fusion and on the concept of ensemble modelling, supported by big data analytics for filling data gaps. This methodological framework and toolbox should support science-based decision-making in the climate action arena, a much-needed prerogative given the uncertainties that characterize the field.

Seasonal and annual spatiotemporal variations of basic biophysical parameters in the Mediterranean using satellite based and model data products

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Keywords: Mediterranean; biophysical parameters; spatiotemporal variations; satellite-based data

Abstract

The Mediterranean is one of the most vulnerable climatic regions on the planet. Extreme weather conditions are gradually increasing in intensity and frequency, and its climate profile is projected to be significantly affected in the near future by the rising of the average Earth temperature. Therefore, a better understanding of the distribution of the Mediterranean climate profile through the spatial distribution and the correlation of basic biophysical and atmospheric parameters is considered important.

The present study aims to determine the climatic profile of the Mediterranean region area by studying seasonal correlations of key biophysical parameters for the period 2000-2018. The methodological approach includes monthly data collection of satellite products and it aims to highlight the spatiotemporal trends and variations regarding the parameters of monthly rainfall, evapotranspiration, vegetation, soil temperature, soil humidity and surface albedo. Table of statistics and thematic maps of the average annual and seasonal values that have emerged over the last two decades and their mean spatial and temporal fluctuations on a seasonal scale have been produced. In addition, their correlations were tested and potential interactions that shaped and influenced the climate profile of the study area were identified. The seasonal maps present a coherent picture and the paper confirmed a direct correlation between the key climate parameters of the Mediterranean, agreeing with the fact that the global warming trends make the issue of water resources as well as the vegetation particularly sensitive in the Mediterranean. Reduced rainfall was observed during the summer, especially in North Africa, parts of southern France, Italy, parts of Greece, western and southern Turkey and the coasts of the Middle East. At the same time, where a decrease in rainfall was reported, vegetation and evapotranspiration also decreased, and soil temperature increased.

Among the main conclusions of this study it was noted that there has been a decrease in rainfall during the summer months of the last two decades around the Mediterranean, particularly in North Africa, in parts of southern France, Italy, parts of Greece, western and southern Turkey and the coasts of the Middle East. At the same time, where you reduce rainfall, vegetation and evaporation also decrease. This is more evident in the eastern and southeastern Mediterranean as well as below the 36th parallel. Another interesting conclusion is the relative high values of the surface albedo not only during summer but in autumn, too. This finding in combination with reduced rainfall it could decrease the vegetation health, leading gradually to land degradation and finally desertification. Finally, important is the conclusion that mainly

during summer there is a significant stress of the vegetation along the Mediterranean coasts which and the high surface temperatures not only in the African part of the Mediterranean but also over the three main peninsulas (Iberian, Italy and Balkans).

SESSION: Policy-Stakeholders Involvement

Climate emergency adaption and sustainable management strategies

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Keywords: climate adaptation, policy, governance, landscape, water management

Abstract

This paper discusses the way in which climate crisis-related strategies and the concepts of climate adaptation, sustainability and governance are being introduced into rural and agricultural landscapes. This forms part of a wider research focusing on pioneer landscape strategies across Europe, examining the extent to which low carbon can be delivered effectively and the ways in which policy guidance impacts on sustainable management strategies and implementation. This paper uses examples from the 'Landscape Observatory' (Catalonia) and the 'Room for the River' (the Netherlands).

Noordward is the largest rural location that the Room for the River programme has addressed, dealing with agricultural land, farming and nature reserves on a strategic scale. An investigation on climate adaptation issues in Noordward, demonstrates the potential and significance of introducing the ideas of landscape, low carbon and governance as vital aspects of rural infrastructure and the ways in which agricultural land and water are managed. The threat of flooding of agricultural land is countered with innovative landscape designs and new policies that explicitly consider the climate crisis. In addition, the paper demonstrates how the Landscape Observatory has changed public opinion by putting landscape at the core of development, to the extent that there is now a public law protecting landscape in Catalonia. Established and run based on the principles of the European Landscape Convention, the Landscape Observatory has had a significant and positive impact on the development of landscape policies in the region. Focusing on the area of Lluçanès, the establishment of a Landscape Charter protecting the agricultural land and examining the natural area of La Cerdanya in Pyrenees, spread between Catalonia and

France, the research extracts best practices in policy and legislation as well as participatory methods on climate and landscape awareness and communication methods between different countries and cultures.

This research concludes that the establishment of a solid project framework and communication strategy, supported by policies, legislation and governance structures, in conjunction with appropriate procurement processes and a wider understanding of the role of landscape result in significantly improved responses to deal with the challenges of the climate emergency and climate adaptation in rural and agricultural areas.

A harmonized framework to mitigate coastal erosion promoting ICZM protocol implementation

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Keywords: Coastal erosion rates, coastal vulnerability risk, remote sensing, wave measurements, wave models.

Abstract:

Coastal erosion is one of the highly growing environmental concerns faced by coastal communities, aggravated by the prospect of accelerated sea level rise due to climate change and the accumulated negative effects of mismanagement practices. Over the past 100 years about 70% of the world's sandy shorelines have been retreating due to coastal erosion, while currently around 20% of EU coastline is eroding. Coastal erosion is directly linked to economic losses due to coastal retreat and loss of land, ecological damage (especially of valuable coastal habitats) and societal problems. In the BMP area the impact of high-frequency and high intensity winter storms, the effect of sediment blockage due to river damming, the degradation of beach stability in areas of urban and tourist activities and the lack of integrated approach in human interventions have led to significant coastal erosion rates. Presently, almost 30% of coasts in Greece are eroding or appear as vulnerable to erosion.

In Cyprus this percentage reaches 38%, while in Bulgaria almost 71% of Black Sea beaches are eroding. In Albania, a country with 420 km coastline, coastal erosion is a significant issue for the northern and central parts. HERMES aims to develop a unified and harmonized framework for coastal erosion mitigation and beach restoration covering the four partner countries (Albania, Cyprus, Greece and Bulgaria) through the implementation of a coherent ensemble of studies, the sharing of already developed technical tools and the design of joint policy instruments. HERMES will aid

coastal stakeholders to harmonize and adapt to the most relevant EU policies on coastal zones, as CC, Integrated Maritime Policy, Maritime Spatial Planning, ICZM, Marine Strategy and Water Framework Directives, Inspire, etc. Coastal municipalities and regional authorities, coastal users, local and international NGOs, landowners and businesses situated in or near coastal areas will benefit from project outputs.

The HERMES project, funded by Interreg Balkan MED Program, capitalizes on previous EU-funded projects (BeachMED, CoastGAP, Coastance, Mare Nostrum) to build a joint coastal erosion methodological framework to be applied at four study sites (one per partner country). At each site: historic and future coastline retreat has been evaluated; erosion and climate change vulnerability indicators were derived; causes related to human interventions were assessed; existing environmental and socio-economic data were collected and integrated into a coastal webGIS; a modeling toolkit (meteorologic, hydrodynamic, wave and morphodynamic) was applied; a series of intervention scenarios was tested and evaluated. HERMES places emphasis on the promotion of environmental-friendly technical works for coastal restoration (e.g., beach and dune stabilization, beach nourishment). Local managers and policy officers are trained on the use of the HERMES system, while actions raising public awareness on the HERMES action plan are organized.

Green public procurement (GPP)

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Key words: Green Public Procurement (GPP), National Action Plans (NAPs), green criteria

Abstract

Public procurement plays an important role in the economies worldwide. In Europe, public authorities are major consumers, as it is estimated that more than 16% of the Union's gross domestic product (GDP) is spent through this procedure. Public authorities can make an important contribution to sustainable consumption and production by using their purchasing power to choose goods and services with lower impacts on the environment. This potential can be reached through Green Public Procurement.

Green Public Procurement (GPP) is defined as "*a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured.*"

GPP is a voluntary instrument, which means that Member States and public authorities can determine the extent to which they implement it. Green purchasing is

also about influencing the market. By promoting and using GPP, public authorities can provide industry with real incentives for developing green technologies and products. The basic concept of GPP relies on having a) clear, verifiable, justifiable and ambitious environmental criteria for products and services and b) best practices that illustrate how public authorities can successfully 'green' a public tender or procurement process.

The European Commission encouraged Member States to draw up publicly available National Action Plans (NAPs) for greening their public procurement. The NAPs should contain an assessment of the existing situation and ambitious targets for the next years, specifying what measures will be taken to achieve them. The NAPs are not legally-binding but provide political impetus to the process of implementing and raising awareness of greener public procurement. They allow Member States to choose the options that best suit their political framework and the level they have reached.

In Greece, the basic legal framework of public procurement is Law 4412/2016. Greece is making slow progress in greening its procedures, if we consider that has not still draw up a NAP. The EU has specified in various Directives the goal of having a 50% share of GPP. However, Greek public authorities have not yet reached this target. The percentage of contracts that are compliant with the green procurement criteria is below 20%, while the national Greek GPP plan is still being elaborated.

Benaki Phytopathological Institute (BPI), is the first Greek Research Institute to have a broad scientific basis in plant health and plant protection and has earned itself a reputation as a guardian of quality and sustainable development in the environmental protection. Among its principles is to show respect for the environment and its top priority is the environmental awareness.

BPI sets ambitious targets and takes specific measures to promote and implement GPP in order to “green” public tenders or procurement processes, although unfortunately this is not yet a common practice in Greece. BPI is eager to adopt environmental criteria for products and services such as ISO certificates of Environmental Management System or equivalent, eco-friendly provisions for cleaning products in cleaning services contracts, as well as to apply best practices such as the electronical implementation of all public procurement procedures aiming to reduce the waste of paper and the improvement of our ecological footprint by using leasing agreements of environmental friendly printing products, equipment and services, among others.

To sum up, public procurement should not be treated as an administrative procedure to purchase products and services but as an important tool to help reaching strategic goals. In the past, the EU created a highly supporting policy framework for GPP, but the real action should happen mainly at local and regional level. Studies showed that one of the main barriers to up-taking GPP is lack of information and co-operation. That proves how important it is, to exchange experience, share knowledge and promote the replication of best practices and that is what BPI always supports.

Governance and policy flows in climate change - from IPCC & UNFCCC to European Union and from E.U. to Greece

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Keywords: Adaption, policies, governance

Abstract

The impacts of climate change are a global problem. Climate change by its very nature cannot be limited spatially, which makes necessary intergovernmental decision-making. The first period of the Kyoto Protocol (2008-2012), as well as the ongoing period (2013-2020) and the third, approved by the recent Paris Conference (December 2015), highlight the importance of specific mitigation policies. At the intergovernmental level, institutions design and propose adaptation measures for mitigation (UNFCCC and Intergovernmental Panel on Climate Change - IPCC).

An important point is how international political decisions are taken, integrated and implemented at the European level and subsequently at the national level. These dependencies between the levels of governance as well as the timely adaptation of decisions in-laws can contribute in a manner of limiting the human impact of climate change. Greece is part of the intergovernmental panel and is obliged to comply with EU directives on the subject. However, Greece is delaying.

The purpose of this paper is to critically analyze the functions of governance institutions and interaction flows at each one level. Moreover, the case study aims primarily to show how since 1974 when the Greek Constitution defined environmental protection as a fundamental principle, the temporal interdependence of these institutions in conjunction with internal change; all these having transformed Greek institutional reality.

The paper consists of 4 main parts as follows. The first part briefly reviews the literature, presents the research objects and the structure of the study. The second one analyzes the governance institutions at each level whether they are institutional (eg United Nations Framework Convention on Climate Change (IPCC)) or NGOs, etc. This section focuses on the critical analysis of the relationships between governance levels at each level and the flows between them. National governments are found to develop and implement climate policies within a framework of national policies and institutions. Sometimes that happens under the auspices of the international climate change regime. European Union countries manage an additional level of regional and transnational cooperation that includes climate change along with many other policy areas. In some cases, sub-national bodies and institutions have become active in the field of climate change policy in several countries. In this way, the multilevel nature of global climate governance and the existence of interaction flows are spatially analyzed. The third part analyzes these relationships by setting Greece as a case study. Four key periods have transformed the Greek climate change governance, starting from 1975 until today. Although 45 years have passed since then, the most significant progress has been made in the period from 2016 to the present day. During this

period, Greece defined the National Strategy for Adaptation to Climate Change (NSRF), which is the main policy document for Greece's adaptation on climate change. The paper concludes with Part 4 presenting the conclusions.

Climate Change & Agricultural Sustainability: Balkan Countries (BCs) adaptation through Water-Drought interaction

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Keywords: Adaptation, Agriculture, Participation, Mitigation, Sustainability

ABSTRACT

Beginning this elementary study about issues of agricultural development in the Balkan Countries (BC), there is evidence that water volumes are one of the major contributors to tangible crop yields in the region even if land productivity is low. In order to sustain agricultural productivity, available adaptive schemes should be applied towards sustainable water management. Especially as the climate changes there is need to support agricultural productivity through using water capital more effectively. Such a contribution depends until today from the minimization of water volumes consumed in the full agricultural production process. Nonetheless, the impact of climate change, like droughts, that can offset tangible agricultural yields, even if not today but in a future scenario, depends from water availability. That's why Balkan Countries are not affected severely from global warming in present days as there is plenty of water. Despite that, the risk and uncertainty of future conditions that will favor random and irrational water appropriation (pollution and consumption) against sustainable use, should consider the current needs of crops in terms of water provision. That will happen in order the provision of water volumes will eventually lead the water footprint (WF) close to zero or close to the volumes that are mostly needed. For that to be realized, there is need to know which component of the WF drives mostly water minimization in order to confront climate change impact like agricultural droughts. In this attempt, addressing crop water needs and scheduling WF minimization in order to curb agricultural drought prevalence, as an adaptation strategy against climate change, is a meaningful challenge from the local to the global level. That can be attested by multiple regression analysis between drought and water due to direct exposure of agriculture to climate and rural vulnerability. So, at BC, the major issues of future agricultural development have to be defended and meet ideal WF levels, as local adaptive measures. These measures need to be assessed in order to adjust water resources at

levels that may protect, eventually, from future extension in droughts in terms of prevalence and severity.

New integrated approaches on climate change, the case of Saturn pan European Project

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Keywords: climate strategies, policy, pan European, framework, food growing

Abstract

The landscape has been described as a blind spot in regional economic strategies. It is not surprising therefore that the immense potential of the peri-urban and rural hinterlands to contribute to the climate emergency is so frequently overlooked. Recognition of the value of landscape in dealing with issues such as carbon sequestration, food and biomass production, risk mitigation, culture, health and identity is further complicated by fragmented ownership, numerous types and scales of often conflicting kinds of designations and a complex infrastructure of governance structures, policy requirements and regulatory frameworks. This underpins the development of inadequate city climate strategies analysed independently of their territory, surroundings and agricultural land.

With partners from across Europe, the pan European Orchestrated Ecosystem research project funded by EIT Climate-KIC, System and sustainable Approach to virtuous interaction of Urban and Rural Landscapes (SATURN) is developing new integrated approaches to deal with the urban, peri-urban and rural landscape in response to an evident need for new ideas in the context of the deepening climate emergency and the need to address air quality, food and water security. By increasing awareness of the capacity of landscape SATURN will also help nation states to meet the 2030 UN Sustainable Development Goals (UNSDG's) and respond to the 2020 State and Outlook of the European Environment (EEA 2019).

This paper reports SATURN's initial findings. Building on expertise developed by partners from Birmingham (UK), Trento (Italy) and Gothenburg (Sweden) it focuses on the relationship between cities, food growing and the rural landscape, and outlines progress made to generate holistic strategic frameworks to landscape management, development and transformation and engage urban populations in urban and peri-urban landscape and local farming.

Concentrating primarily on the re-use of abandoned territories, SATURN, by supporting, extending and evaluating a range of local and national food growing initiatives is reintroducing and invigorating the production of organic agricultural products and is building skills and competencies in traditional and new agricultural practices through the provision of collective growing spaces (or vegetable gardens).

The project builds on the work undertaken by a number of existing initiatives including the sustainable approach of farming developed in Gothenburg, the policy work developed in Trento, the UK's social farms and garden network and the International Traditional Knowledge Institute. It is building up a comprehensive and flexible framework to help cities implement food growing and water cleansing policies and projects at a range of scales in their surrounding landscape, taking into account land use assets and cultural identity.

Responding to the increasing interest from consumers, citizens, and private/public institutions, it is raising awareness of the capacity of the land and local production to mitigate climate change. Setting out the next phase of the project, the paper concludes with key lessons learned, the identification of processes that can be applied in regions across Europe and an evaluation of the significance of exchanging knowledge between different countries.

SATURN Partners:



SuWaNu Europe-Network for effective knowledge transfer on safe and economic wastewater reuse in agriculture in Europe

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Keywords: water reuse, agriculture, circular economy, rural development, sustainable water management, networking

Abstract

Reclaimed water shows a strong and serious potential for complementing conventional water resources. According to the European Commission communication “Closing the loop - An EU action plan for the Circular Economy” (COM(2015)0614): “..the reuse of treated wastewater in safe and cost-effective conditions is a valuable but under-used means of increasing water supply and alleviating pressure on over-exploited water resources in the EU”. Water reuse is especially relevant and critical to agriculture as this is one of the main water consumers, having additional benefits for farmers such as lower cost compared to other solutions (e.g. desalination), reliability of supply regardless of season, improvement of climatic conditions and associated water restrictions and nutrients contribution of the treated wastewater that can supplement or replace conventional fertilizers. Based on the results of a previous EU project “SuWaNu” whose main result was to set research driven clusters in the field of water reuse in target countries, the current SuWaNu Europe (Horizon2020), presented in this paper, is intended to bridge the current innovation gaps and achieve an effective implementation of reuse solutions in agriculture. SuWaNu Europe extends its geographical coverage at 20 beneficiaries all over Europe with 8 target regions participating in the project. The SuWaNu Europe project, in its 30-month duration, will summarize, share and present existing and upcoming knowledge and skills in the field of water reuse in agriculture to the relevant stakeholders such as farmers and farming advisory groups. SuWaNu Europe aims to create regional working groups for the development of general and regional action plans. These action plans are to set strategies at regional level with the objective of boosting innovation in the agricultural and water sectors, improving best practice development and identifying the most appropriate channels to reach stakeholders and key players in agriculture and water management. In addition, dissemination and training at all target regions and beneficiaries will create the capacity and competencies needed to implement these results in a European scale network.

Greece is one of the participants in the SuWaNu Europe project. ANETH S.A., the Development Agency of Thessaloniki, is a Lead Partner in the project. The role of ANETH S.A. is to coordinate all beneficiaries to develop and implement the general and regional action plans. Along with the Aristotle University of Thessaloniki, which is also a beneficiary, an in-depth state of play analysis at regional level has been performed for a thorough comprehension of the current implementation degree and applicability potential for water reuse solutions in agriculture. The state of play analysis was compiled in 8 regional reports, one for each target region: Andalusia-Spain, Braunschweig-Germany, Flanders-Belgium, Santarém-Portugal, Thessaloniki-Greece, Occitan-France, Plovdiv-Bulgaria and region of Po river Valley-Italy. Since the project aims to knowledge exchange and sustainable use of reclaimed water in agriculture info-packages and actions are developed and adapted to the needs of each relevant

stakeholder groups such as: wastewater treatment operators, farmers/irrigators, water engineering companies, providers of agricultural advisory services, consumers and authorities. The SuWaNu Europe project will establish an inter-operable and effective network across Europe for the sustainable wastewater reuse in agriculture.

SESSION: Circular Economy

Microalgae-based bioremediation of a liquid digestion effluent for the production of biomass

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Keywords: Anaerobic digestion effluent, Microalgae, Nitrogen removal, Anaerobic digestion

Abstract

Anaerobic digestion, as a methane production route, is a feasible and straightforward way to harvest bioenergy from the co-digestion of several waste streams including among others cattle slurry, chicken manure, cheese whey, olive mill waste and maize silage. Biogas plants produce a digestate effluent, containing most of the nitrogen, phosphorus and micronutrients originally loaded in the anaerobic digestion unit, which can serve as an inexpensive, nutrient-rich source for microalgae cultivation. Furthermore, the carbon dioxide produced by the entire biogas plant can be utilized as carbon source for the photosynthetic microalgae cultures. The present study, in a complete alignment with the concept of circular economy, aims to assess the cultivation of microalgae in a tubular lab-scale PBR system, fed with the anaerobic digestion effluent (ADE) of a biogas plant, using natural or artificial light. The ultimate scope is to investigate the potential of such a system to be integrated in a biogas production plant as a wastewater treatment unit producing in parallel microalgae biomass as a renewable raw material for the production of biofuels, bioenergy and biochemicals. A microalgal species naturally grown in an anaerobic digestion effluent provided by an industrial biogas production plant has been isolated and genetically identified (identified with the 18S-rDNA gene sequence analysis). This species, which matches to *Chlorella Sorokiniana*, was employed and its capacity in the bioremediation of the given

ADE stream was explored. Precisely, the growth of *Chlorella Sorokiniana* was tested in two cultivation media, the BG-11, used as model/reference one, and the anaerobic digestion effluent diluted to 6 % to equate the ammonium nitrogen ($\text{NH}_4^+\text{-N}$) concentration of ADE with the nitrate nitrogen ($\text{NO}_3^-\text{-N}$) concentration of BG-11. The growing efficiency of *C. Sorokiniana* cultures in the diluted ADE medium was compared against the respective growing efficiency in the reference medium under the same cultivation conditions (aeration rate, lighting and nutrients sufficiency). The tolerance of the studied microalgae species to the effluent was evaluated by varying the dilution level and the mitigation efficiency of the ammonium and phosphoric salts in the medium was measured. Reduction of the ammonium nitrogen and phosphorous contents by more than 80% and 95% wt. of the initial ones respectively was observed, demonstrating the excellence of the particular microalgae species in wastewater treatment processes. The results of this experimental study assisted our understanding over the assimilation mechanism of the underlying nitrogen sources by microalgae and helped us identifying the critical process variables for scale-up studies.

Acknowledgements

This research has been co-financed by the European Union and Greek national funds through the Operational Program Competitiveness, Entrepreneurship and Innovation, under the call RESEARCH – CREATE – INNOVATE (project code: T1EΔK-00406 -title «Innovative technologies for the elimination of NH_3 toxicity in anaerobic fermentation to increase methane production»).

Biopolymer based packaging using novel hydrocolloids

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Keywords: Edible films, Persian gum, Whey protein isolate, Sorbitol, Water vapour permeability, Moisture sorption isotherms, mechanical properties

Abstract

The wide use of synthetic petroleum-based plastics in food packaging systems has raised various environmental issues due to their non-biodegradability as well as the depletion of natural resources. In this respect the use of biopolymers as packaging materials is rather promising and has been in the spotlight the last years. Lately various polymers have been examined in an attempt to improve the barrier, mechanical and

thermal properties of the biopolymer-based films. In this study, the effect of Persian gum (PG) as a novel gum to be used in edible films was examined. Sorbitol-plasticized whey protein isolate (WPI) films with incorporation of PG in different ratios (100:0, 80:20, 60:40, 50:50, 40:60 and 20:80 WPI: PG) were prepared. The effect of PG addition on the rheological properties; physicochemical properties; water vapour permeability (WVP), moisture sorption isotherms and mechanical properties was assessed. Regarding the rheological properties, PG solutions exhibited a typical non-Newtonian shear thinning behaviour. Incorporation of PG in the film matrix significantly increased WVP ($p < 0.05$) when added in ratios 60:40, 50:50, 40:60 and further increased in the ratio of 20:80 (WPI: PG). The moisture uptake of the films was not greatly affected by the increment of PG. Moreover, addition of PG in the lowest concentration of 80:20 (WPI: PG) highly decreased the tensile strength of the films; however further addition of PG did not cause any great decrement. A significantly higher elongation was observed especially when PG was present in ratios 40:60 and 20:80 (WPI: PG). Such findings are of great importance for the development of biodegradable films with enhanced properties.

Using circular economy practices to mitigate climate change: Case study of using biosolids as a soil improving material and carbon sequestration

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Key words: soil improving material, BIOSOLIDS, circular economy, bioeconomy, carbon sequestration

ABSTRACT

The many aspects of climate change and proposed solution to mitigate the negative effects of it, include primarily management approaches and end-products resulting from recycling organic materials. In a very simple approach-yet the most effective- the efforts focus of saving carbon from escaping to the open atmosphere and retain it to soil. The major property of soils affecting their productivity is their soil organic matter, since it affects many processes related to the rhizosphere, and plant growth and yield. At the same time, the major problem of Greek soils is the low content of soil organic matter which is also yearly decreasing, as a result of erosion by water and wind and by no appropriate management. Therefore, the need to replace it, using carbon sequestration methods and products, in the context of circular economy and bioeconomy, is of immense importance for sustainable production and management. Long term studies at Perrotis College/American farm School with sustainable cropping systems using new technologies (Precision Agriculture) and

innovative organic products (BIOSOLIDS, www.biosolids.gr) resulted in very promising results aiming to maintain the carbon at the soil, reduce emissions of it to the atmosphere and supporting the sustainability of the entire agro-eco system. BIOSOLIDS, a soil improving material, resulting from aerobic decomposition under optimal conditions and management of waste products from fruit and other agricultural businesses, was used in long term studies and in many plant species (olives, leafy vegetables, strawberries, etc.) and resulted in increased yield from 10-75% and plant health status as evidenced by less disease and insect problems. Some case studies will be presented in this event.

Pre-treatment processes for a bio-based circular economy for plastics

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Keywords: micro-plastics, pre-treatment of polymers, biodegradation of polymers sonochemistry

Abstract

The contemporary bioeconomy, which is flagged to bring green and sustainable solutions for a circular economy, is dominated by the biomass-based economy. However, progress is limited and over the past decade the amount of biomass used in the chemical and plastic industry in the EU has almost stagnated. Strong limiting factors for biomass-based products include the lower cost of petroleum-based plastics, direct competition with food production and significant greenhouse gas (GHG) emissions associated with the cultivation and processing of products from biomass. In contrast, new biotechnological processes using microorganisms and/or enzymes to convert carbonaceous resources, either biomass or depolymerised plastics into a broad range of different bioproducts are recognised for their high potential for reduced energy consumption and reduced GHG emissions.

A solution to reduce the impact of non-biodegradable polymers spread in the environment would be to make them biodegradable. However, the hydrophobicity, high molecular weight, chemical and structural composition of most of them hinders their biodegradation. Different physical, chemical, mechanical and photo/thermal oxidation approaches will be evaluated for enhancing their biodegradation.

The overall aim of this work proposal is to develop and optimize the pre-treatment technologies to enhance the microbial degradation of plastic waste by using various microorganisms and enzymes for individual/mixed non-biodegradable and bio-degradable plastics.

- Characterization of plastic waste feed stock for pre-treatments.
- Designing the novel pre-treatment processes to improve the accessibility of plastic waste for microbial degradation.
- Testing the effect of various pre-treatment methods to generate carbon source for valorization.
- Monitoring the physical, chemical, thermal and mechanical properties of plastic waste to monitor the efficiency of pre-treatment processes.
- Designing the separation process for the recovery of available carbon source for valorization from pre-treatment process.

The proposed technology is designed to complete the life cycle for plastics that is derived from and operates in tandem with nature, ensuring an optimal premise for success, while greatly accelerating naturally occurring plastic degradation processes. We propose a route for the seamless replacement of our current recalcitrant petroleum-based plastics with equivalent biopolymers and bioproducts without disruption to human plastic dependent lifestyles and needs for examples in the demand that “plastic prolong the shelf life of food resources which greatly reduce waste”.

In the proposed biomimetic strategy, mixed recalcitrant and degradable plastic waste undergoes a triple action depolymerization process which includes novel mechano-biochemical, enzymatic digestion and microbial degradation. Each of the processes used is mirrored by processes naturally occurring within the environment with a series of innovative approaches and novel techniques devised to accelerate and enhance the responses that would develop organically over much longer time scales. Each process has an equivalent approach in nature: •Mechano-biochemical treatment equates to Environmental fragmentation •Depolymerization through enzymatic digestion mimics natural enzymatic activity •Depolymerization through microbial degradation mimics natural microbial activity •Valorization equates to regeneration

The necessary pre-treatment steps we propose here are green technologies like sonochemical processes (ultrasound-based chemistry), mechanochemistry, UV activation and their combinations.

Evaluation of the environmental performance in a local area regarding the Waste Framework Directive and the Circular Economy Strategy

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Keywords: solid waste, circular economy, compositional analysis

Abstract

Environmental protection and economic development are two concepts that are inextricably linked and have prompted the interest of both the scientific community and policy makers. Human activities are proven to pose a threat to the environment, as it contributes, to air and water pollution, the uncontrolled use of natural resources, the decrease of biodiversity, the increase of waste and climate change. The municipal solid waste problem is expanding rapidly, and the world's municipalities are affected the most severely. The irresponsible production of municipal waste and its management consist an object of continuous research and is included in the international / European legislative framework as well as in strategies. The main aim of this research is the evaluation of the environmental performance of the Municipality of Sotira, a small newly established Municipality in the Famagusta District of Cyprus, through the management of municipal waste and comparing its results with the objectives of the Waste Framework Directive and circular economy model. This study implements several indicators such as compositional analysis of household waste, level of recycling index, participation in home composting, and public awareness activities. The results indicate that more than 75% of the citizens are participated in the recycling door to door program. However, the recyclable waste that are been collected are not clear as include other impurities. For example, the impurities in PMD is more than 20% indicated that a door to door training program is needed. Also, the concentration of PMD and Papers in the household waste count more than 18% indicated that the waste sorting at source needs further attention. Home composting seems to be a promising method to treat leftovers and other yard wastes and minimized the volume of organic waste that are dumped in landfills. The results of the compositional analysis highlighted the need to develop an effective and efficient solid waste management program in order to achieve the objectives set by the circular economy. Actions to divert specific waste streams such as recyclable, green and food waste, as well as the development of awareness activities must be taken.

Environmental impact assessment of the transformation of food waste to animal feed via a solar drying unit

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Keywords: Life cycle assessment; food waste; solar drying; animal feed; hospitality

Abstract

It is estimated that 90 million tonnes of food waste is produced every year in the EU, equivalent to 180 kg per person. Besides its financial, social and environmental implications, food waste generates pressures for the municipal bio-waste management systems. Bio-waste and its separation at the source is a key priority in the management of municipal solid waste. Since separation of food waste at the source and their collection is easier, cheaper and more efficient when applied in catering businesses, they are the first to be required to implement the relevant actions.

In order to tackle the aforementioned issue, an EU based partnership has been formed in order to implement the Life+ F4F (Food for Feed) project. The main aim of the project is to evaluate, through a pilot-scale demonstration, an innovative and simple technology, and a low-emission process that enables the safe transformation of food waste, mainly from hotels (and more generally from the hospitality industry and restaurants), into animal feed. The goal of the present study is the calculation of the environmental impacts caused by the pilot scale plant required to transformed food waste into animal feed.

The first step of the process will be the collection from selected hotels of separated food waste. The collected food waste will be transferred to the presorting unit, where it will be cleaned via means of manual hand selection. Then, the preselected food waste will be mashed and transferred via a pump to one of two drying channels of the solar drying greenhouse. The dried product will be the raw material for the production of animal feed.

The goal of the manuscript is to present the environmental impact assessment of the infrastructure required to transform the separated food wastes into animal feed utilizing an altered solar drying process. The scope of the study includes the infrastructure of the pilot drying unit. More specifically, the scope of the study includes:

- Excavation works and construction of the presorting unit and the drying greenhouse; construction of an underground tank for wastewater collection in addition to the hydraulic and electrical infrastructure of the presorting and solar drying units.
- Infrastructure of the drying greenhouse: metallic structure, polycarbonate greenhouse covers, a transfer belt, a pump for the transfer of the mashed material, a submerged pump for wastewater. Moreover, the solar collectors, the floor heating pipes needed for drying and two refrigerating units.
- Operation of the presorting unit and the drying greenhouse: the electricity and water use required for the operation will be assessed.

SESSION: Waste Management

Proper disposal and treatment of common pharmaceuticals. Antimicrobial resistance

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Keywords: pharmaceuticals, antimicrobial resistance

Abstract

The contamination of surface and groundwater aquifers from pharmaceuticals disposed from households, industries, hospitals and other activities in urban areas is quite significant. The scientific community is examining the extent of this pollution and its consequences on the environment and the living organisms. It is anticipated that the degradation of the aquatic environment due to pharmaceuticals will continue and even expand, if adequate response measures will not be taken. Population growth rates, technology, socio-economic factors (such as the access of people to health and medicines) and diseases' increase contribute to the problem.

Recent research reveals that antibiotics are detected in water aqueducts. The incorrect disposal and their excretion to the sewage system, provides an opportunity for bacteria that coexist with them in an environment such as that formed in wastewater treatment plants, to develop resistance to antibiotics and to multiply, thus causing 'antimicrobial resistance'. That is increasingly of concern to the scientific community, because these bacteria can reach people and cause problems through

many ways - and through water. As with any problem, however, there are solutions that can be implemented to hinder the degradation. These solutions are classified in two categories.

The first category includes the prudent use of pharmaceuticals and their safe disposal. A questionnaire was carried out, in order to estimate the knowledge or ignorance of the public to these issues, and at the same time activate and inform citizens on the negative effect of pharmaceuticals on the water resources and the protection of the environment and water quality by individual acts.

The second category refers to what scientists and engineers can do to control and diminish the problem. Advanced disinfection technologies can be applied in wastewater treatment, so that the treated wastewater, which returns back in the aquatic environment, is free of antibiotics and other pharmaceuticals.

Activated carbon ceramic supported electrodes for energy generation from a municipal solid waste landfill concentrated leachate

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Keywords: municipal waste treatment, energy production, sonochemistry, ceramic electrodes

Abstract

A lot of effort in valorization of real waste extracts or feedstocks and simultaneous energy production is currently under research. One method of addressing this dual task is using biochemical reactors called Microbial Fuel Cells (MFCs). These cells can perform the above dual operation showing promising results. They consist of a biofriendly anode and a cathode that promotes the Oxygen Reduction Reaction (ORR). An acclimation of a microbial biofilm, which is deposited on the anode, consume the organic content of the anolyte/waste and produces protons which are reduced in the cathode through ORR. The use of electrodes that promote oxygen reduction reaction (cathodes) is currently under optimization

regarding the nature of their support, their catalytic efficiency and their configurations. On the other hand, anodes are mainly consisted of carbon (rods, fibers, cloths, granules) in order to facilitate the generation of an appropriate layer of biofilm. In this work, we present facile preparation methods for ORR electrodes tested in a simple microbial-free two-electrode setup, consisted of inexpensive materials and techniques in order to exploit their electrochemical potential for simultaneous waste treatment and valorization via energy harvesting without being using an MFC. A batch biochemical reactor with a stainless-steel sponge as anode and a ceramic supported electrode as cathode was used for energy harvesting by the concentrated liquid residue after the reverse osmosis (RO-CLR) treatment of the leachate generated from the waste decomposition in a major Greek landfill unit. Activated Carbon and an acrylic conductive paint (HSF54) were mixed to produce the active catalyst phase and three different techniques of catalyst deposition on the ceramic support were applied (washcoat, brush coat and sonochemically) and evaluated on energy generation and waste valorization. The catalyst was supported on the inner surface of a ceramic mullite tube (with 17% porosity) while the outer surface of the tube was exposed to waste.

Full electrochemical characterization of the cathodic electrodes has been performed through a Potentiostat/Galvanostat BIOLOGIC SP150 system with a three-electrode setup using a saturated Ag/AgCl reference electrode. Open Current Voltage (OCV) was monitored, Polarization Curves from OCV to zero potential were obtained at a rate of 0.3mV/s, and Electrochemical Impedance Spectroscopy (EIS) was applied from 200kHz to 10mHz. The same measurements were conducted in NaCl 3.5M for the characterization of the ceramic electrodes using Pt as a counter electrode while under batch operation cycles with sewage waste a stainless-steel sponge is used as a counter electrode. COD, pH and conductivity properties of the sewage waste were characterised prior and after batch operation cycles. The first two deposition techniques (wash coat, brush coat) were found to provide 2 times lower power output than the electrodes prepared by the sonochemical method. The sonochemically prepared ceramic supported catalysts at the same time showed higher COD decrease per volume. This is attributed to the morphology of the sonochemically prepared ceramic supported catalysts and the improved adhesion of the catalyst phase. EIS experiments revealed the nature of capacitance layers and resistances during energy production from the waste.

Environmental pollution due to veterinary pharmaceuticals in treated animal wastewater

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Keywords: Veterinary pharmaceuticals, Wastewater treatment, GMS-MT3D.

Abstract

Recent studies show that pharmaceuticals are detected in groundwater, potable water and treated wastewater. Veterinary pharmaceuticals are used daily for the prevention and treatment of animal diseases. Specifically, in livestock farming, they are used to enhance animal development. The detection of veterinary pharmaceuticals in treated animal wastewater (TAWW) is of great importance. The use of TAWW as land improvers arise the problem of the contribution of veterinary pharmaceuticals to groundwater pollution. Additionally, their content in the original animal wastewater (AWW) can largely affect the selection of the effective waste treatment method and location of the plant. The intensity or frequency of this phenomenon is not well defined yet. Neither the effect on humans has yet been determined. There are indications however, that they cause various effects on living organisms in the natural ecosystem. The most important of them is the increasing of microbial resistance and creating of interracial species.

An extensive literature review was carried out on the available detection and removal methods of veterinary pharmaceuticals in AWW. Even though this research field is novel, the scientific community is approaching this new pollution source with specific detection methods and elimination procedures, which promise to be effective. On the other hand, both European and Greek legislative framework is still condensed. The detection limits of such chemicals are very low, and not yet incorporated in the removal procedure in animal wastewater treatment plants.

The extent of ground water pollution from veterinary pharmaceuticals is also studied by applying a hypothetical sewage leakage scenario from an animal wastewater treatment plant and a possible entrance of chemicals in an underground aquifer. The GMS-MT3DMS model was used in this study. The model simulates the evolution of the pollutant in terms of advection, dispersion, adsorption and degradation. The study shows that the applied modeling tool can be effectively used to predict the level of the caused environmental pollution, given the soil and water characteristics, as well as the chemical properties of the potential animal drugs contained in AWW. The model can also be used to optimize the location of injection and pumping wells, in order to direct the plume away from sensitive aquifers. Moreover, it may be applied to predict the effect of climatological conditions on the penetration of veterinary pharmaceuticals in the aquatic environment.

This study comes to summarize the recent bibliography on the detection of pharmaceuticals in the wastewater and water aquifers, outline the relevant legislation and removal methods, and finally pinpoint the available tools for tracking the

evolution of such chemicals in the watercourse. Since the reduction of drugs provided to animals is implausible, measures must be taken to protect the environment and the living organisms, from the effects of increasing concentrations of chemicals, either by treating AWW more effectively, and/or by constraining the TAWW from entering sensitive aquifers.

Wastewater treatment plants' contribution in micro-plastic contamination of surface water. Detection techniques review

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Keywords: Wastewater treatment, Microplastics, Detection techniques, Effluent concentration

Abstract

Microplastics are plastic particles, smaller than 5mm, which recently gain notable attention since they are identified as a source of contamination in the water bodies. They are originated from land-based or sea-based sources related to anthropogenic activities. Increasing production and recurrent short-term usage of plastic products enhance their disposal rates. Urban areas where anthropogenic activities are concentrated are potential hot spots for microplastic contamination that need to be examined. Main pathways of microplastics from urban areas to the aquatic environment are effluents from Waste Water Treatment Plants (WWTP), Combined Sewer Overflow (CSO), run-off from impervious areas directed into sewers or into surface waters, wind-blown diluted microplastics, however they have not been fully quantified yet.

Although typical WWTPs are found to be able to remove 70-90% of microplastics from wastewater, these particles are still present in effluents. Microplastics' removal is mainly achieved in the first stages of wastewater treatment, i.e. skimming of floating particles and sedimentation. Particles which are removed from wastewater treatment stream are transferred to sludge, which in turn enters the environment through disposal or reuse of wastewater sludge for agricultural purposes.

Even present in small concentrations in WWTPs effluents, microplastics' accumulative effect can be significant, since WWTPs release large amount of treated wastewater every day. It is indicative that the daily discharge from a WWTP, as estimated, is up to 4 million microplastics. Microplastics' concentration that has been reported in effluents, range between less than 1 particle/L and more than 50 particles/L or, in terms of mass, between less than 1 mg/L up to a few mg/L. To our knowledge, there is no available data of microplastics concentration in WWTP

effluent, in Greece; instead Suspended Solids (SS) can be used as a surrogate parameter to estimate them.

The examination of microplastics' existence in wastewater includes three main steps, collection of samples, samples preparation and pre-treatment, and particles' quantification and characterization. Samples are taken from influent and effluent of WWTPs and from intermediate treatment stages to assess each stage and the whole WWTP effectiveness in removing microplastics. Pre-treatment comprises sieving or filtering, organic matter removal and density separation of microplastics from other inorganic solids. Sieving or filtering of samples is performed in situ. Quantification and characterization are based on visual observations of treated samples, either using microscopy, or more accurate methods, the most common applied is Fourier Transform Infrared (FTIR) spectroscopy or a combination of them. By microscopy the material of particles cannot be accurately determined and quantification of microplastic has high level of uncertainty due to possible false positive characterization of particles as plastics. Spectroscopic techniques present higher level of accuracy, however they are time consuming. A combination of them can exploit microscopy for sample size reducing and spectroscopy for more precise characterization of microplastics. Results express the number of microplastics per mass or per volume of the sample matrix, their mass and classification based on their characteristics especially size, shape, colour and material.

This study focuses only on the contribution of WWTPs effluents to surface water contamination from microplastic particles and summarizes the available measurements and identification techniques.

Detection and removal of common human pharmaceuticals and PPCOs in water

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Keywords: Pharmaceuticals, PPCPs, Detection limits, Water treatment, Advanced technology

Abstract

Groundwater and surface water are the two most important sources of drinking water worldwide. However, groundwater and especially surface water are both susceptible to pollutants. Public water supply managers and water quality experts are increasingly concerned about a new emerging water pollution: chemicals deriving from prescription drugs, over-the-counter medications and personal care products. Drugs disposed through the sewerage system; perfumes, colognes, skin lotions and sunscreens that wash off people's skin and flow in the sewerage pipes, end

up in the wastewater treatment facilities. According to the European and national regulations no limits have been set on those chemicals, with respect to the WWTPs effluents. It is identified that the concentration of these chemicals is much lower than the concentration of other measured constituents in wastewater. Since it is impossible to detect these chemicals before the concentration reaches billions of molecules, their effect on any living organism is under investigation. However, some common chemicals from drugs and cosmetics have been detected and identified in groundwater, lakes, rivers and streams, as the literature reveals.

This work focuses on water pollution from pharmaceuticals and personal care products (PPCPs). More specifically it presents the most common drugs that are identified in water. It also investigates how some candidate drugs leach into groundwater and potentially into the drinking water. Possible effects of the contaminated water on human health and wildlife are summarized and, finally, methodologies for diminishing this problem are suggested.

At this point, there is not enough evidence of the effect of pharmaceutical and personal care products' water pollution on humans. It is not known what, if any, problems may occur with life-long ingestion of ever-changing combinations of drugs and chemicals. It is acknowledged, however, that up to 90% of oral drugs can pass through human tract unchanged and many of them do not biodegrade. Unused or not fully consumed drugs end up in either the sewerage system or in solid waste plants. Sewage treatment plants require advanced treatment methods in order to remove pharmaceuticals from wastewater. Depending on the life cycle of drugs in the water, some of them continue to exist in groundwater for years. However, a certain amount of pharmaceutical contamination is removed when water gets treated for other purposes. Since this is a novel research field, many research groups around the world are looking into new water cleaning technologies in order to reduce pharmaceuticals and other drugs from drinking water. Towards this direction, a case study is presented from a water treatment plant in Barcelona. The published research compares the effectiveness of conventional drinking water treatment technologies (coagulation, flocculation, filtration, ozonation, disinfection with chlorine) with the efficiency of advanced water treatment processes (ultrafiltration, disinfection with UV radiation, reverse osmosis), with respect to the removal of pharmaceuticals.

In addition to the technology advancements, public information of proper disposal of drugs is imminent. Proper management of pharmaceuticals and personal care products (PPCPs) requires that unused and leftover products are not disposed as urban liquid or solid sewage, but as medical sewage that needs special treatment

Flax shive derived chars: Characterization and Potential Applications

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Keywords: flax shive biochar, pyrolysis, porosity, functional group, biosorbent

Abstract

It is well known that biomass is a sustainable feedstock for chemicals, energy and environment products. In this work, interest is credited to flax shive and the potential of its pyrolytic chars in fields like agriculture, energy and environment.

In this objective, different thermal treatments have been applied to pyrolyse flax shives in order to get different chars and investigate their suitability in yielding good-quality biofuel, biosorbent and/or biofertilizer. Processes of pyrolysis in a flow bed reactor at different final temperatures were among the operating conditions tested to get the most adequate chars for a given specific outcome.

These biochars were then fully characterized in terms of composition, structure, morphology and texture, using several analytical techniques including X-Ray Fluorescence (XRF), Scanning Electronic Microscopy (SEM), CO₂ adsorption, Raman Spectroscopy, DRIFT (Diffuse Reflectance Infrared Fourier Transform) Spectroscopy, etc.

Valuable information could then be obtained regarding the potential of flax shive biochars (table 1).

In particular, fixed carbon content increased by about 25% (up to 73.2%) with increasing applied pyrolysis temperature from 400 to 600°C. According to Raman spectra, the char structure also changed with the pyrolysis severity from amorphous to more organized carbon (turbostratic char).

The examination of porosity development and the BET calculations confirmed possible use in aqueous and gaseous pollution prevention. Indeed, the flax shive derived char is very promising for pollutants removal from gaseous and liquid effluent and/or for gas storage as its surface area as well as its microporous structure are interestingly developed. Increasing the temperature by 100°C intervals ameliorated the BET specific surface area by more than half at each step. This evolution is explained by the modification of the textural properties of the chars that can be attributed to the devolatilization which continues when temperature is further increased. The extra volatile release, caused by higher temperatures, also generates a higher microporosity into the carbon matrix, as the microporous gets larger by 62% (from 0.053 to 0.086 cm³/g). Moreover, the already high specific area of the 600 °C flax shive char may

incite an activation process which would yield activated carbons with high SSA and numerous micropores.

Besides, when correlated to the rates of mineral matters, these activated biochars would play a twofold objective when released in soils: a pollutant trapper and a plant fertilizer. Indeed, on one hand, minerals such as Silicon, Calcium, Potassium, Magnesium and Phosphorous are detected in quite respectable quantities encouraging the use of the chars as soil amendment. On the other hand, the multiple functional groups depicted in the flax shive biochars during the DRIFT analysis, play in favor of the argument of soil pollutant trapping.

Finally, the chars could also find possible fate in industries such as metallurgy and cement factories as biofuels in co-firing, even if the most relevant property which is the high heating value is not measured yet. In fact, these outputs might be possible thanks only to our calculations of fixed carbon (higher than 70%), porosity (more than 250 m²/g) and ash content (less than 7%wt on dry basis), mainly for 600°-chars.

Table 1. Characterization of flax shive derived chars

		Final pyrolysis temperature (°C)		
		400	500	600
Char yield (%)		34	30	28
Elements (g/kg)	Na	0.64	0.71	0.93
	Mg	1.13	1.31	1.49
	Al	0.96	1.04	0.99
	Si	2.91	3.92	3.38
	P	0.84	0.84	0.93
	S	0.20	0.26	0.14
	K	3.56	3.43	3.91
	Ca	2.59	2.87	2.97
Proximate analysis (%db)	Volatile matter	34.5	25.9	19.9
	Fixed carbon	60.2	67.5	73.2
	Ash	5.3	6.6	6.9
Textural properties	SSA (m ² /g)	167.6	207.5	257.5
	V _{micropores} (cm ³ /g)	0.053	0.072	0.086
	Mean pore diameter (nm)	1.26	1.39	1.35

SESSION: Life Cycle Analysis-Data Processing

Trends, challenges and opportunities for assessing GHG mitigation in agriculture using life cycle analysis

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Abstract

Greenhouse gas (GHG) emissions are inevitably linked to agricultural production and subsequently to climate change, and thus any efforts to mitigate the associated environmental impacts from this GHG-intensive sector are now emerging (Guardia et al., 2019). Over the last two decades, life cycle analysis (LCA) is one of the most critical and well-established tools for both assessing environmental impacts and guiding research and policy to improvement options (Bartzas et al., 2015; Bartzas and Komnitsas, 2017). In this context, the aim of this study is to provide an up-to-date systematic review of using life cycle analysis for assessing GHG mitigation in agriculture, raise the limitations and gaps of conducted research as well as discuss the major challenges and propose potential solutions to overcome the identified issues.

In the present study, agricultural LCA studies focused on Europe and published after 2009 are systematically reviewed, in order to draw the existing knowledge map of related research, evaluate the level of reliability and validity of data and methods and identify the research gaps in application to GHG mitigation systems. For that purpose, search of well-defined keywords related to application of GHG mitigation in agriculture using the Scopus online database was considered.

The results of this study show that critical gaps remain in current knowledge and practice related to LCA application at farm or regional level. The major challenges identified in agricultural LCA include concerns with data reliability and quality, inadequate definition of system boundaries, limited use of GHG mitigation scenarios based on past, ongoing or contemplated agricultural practices applied in the field, lack of uncertainty analysis and extensive use of assumptions for life span and service life. Despite the high quality of existing databases and mathematical models for estimating GHG fluxes, the availability of real field data for GHG emissions, use of regional database and consideration of climatic conditions and other seasonal variations as well as inclusion of socio-economic aspects is needed to reduce uncertainty. To this end, real time GHGs measurements using innovative techniques such as LIDAR as well as field monitoring and survey campaigns for assessing climate change impacts in the long term are proposed.

This review study suggests that the assessment of GHG mitigation in agriculture using LCA requires specific attention and a coherent and multidiscipline

approach. As a result, advanced field research is needed on taking into account the three pillars of sustainability i.e. environment, society, economy on the overall quantification of the climate change impacts from agriculture; however, real data that may allow LCA simulations to reduce uncertainty is clearly still lacking.

ACKNOWLEDGMENT

The authors would like to acknowledge the financial support of the European Commission (LIFE+ Environment Policy & Governance) in the framework of the LIFE17 CCM/GR/000087 project "Innovative technologies for climate change mitigation by Mediterranean agricultural sector" <https://life-climamed.eu/>.

Carbon Footprint Estimation of a Winery

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Keywords: carbon footprint, life cycle analysis, vineyards, winery.

Abstract

There is an ongoing debate about carbon footprint, global warming and the extent that human activities contribute to the problem. Agriculture is one of the activities that contribute to Green House Gas (GHGs) release. The vine and wine sector entail a series of activities, which sequester and emit greenhouse gases, including the four greenhouse gases and two groups of gases considered under Kyoto Protocol (CO₂, CH₄, N₂O, SF₆, HFCs, PFCs). It is known that carbon dioxide is generated, from the use of tractors and machinery as well as other planting, harvesting activities (using fuel, fertilizers, and pesticides) and further processing of the products produced.

The current study examines the best practices and the different types of machinery used for planting, fertilising and harvesting as well as a detail analysis of Green House Gas emissions (GHGs) in the wine industry. Vineyard and winery data were collected from a Cypriot winery and the Life Cycle Assessment approach was used to calculate the Carbon Footprint (CF). The methodology described in the ISO / TS 14067 standard was followed for the CF calculation. The specific standard specifies principles, requirements and guidelines for the quantification and reporting of the CF of a product in a manner consistent with the International Standard of the life cycle assessment. System boundaries were set from vineyard planting to winery operations and waste disposal whereas distribution was not in the scope of the case study. The

data collected included vineyard and winery data, which include vineyard planting, the pre-production phase, grape production, wine production, bottling and packaging. Processes included only equipment usage.

The purpose of this study was to identify the most critical hotspots and to propose methods for improving efficiency and reducing GHG emissions. Several practices were proposed in order to improve the CF of the vineyards and the wine processing as well as reduction of the production cost. These practices include oil management, cultivation practices, energy efficiency for machinery and buildings, energy production and agricultural machinery operation.

VESSELSLIFE.COM: A new DSS tool for ship life cycle assessment (LCA)

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Keywords: VesselsLife.com, LCA, DSS, ship construction, operational, maintenance, KPIs.

Abstract

In this paper we present the initial development, structure and the functionality of the VesselsLife.com software Tool. VesselsLife.com is a web-based platform delivering ship LCA decision support services to the entire maritime industry (e.g., shipowners, shipyards, vetting companies, investors, cargo owners, busters, maritime consulting companies).

Ship LCA – Life Cycle Assessment refers to the evaluation and analysis of environmental and economic factors throughout all the phases of the life-cycle of a ship from cradle-to-grave in three phases (I, II, III), i.e., (I) design/construction, (II) operation/maintenance, and (iii) end-of-life/scrap,. VesselsLife.com regards the problems that arise during the ship life cycle as “decisions to be made”. For example, in Phase I, it supports the user to obtain different optimal designs configurations, a great number of options for the structure and superstructure materials, types of fuel and engines, etc. These designs are based on a primitive ship construction (ship reference) and are selected to fulfil all technical, cruising, safety and environmental regulations. Accordingly, during the operation / maintenance (Phase II), VesselsLife.com aids to solve problems related to minimization of the operational costs, the maximization of revenues, the selection of the best retrofit technology, the evaluation of different recovering actions after a costly damage, and other. Finally, at

the end-of-life ship stage (Phase III), helps ship owners who face decision to dismantle a ship (sell the ship to a scrap yard operator, or to a broker).

VesselsLife.com employs multi-criteria decision-making methodologies to structure and evaluate different alternative decisions. A basic characteristic of the platform is the use of KPIs-key performance indicators (e.g., Capital & Operational Expenditure, Maintenance/Repair Cost, NPV, Energy Efficiency Design Index, NOx and SOx emissions) that describe important economic, technical, operational and environmental dimensions for alternative decisions. KPIs are aggregated to composite indicators so to aid the decision-making. Optimal decisions proposed by the system are documented and presented using graphical tools. A series of real business applications is provided.

Multi criteria analysis concept to asses strategic energy planning sustainability evaluation methods

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Keywords: Sustainability, decision making tools, MCDA, energy planning, Cyprus

Abstract

Multi-Criteria Decision Analysis (MCDA) is widely used for the comparison of different options and the selection of the most suitable, between alternatives. It can be applied for products, processes and projects. Various methods of this concept have been developed over the years and they generally use and quantify multiple criteria in order to evaluate the diverse choices.

Cyprus, the latest years, faces several challenges for its energy future. Have always been energy isolated and depended on imported fossil fuel, the island has a significant renewable energy potential shall be further exploited in order relevant EU and national targets to be achieved. Furthermore, offshore hydrocarbons reserves have been recently detected and pipeline and electricity interconnections are under development. In this framework there are different options for the future energy strategic planning for the Country. However, these have to be sustainable and satisfy conflicting requirements. Although, under the climate change threat, environmental protection is of high priority and international priorities and policies lead to fossil fuel use mitigation, indigenous reserves extraction is believed that will cause economic growth, low-cost and secure energy supply is presupposed and renewables still need to be further technologically developed. Therefore, suitable methods to evaluate the sustainability of the energy planning choices are needed.

This paper presents two alternative methods for the sustainability evaluation of the strategic energy planning options of Cyprus and investigates the application of MCDA to compare them in order the most suitable to be emerged and proposed.

Life cycle assessment of alternative agricultural production: The case of Aeropony

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Keywords: Life cycle assessment; agriculture; aeroponic production

Abstract

The aim of the present study is to evaluate the environmental impact of aeroponic lettuce production, during its entire life cycle, via means of Life Cycle Assessment. Aeroponic culture is the most modern method of farming technology with which vegetables grow faster with zero run – off (dripping) to the environment. In aeroponic culture, roots are hanging in the air in closed trays and sprayed with water and nutrients with droplets with the help of high pressure (mist). Because the system is closed, we have no dripping of water and nutrients to the environment. Also, no pesticides or fungicides are used. Consumption of water, nutrients and energy is kept to a minimum while plants maximize their yields.

Three cultivars of lettuce were conducted, the first one in winter, the second one in the spring and the third one in autumn - winter. For all cultivars data were collected on the consumption of water, nutrients and electricity. Moreover, data on the construction of the greenhouse were also taken into account.

The CML 2 Baseline 2000 impact assessment method was used for impact assessment. The impact category indicators, included in the CML 2000 ready-made method, considered in our assessment, were: abiotic depletion factor, stratospheric ozone depletion potential, global warming potential for time horizon 100 years, Marine aquatic ecotoxicity potential, fresh water aquatic ecotoxicity potential, terrestrial ecotoxicity potential, human toxicity potential, photochemical ozone creation potential, acidification potential, and eutrophication potential.

The results of characterization of this study showed that among the three cultures of lettuce the second one, which consumes more water and energy because of the seasonal planting, affects more the environment in all impact categories. The characterization and normalization showed that in all impact categories the energy was the most significant impact and for three cultures.

The environmental footprint as a tool towards sustainable viticulture and winemaking in Mediterranean islands

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Keywords: Viticulture, GHG emissions, Energy balance, Water footprint, nexus, Cyprus

Abstract

The agricultural sector accounts for approximately 20% of emissions globally, underlining the importance of the development and adoption of mitigation measures to reduce carbon emissions. Viticulture is among the most important agricultural activities worldwide, with vineyards covering 7.4 Mha worldwide. The EU initiative on the Product Environmental Footprint (PEF) is a recent development, aiming at identifying the potential environmental impacts of viticulture, including emission hotspots. Viticulture is one of the oldest agricultural activities on the Mediterranean island of Cyprus, and cultivation of vines through millennia has led to the selection of indigenous varieties adapted to the hot and dry climate of the region. The current research, aimed to determine basic parameters of the PEF (e.g. Carbon Footprint, CF; Water Footprint, WF; Energy Intensity, EI) in vineyards on the Mediterranean island of Cyprus. While indigenous varieties generally depend on low quantities of certain inputs such as pesticides, they might require high amounts of other inputs, such as fuel. Here, we determined in vineyards managed by six SME wineries, located in the area of Limassol, Cyprus. An agriculture tailored LCA (Life Cycle Assessment) was applied to collect data about the inputs and outputs (yield) for grape production for the period 2018-2019. The system boundaries were farm to winery gate. The results showed that the average value (± 1 s.d.) for CF, WF and EI for the grapes produced for the needs of the six wineries were 0.209 (± 0.6) kg CO₂-eq, 971 (± 96) L and 1.31

(± 0.57) MJ per kg of grape produced, respectively. Fertilizers production, field and transportation energy were the hotspots for CF while for energy intensity, energy from fuels and fertilizers production were the main contributors. Regarding the WF, only rainfall water was considered in the analysis, as all the studied vineyards were non-irrigated. Further research is required to determine the “gray” WF, due to the use of fertilizers and pesticides. In order to support zero PEF grape production, strategies for fertilizer use reduction as well as promotion of C sequestration in the soil should be examined. The benefits of low inputs viticulture to biodiversity in Cyprus should be also studied, to incorporate this important parameter for Cyprus and the Mediterranean region in the PEF.

SESSION: Education and Climate Change

Climate change: Do we understand what we see around us?

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Keywords: Climate change, teenagers, understandability, action design, responsibility

Abstract

Without doubt, one of the major problems that the global community faces today is that of climate change and its impacts, if the scenarios and climate projections will be verified.

Nowadays a lot of information is disseminated to citizens, mainly by scientists and not only, regarding the necessary measures to be taken for climate change mitigation and adaptation at governmental level and also by the citizens themselves.

But to what extent do citizens, and especially young people, understand the severity of the problem and above all, to what extent they have made themselves available to contribute to the global effort of mitigating climate change and its impacts? Before answering these questions, however, it is necessary to assess the extent to which the young people understand the causes and the significance of the problem as well as to identify the framework within they could act in order to contribute to the problem mitigation positively.

The purpose of this work, which is aimed at young people and especially teenager students, is to clarify conceptual elements of climate change and its impacts and to identify parts of young people's environment that are usually overlooked or underestimated, the proper management of which, however, is at their own responsibility.

To this end, issues such as the importance of nutrients in daily life (e.g. nitrogen, phosphorus), the importance of biodiversity, water degradation from potable to non-potable due to wastage, energy waste and how it is linked to degradation of natural resources, air conditioning systems, the role of forests and soil in carbon capture, the importance of proper soil management and signs of erosion, waste management systems, etc., are discussed and analyzed from the perspective of the teenagers.

The work also focuses on concepts such as circular economics, bioeconomy, sustainability and worth living, with an emphasis on understanding the extent to which these concepts can be adopted as young people's way of thinking.

Sustainable school and climate change education

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Keywords: UNESCO, Climate Change Education, Sustainability Education, Sustainable School Indicators, Education Indicators for Climate Change

Abstract

Climate change is a difficult and dangerous problem. One of the ways to deal with this problem is to educate the whole population and especially the young people about how to mitigate and adapt to it. The problems posed by climate change make it clear that Sustainability Education (SE) requires a strong climate action dimension. In this abstract, we present the UNESCO proposal on Climate Change Education (CCE), supplemented by the addition of Climate Change Education Indicators.

This proposal was presented at the UNESCO seminar held in Dakar (Senegal) in 2016, as an additional tool for climate change education, as promoted by UNESCO. Education for Sustainability underlines the need to tackle climate change. Schools can play a central role in helping people understand the causes of climate change, prepare them for surviving in extreme weather conditions (adaptation) and contribute in fighting climate change (mitigation) by moving to more sustainable lifestyles.

The Holistic School Approach (HSA) has been recognized as the most effective method for implementing Sustainability and Climate Change Education. The main objective of the Holistic School Approach is to make it easier for the school community to ensure that students are provided with the knowledge, skills and motivation needed to act on climate protection. In other words, students completing their education (primary and secondary) are expected to be aware of the causes of climate change, its expected impacts, and be able to suggest ways to mitigate climate change and its impacts, as well as the most appropriate ways to protect themselves in case of extreme weather conditions.

Climate Change Education is considered to be an important part of Sustainability Education, with a focal point on climate action. A Holistic School Approach involves the incorporation of sustainable development and climate action into all aspects of school functioning, which can fall under four interrelated areas of action: school administration, teaching and learning, building and operations, and social partnerships (UNESCO, 2016). Changes and improvements in these four areas are achieved through a process of continuous planning, action and critical reflection.

The proposed approach extends the UNESCO proposal with 23 Climate Change Education Indicators, which serve as incentives and guidelines for the school community. These indicators, which are divided into the four areas of action (school administration, teaching and learning, building and functions and social partnerships), can help to design both the introduction of school in Climate Change Education and in formative assessment. There are five indicators for school governance, six indicators for teaching and learning, eight indicators for building and four indicators for social partnerships. The indicator package is accompanied by the Climate Change Education Calendar, an Excel file in which the school records and monitors activities undertaken by the program.

Heading into a sustainable school barriers and opportunities for sustainable development initiatives in a public school

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Abstract

The presentation regards a real-life example of a public school and the emerging challenges in transforming it into a "Sustainable School". Is "Sustainable School" an attainable vision or a utopia? The main idea of a "Sustainable School" is to integrate the idea and values of sustainability into every aspect of its life, namely: administration, learning process, building management, movement to and from school, school relationships with the school and the wider local community. The development of environmental culture in the Greek school is a prerequisite for the development of a comprehensive action plan for the creation of a "Sustainable School". But what happens when a school lacks the appropriate culture? How can we motivate the school community and raise awareness of the objectives of sustainable development? Where should we begin? Is it a matter of administration or students? This presentation attempts to answer these questions by referring to the current context and giving examples of initiatives that aim to create sustainable awareness, especially for students, but also for teachers.

STEAM Festival: Climate changes. Do you?

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Abstract

The presentation is about the educational approach to climate change (causes-consequences-solutions) by elementary students through applications of the modern STEAM educational stream and the display of their results to the general public through the organization of STEAMfestival.

Our school adopts the innovative STEAM approach to curriculum design. It is the most up-to-date international educational stream that approaches science and technology with a comprehensive teaching approach through Engineering and the Arts. All content has a common denominator in Mathematics. Through their participation in the STEAM learning project activities of the Andreadis Schools, students discover experiential learning, become familiar with problem-solving, release their imagination and creativity and cultivate their judgement in a fun and interactive learning environment. At the same time, however, we also adopt the philosophy of an open school to society, a school that interacts with the society and promotes student's active role as citizens.

Our students initially studied within the school unit the contemporary theme of climate change. They decided to stand against the environmental disaster that is taking place nowadays and create interactive exhibits that will be presented to students at STEAMFest.

Under the coordination and supervision of their teachers, the children will model the greenhouse effect, they will introduce us to the crisscrosscubes and the devastating effects of burning forests, they will present to us the changes that have occurred on earth's surface with a timelapse method, they will clean the sea of oil spills, they will program robots that collect and sort recyclable waste, they will build bioclimatic houses and a city that uses renewable energy, they will produce biodegradable plastic, they will make reusable objects, they will represent the Earth inspired by famous artists / painters, they will measure our ecological footprint and suggest solutions to help each of us individually change, before the climate!

Can primary students play a significant role and change adults' mistakes? Will students and the general public benefit from participating in these activities? These are some of the questions we hope to answer.

Climate change and students: To what extent do they understand and worry?

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Keywords: Climate change, students, raise awareness, educational actions

Abstract

As regards the contemporary global problem of climate change, school, teachers and students can play a key role, notably in changing the mindset, which must yet take place from primary education.

The problem of climate change as one of the leading problems of modern societies and the important role that school has to play are being recognized. However, the educational methods and curricula appear to be far from being able to contribute effectively both in changing the way of thinking, and mainly in urging students into everyday good practices when using resources, they are called upon to manage.

The purpose of this work, which was prepared by the 5th High School of Petroupoli Attica, is to raise the level of information and awareness of high school students about climate change and the ways in which they can contribute to tackle a global problem.

Students' daily practices as well as their opinions were recorded in questionnaires, evaluated and then compared with corresponding replies from students deriving from other schools in Greece and Cyprus.

The main conclusion of this study is that indeed exists general concern in students about the future evolution of the phenomenon and its impact on their lives. Though, they lack of knowledge and ability to plan their reaction and behavior.

Robotics vs Climate Change

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Keywords: Climate Change, Crisis, Robotics, S.T.E.M., Agriculture

Abstract

We are "Environment-All", students of the third grade of junior high 1st St. We decided to participate in this conference because the combination of open

technologies and Climate Change (as a subject) not only interests us but causes us to contribute to the solution of the problem as we can.

After robot means work, we wondered if there is a robot to process the results of the climate crisis and presents them in a simpler, more concentrated form by graph so their use in the improvement of agricultural production / harvest or green growth in an area, urban or not. The RoboKlimUs is capable of taking measurements through specific sensors available for the atmosphere: temperature, humidity, quantity of carbon dioxide and for soil: pH, temperature.

The entire robot is controlled by the microprocessor Arduino Mega 2560rev3. The energy produced by the solar panel on top of the robot. In front of the machine there are step motors, which move up and down the temperature and soil pH sensor. Next to the motors is the humidity, temperature and CO2 atmospheric sensors protected from the weather. For data communication that collects the Arduino a Bluetooth transmitter used. The robot collects data multiple times within a specified time period, to provide more reliable results over time. The Robot contemplates region into strips from top to bottom. The data relating to the temperature and CO2 of the atmosphere and soil acidity.

After each measurement, the data are sent via Bluetooth to a remote computer - control center. The computer holds a large database with information from official sources. The data processed by an application written in python and with the help of XlsxWriter creating Excel spreadsheets with charts. To create graphs used data from official sources and from the site from which it took periodic measurements the Robot in a certain time.

Because we are concerned about the future and we must do something, we believe that the RoboKlimUs is our contribution to the reduction of climate change effects.

Our proposal combines themes on Agriculture Ecological Improvement of production / harvesting and climate monitoring. The data obtained through the measurements can be used:

- In agriculture for improving harvest or in suitable culture selection
- Select planting in an urban area or not
- The monitoring of parameters that contribute to climate change.

Experimental - educational laboratory for sustainable development "Polyphytos lake in 2030 – discussion for the future of our lake"

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Keywords: Experiential workshop, Sustainable development, 17 Global Goals

Abstract

The workshop is an educational, interdisciplinary approach to a topic that could concern the local community of the lakeside settlements of Lake Polyphytos. The title "Polyphytos Lake in 2030 - discussion for the future of our lake" refers to the UN AGENDA 2030. Issues related to the viability of the biodiversity-rich area are displayed and highlighted in combination with the conflicting interests of residents and professionals. Through a role-playing game and the use of a scenario, students are invited to apply knowledge and skills to simulate a city council's conditions. The methodology underlying the laboratory can be an example of good practice and be used in the classroom by a different scenario from all teacher specialties.

The workshop " Polyphytos Lake in 2030 - discussion for the future of our lake" is about the sustainability of the lake itself, its rich bird and fish habitat and its lakeside settlements populations (businessmen, fishermen, farmers, livestock farmers). Through a scenario (casestudy) used as a launch and mobilization, participants - (who take on the role of city council members) - are urged to take action, each with its own capacity negotiating for Polyphytos Lake viability.

Under the scenario, a construction company undertakes to build a hotel unit in the area around the lake. Because the interests of the participants are conflicting, they are called upon to act, above all, as active citizens, with the ultimate objective to find a viable solution. They are asked to listen carefully the arguments of all parties involved and to negotiate their interests from the space that everyone represents. A total of ten roles have been selected for the simulation of the city council, both for local leaders and local community representatives, environmental movement, press, entrepreneurs with interests in the area, and the Sustainable Development Advisor. This particular role acts as a reminder of sustainability and prevents the other roles from focusing exclusively on their personal interests; it works in a balanced way, always proposing the most viable solution for the region. The proposals and the whole debate end up being related to the 17 Global Goals. This is accomplished by giving keywords to each role, facilitating the negotiation process. The purpose of the role-playing game is to link each role's argumentation to one or more of the Global Goals at a time. At the same time, participants practice themselves in communication and social skills, in a fruitful dialogue that rejects authoritarianism, racism and rudeness and cultivate constructive dialogue principles, values and practices.

The expected objectives of the workshop are, inter alia:

- To cultivate solidarity and respect for one another
- Enhance skills such as leadership, exploration, research and critical thinking
- Promote conscience, confidence, respect for different perspectives
- Enhance knowledge of local Sustainable Development issues
- Improve understanding of the interconnection of people and the environment
- Creating Active Citizens

The pedagogical background and methodology applied and proposed in the laboratory are based on the criteria of the PISA Assessment Framework (Programme for International Student Assessment) and the OASA International Student Assessment Program.

Recycling and students: if it comes from the earth it can go back to the earth

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Keywords: recycling; composting; environmental education; sustainable development

ABSTRACT

Recycling and composting are two waste management actions for the benefit of humans and the environment. The use of recyclable materials has been continuously increasing due to environmental and art developments. Good food starts with good soil. Composting is a direct way of recycling. It is a natural process that converts organic materials into natural fertilizer. Students of the 6th Heraklion High School, through an environmental education program, used recycled materials and made the portrait of Nikos Kazantzakis, old-fashioned bags, a worm named Rosalinda, and a wooden compost for school. The students also made a lamp of plastic cups and presented a small theatrical event about the plastic bag. The project was implemented in the 2018-2019; by 25 females and 20 males' students, lasting seven months. The aim of the program was to provide the student with an environmental awareness and quality of life in their daily life with an objective to sustainable development. The evaluation of the program using anonymous questionnaires and comics determine whether a recycling education program would lead to a positive change. The survey results confirmed that students understood well the important role of composting and recycling in our lives.

SESSION: Climate Change – Education and Teaching

Experiments for teaching climate change science in secondary schools

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Keywords: climate change, science curriculum, secondary education, teachers training

Abstract

Although climate change is one of the most significant environmental challenges we face, it is difficult to teach and hard for high school students to learn, because it is a complex subject, involving many variables interrelating over time, that needs interdisciplinary approach. In addition, climate change is a topic that is mostly learned through the media and the internet, resulting to confusion and misconceptions for students and teachers. On the other hand, preparation of well-informed citizens in a global society requires the introduction of climate change topics in the formal curriculum. In this paper we propose an innovative model to help science teachers to introduce climate change topics into the classroom by doing experiments that a) fit very well to the national science curriculum and b) demonstrate the basic principles and phenomena behind climate change.

The experiments are low cost and easy to be developed in the school science labs. We present the experiments, along with the supportive educational material, so that teachers can introduce the science of the anthropogenic climate change by using inquiring based learning techniques. Before the experiments students are asked to create a model that explains the phenomenon to be studied, so that a) their misconceptions are recorded and b) they participate actively in the science experience. After each experiment and through a series of guided questions students, working in groups, explore the topics and in a third step they revise their model.

The topics that are investigated during this experimental educational project are:

- a) The greenhouse effect and the role of CO₂ as greenhouse gas: experiments with a) the construction of a simple model for the greenhouse effect using boxes, which is analogous to the atmosphere's ability to trap heat and b) the production of CO₂ in a bottle and measurement of temperatures in the "atmosphere".
- b) The continental and sea ice melting and the consequences: experiment by studying a simple construction that represents land rising out of the ocean (made with 2 plastic tubs, water, ice and clay). In this way students come up with conclusions about the importance of continental ice.

c) The Albedo effect: experiment in which students measure temperatures inside two different boxes (one dark and one light) and discuss once again the importance of continental ice and

d) The water circulation in the oceans and the oceanic streams: by different experiments, studying the water density as a function of temperature and salinity and the corresponding water movement in different mixtures.

e) The acidification of the oceans and the consequences for the living organisms: Students conduct a set of acid-base experiments to see what could happen to the pH of the ocean as carbon dioxide levels rise in the atmosphere and in a follow up activity they work on the chemical reaction of CaCO_3 with an acid. Then they reflect on the scientific processes of the effect of global warming on coral reefs and other oceanic organisms.

In the proposed educational project students learn climate change by integrating the effects from various disciplines in ways that are understandable for them. After the professional development workshops that we have organized for science teachers to present the experiments and the material of this project, teachers expressed their willingness to apply the proposed activities in their classroom. They considered that the experiments are easy to be repeated in the school and they feel comfortable to teach these well-understood and noncontroversial areas of science according to the official instructions.

Steam and acoustic ecology in the study service of climate change: Case study 'When the bees were late one day...'

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2 - Environmental Education Center "Edessas Giannitson"

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Keywords: Climate Change, pollination, STEAM, acoustic ecology, coding unplugged, Agenda2030

Abstract

It concerns an educational program aimed at the psychomotor activation of learners in relation to climate change, in the context of their environmental and technological literacy. Specifically, the design interest of the designers of this innovative approach was aimed at the resonance that was expected to have in children * * Preschool and school age level in relation to the understanding of such a serious environmental issue, using Coding Unplugged -as a means of debunking of science, new technologies and technological thought-. The aforementioned combination of technological and environmental literacy in this learning process

prepares children for the digital future that awaits them, cultivates their critical thinking and problem-solving skills, teach them a new language in a fun way. At the same time children are helped to understand concepts such as climate change and the role they play in their quality of life, now and in the future.

The aforementioned purpose was attempted to be achieved by having as a learning object the impact of climate change on the pollination of peach * * by bees. The theoretical framework of learning intervention is made up of constructive learning theory, the subjective expression of postmodernist ideology and education for sustainability. The teaching principles that govern it are those visuals of the New School. I.e.:

- the principle of psychological acceptance and support (respect and acceptance of child nature),
 - the principle of self-participation (the free and self-active participation of the child in the educational process),
 - the principle of wholeness (the human mind understands organized sets and not sums of individual elements),
 - the principle of offering systematic knowledge (in the Learning Act offers organized and systematic valid and reliable knowledge),
 - the principle of supervision (concerning the decisive role of experience in the learning process, especially for elementary school pupils),
 - the principle of inductiveness (whereby the thought should be directed from the concrete to the abstract, from the close to the distant, from the simple to the combo/movement of Critical thinking),
 - the principle of differentiation and
 - the principle of the outreach approach (it upgrades qualitatively and enhances the learning process and the knowledge that arises from it).
 - Also exploited elements of music kinetic education, as well as acoustic ecology.
- The intervention was addressed to pupils aged 6-12 years.

How can teachers be encouraged to commit to Sustainability?

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Keywords: education, environmental education, teachers, sustainability, climate change

Abstract

At the expiration of the decade 2010-2020, mankind was hit and cruelly marked by a host of severe weather phenomena. More than ever, we are confronted with the issue of Climate Change affecting humanity in multiple levels around the world.

We experienced a strike of unheard hurricanes in Halkidiki (July 2019) and the tragedies of Mati (July 2018) and Mandra (November 2017), in national level, as well as the incalculable losses of natural capital, such as the Amazon's oxygen lung (September 2019) and the Australia's endless parcels of land (December 2019). It is quite obvious that we face an unprecedented environmental and social crisis in a global level. Crisis of values, priorities and worldviews. The model of extreme industrialization and consumerism is proved to be excrescent and non-functional.

Countless organizations, government agencies and NGOs, convene meetings and conferences, open dialogues and set goals towards a sustainable direction. We could say that so far, the most representative framework for sustainable development is summarized by the 17 goals, as assigned from the United Nations. Their content relates to environmental, economic and social areas and involves citizens, governments and companies. More and more scientific fields have come to the conclusion that the achievement of the 17 goals can be accomplished through the promotion of education system in all levels. The wide spectrum of educators (kindergarten and primary school teachers, and professors) can highlight the significance of the 17 goals. At the same time, with the contribution of Environmental Education, they can increase both environmental literacy of students of all ages (kindergarten & elementary school, secondary education, higher) and environmental sensitivity of the world's future active citizens. However, it is highly visible the contrast between the theoretical training provided and the absence of practical training that could enhance ecological interaction. The importance of Environmental Education is recognized authoritatively from all countries of the world and curricula are enriched with the elements of this field. But teachers state unanimously that they do not have enough opportunities to apply what they know and interact effectively in school societies.

Therefore, is extremely important to provide more concrete chances that will help teachers develop their self-efficacy feeling. This will enable them to commit to the idea of Sustainability. In this demanding project, new technologies should be treated more as a useful weapon instead of a dangerous enemy. The demonization of technology's creations must be replaced by the vision that they are a powerful steppingstone and an effective teaching tool. Of course, this does not mean that we should completely ignore the strands of traditional - classical teaching methods. It is required to find a new balance in our present practices, whether they require modifications or radical changes. The 17 goals are achievable, as long as the effort is made individually and collectively at the same time, for the benefit of us all, for the present and the future.

Using children's literature to build environmental awareness in primary education

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Keywords: environmental education, literature, primary school

Abstract

Children's literature is characterized by the emotional language that embraces optimism and hope. It can influence the heart and mind of the young reader by shaping positive attitudes. It can also become a medium of instruction for presenting social qualities that have a positive theme. Yet another crucial element of children's literature is that it assists the child in not only learning about the world, but in discovering who they are in that world. In this context, we can conclude that literature can be used in school context for introducing children to the notions of environmental education and encourage them to behave in an environmentally responsible way. The present paper attempts to highlight the importance of introducing children's literature in the teaching context of primary education as a means of building environmental awareness and teaching environmental values. In our study, attention is focused to the presentation of the ecological thematic of the book *Εμένα με νοιάζει* (I care) written by Galateia Soureli-Grigoriadou. Our work emphasizes the need to teach the whole literary work rather than a fragmented text in order to raise environmental awareness for sixth grade students of Greek state primary school. The core of the presentation is the use of literature for designing a lesson plan that provides factual and fictional information on the topic of pollution. In the end, this study will hopefully increase children's awareness to protect, preserve and nurture the environment in the near future.

Comparative approach to school activities and educational Programs Environmental Education Center: A case study

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Keywords: Environmental Education, School Activities Programs, Center of Environmental Education

Abstract

Environmental Educational came to be as a result of both environmental and educational processes. Parts of its characteristics come from its educational

dimension, part of them from its environmental dimension and part of them have a common origin.

The complexity of Environmental Education is due to the variety of ideologies (educational and environmental dimension) that were not understood but also were not put into effect in the same ways. This empirical survey was conducted in order to study the programs of Environmental Education in relation to Programs of School Activities in the domains of Cultural Themes and Health Education in primary education, of a Regional Directorate of Primary Education of Central Greece and the simultaneous realization of such projects in the primary level of the Center of Environmental Education of the Prefecture.

The research questions to be answered concerned: a. quantitative parameters-data regarding programs of Environmental Education, Cultural Programs and Health Education Programs in relation to the total number of school programs, b. the trajectory of the implementation of the programs of Environmental Education of the Center for Environmental Education during the years 2012-2013 to 2018-2019 and c. the role of the executives in the management and scientific guidance in promoting and utilizing school activities in the modern multicultural school.

Regarding the methodology that was used, the Programs of School activities (Environmental Education, Health Education, Cultural Issues) that were actualized during the school years 2012-13 to 2018-19 by the Directorate of Primary Education of the Prefecture, as well as the Educational Programs of the CEE of the same Prefecture were investigated. Possible correlations were detected and the opinions of the executives of the Management and Scientific Guidance branch concerning the positive but factors as well as the deterrents for realizing such Programs of School Activities. The data used were the files of the Directorate which contained decisions on Approved School Activities and Semi-Structured Interviews.

Innovative educational program: Teaching and educated about forests, in the same time.

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Keywords: forest water balance, climate change, modernity, postmodernity, educational innovation, forest education for worth living development

Abstract

The Environmental Education Center (EEC) “Edessas Giannitson” and the Environmental Education Center (EEC) “Anatolikou Olympou”, as part of their educational work, designed and carried out two interrelated, innovative in design, workshops entitled "Teaching and educated about forests, in the same time". The aim of the above training interventions was to literacy of the participating teachers, both through central suggestions and workshops, and by suggestions of their own. The introductory workshop was designed to educate the trainees in the theme of the water balance of the forest and the disturbance caused by it in the wider area after a fire in the forest. After the first workshop, as a post cognitive evaluation, and within 45 days, the acquired knowledge was exploited in their school class by the participating teachers, in an hourly project. Some teachers were educated at the workshop that preceded them to teach with teaching approaches governed by the ideology of post modernism e.g. role-playing, discussion, poster design, etc., while others trained and then taught with teaching approaches of modernism e.g. lecture, obstetric method, etc. Each trainee taught and recorded through evaluation tools the learning footprint of his work (individual questionnaire before and an individual questionnaire after teaching intervention, as well as a monitoring catalogue during learning intervention). Then and during the second workshop, each trainee recommended to the rest the process, the educational tools and means, as well as the learning result recorded by himself in his class from the implementation of his hourly program. The results of the recordings were recorded in Google forms, enabling valuable conclusions to be immediately exported by means of analyzing and interpreting related charts. The training was addressed to 40 teachers from the Primary and Secondary Education Units of Pieria and Pella. Took place, (a) on 30 March 2019, in the Hall of the Eastern Olympus EEC in Paleo Ag. Panteleimona and on the paths of Olympus, b) on May 18, 2019, in the Hall of the Edessa EEC in Edessa and on the paths of Loutrake (Pozar) in Almopia. The above-mentioned innovative design of the training programme provided for the dissemination of its results, through this presentation, with a view to activating the involvement and motivation of the trainees.

The development of International and European climate case litigation and the Climate Generation. Can they save the planet?

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Keywords: Climate case litigation, human rights, environmental protection, climate generation, future generation.

Abstract

“If world leaders choose to fail us, my generation will never forgive them”

Greta Thunberg

The damage that humans are doing to the global climate may be one of the gravest injustices of all time. Many who will suffer the most are contributing almost nothing to the damage. So, Courts around the world are stepping up to address climate injustice and pushing governments to protect threatened communities, environment, youth and future generation. There is no longer any debate that global warming is real, and that it is happening now at an alarming rate. It is transforming the global climate system before our eyes. The rise of fossil-fueled economies and the consumer societies over the past 200 years, since the end of World War II, is clearly the cause of our mounting climate crisis. But even though 99% of climate scientists do recognize what is happening, world leaders and politicians don't. On the other hand, the Paris Agreement requires countries to implement their nationally determined contributions, necessary for keeping the rise in global mean temperature well below 2°C. This will require countries either to introduce new laws and policies, or to revisit, revise and strengthen their existing laws and policies. Besides, Courts around the world are considering a growing number of climate cases. Citizens and organizations are turning to judicial systems to protect the rights of those impacted by the changing climate; require governments to take bolder action to stop harmful emissions. A new wave of strategic court cases linking climate and rights is emerging. A rise in strategic cases has occurred, with NGOs, individuals, and subnational governments filing such cases as a bottom-up strategy to push courts to examine linkages between climate change and rights protection. These cases are small in number but could have big impacts beyond the courts. Strategic public climate litigation has seen some success. The landmark case of *Massachusetts v. Environmental Protection Agency (EPA)* (2007) confirmed that the US EPA must regulate greenhouse gas emissions under the Clean Air Act if the EPA determined that emissions endanger the public's health or welfare (which it did in 2009). But it was the 2015 decision in *Urgenda Foundation v. Kingdom of the Netherlands* that inspired a whole new wave of cases. Scientists and experts, Universities and other Institutions and Organizations called for urgent action to halt climate change and reduce pollution, through the introduction of cleaner fuels and vehicles, and policies to encourage safe and active transport or less consuming. Also, climate change and the environment are priorities for young Europeans. After months of global strike action, young people have demonstrated their concern for climate change. All the above, will be discussed in my conference presentation.

The importance of postgraduate education on environmental protection and sustainable development

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Keywords: Education, Environment, Sustainable Development

Abstract

Education is considered to be one of the main instruments for the successful implementation of the Sustainable Development Goals as defined by the United Nations and adapted by all countries of the world under the Paris agreement in 2015. Environmental educational programs, especially on a postgraduate level, may have significant impact in the implementation of the SDGs, since they can approach several of the goals simultaneously, providing high quality scientific information to mature scientists.

The Department of Civil Engineering of the Aristotle University of Thessaloniki provides a postgraduate program on the protection of the environment under the concept of sustainable development for 22 consecutive years. With almost 600 graduates of, not only engineering background, but of other scientific fields relevant to the environment, this postgraduate program has been established as one of the most important contributors to environmental education in the country.

In this paper, some of the main characteristics along with the most important milestones and achievements of this postgraduate program are presented.

The water balance of the forest as an impact factor in the micro-climate of a region. Information and awareness planning, with the use of a prototype educational material

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Keywords: forest water balance, climate change, modernity, postmodernity, forest education for worth living development

Abstract

In the context of this study it was a question at exploring sources and scientific articles on the more effective achievement of learning- environmental literacy for the Forest Ecosystem (FE) in the framework of Sustainability Education. The latter was called upon will assume the mediation role between the FE and the trainee, through the exploitation of original educational material. The design of teaching interventions provided for the exploitation of pre-existing knowledge and experiences, perceptions and interests of learners.

The learning process,

- includes the creation of learning plans and the development of educational interventions in the view of modernity compared to that of postmodernity
- is governed by the theory of learning of reconstruction in the thematic area of Forestry and in particular the water balance of the forest as an impact factor on the microclimate of an area.

The scholars in this programme cited social theories which in their implementation should lead to the emergence of learning interventions in favour of the protection and sustainability of the FE. This study is therefore expected to demonstrate the most effective transition from familiar with the Forest Ecosystem to understanding and ultimately familiarizing functions that contribute to its sustainability. Attempted learning design is distinguished in two approaches. The first approach prevails the philosophy of modernity with the scientific discourse dominant (positivism/rationality) and fully directed communication between the thematic field, learner and trainer. In the second approach, the learning design refers to the perspective of the postmodern philosophy, setting equal to scientific and narrative discourse (prevalence of subjectivity). In this case communication is two-way between the thematic field with the learner and his trainer in an animator role (prevalence of subjectivity). The ultimate goal is to highlight those parameters that enhance or slow environmental literacy regarding the FE and its sustainability, with an emphasis on the individual peculiarities of its visitors (theory of multiple intelligence). It is a prerequisite, in the context of Education for Sustainability, to enter the learning process experiences, interests, needs, perceptions and knowledge of the FO of learners. A key role is called to play the function of self-awareness and empathy as tools and means of achieving communication with pedagogical objectives (holistic communication model). The educational material used in this study is original and adapted to the specific needs of teaching interventions.

Science and technology education towards a sustainable future

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Key words: Science Education, Technology Education, Sustainable Society, Teachers' perceptions

ABSTRACT

This paper includes a literature review focused in the necessity of incorporating environmental issues, in Science and Technology Education and a qualitative research that was carried out concerning teachers' perceptions for incorporating such issues in the existing curriculum in secondary education in Greece.

Nowadays we are confronted with many issues related to the triptych Science-Technology-Society such as greenhouse effect, ozone hole, waste management, adequacy and quality of drinking water on the planet, overpopulation, hunger in the world (Rubba,1991). The best way in resolving such issues is that today's student and tomorrow's citizen to be informed and trained in such matters so that he or she is able to make the right decisions and take responsible action in the direction of sustainable development.

During the 1980s many researchers (Aikenhead, 1988b; Bybee, 1987; Hickmann & Bybee, 1987; Layton, 1991; Rubba, 1991; Rubba & Wiesenmayer, 1985a) suggested to incorporate Science-Technology-Society (STS) items in the Science Curriculum. These programs focused on social and environmental issues with significant scientific and technological dimensions.

Bybee (1987) argues that education (therefore education in Science) is a social institution and as such should follow the instructions of all social institutions, covering the needs and continuous development of individuals and meeting the demands of a democratic and sustainable society.

A sustainable society is one that can persist over generations, one that is far-seeing enough, flexible enough, and wise enough not to undermine either its physical or its social systems of support (Meadows, Meadows, & Randers, 1992). A sustainable society appreciates the interconnectedness of people and nature, values the importance of natural and cultural diversity, acknowledges that the world's resources are finite, and recognizes that our actions may have implications for current and future generations.

In order to achieve this, the goals of the Science and Technology programs should be redrafted to include both personal and social dimensions. By bringing Science, Technology and Environmental education together in the school curriculum, science content is appropriate to a wider range of students and more culturally and socially relevant. The convergence is also important for environmental education, because it needs science and technology education to underpin the achievement of

its objectives and to provide it with a legitimate space in the curriculum to meet its goals. Merryfield (1991), intersecting research work in Science and Technology Education (Barman, Harshman, & Rusch, 1982; Bybee, 1984; Bybee & Bonnstetter, 1986; Bybee & Mau, 1986; Hickman, 1982), Social Sciences (Alger & Harf, 1986; Anderson, 1979; Becker, 1979; Hanvey, 1976; Kniep, 1986, 1989; Muessig & Gilliom, 1981; Woyach & Remy, 1989, Waks, 1987) proposes a number of global issues that concern the whole planet and how they can be integrated into the Science and Technology Curriculum. Examples of global environmental issues may be: land use/degradation, deforestation, air, water, soil, pollution, greenhouse effect, global warming, ozone depletion, acid rain, pesticides, waste disposal (nuclear, toxic and hazardous) management of natural resources, extinction of certain plants or animals, export toxic waste.

In a study designed and conducted for exploring the perceptions of Science and Technology teachers in secondary education in the area of Pella about incorporating environmental issues in science and technology curriculum, the majority of them, irrespective of their theoretical background, consider that such issues should be involved in Curricula with benefits for both sides.

Introduction and sensitization of students of the Faculty of Education University School of early childhood education of Aristotle's University of Thessaloniki to the concept of sustainable mobility

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Abstract

This paper presents the design and the implementation of a project about acquaintance and awareness of students of the Faculty of Education University School of Early Childhood Education of Aristotle's University of Thessaloniki to the concept of sustainable mobility through the presentation of the European Project BAMBINI - Socialization for clean and energy efficient mobility in the frame of the Community Initiative "Intelligent Energy Europe". The project aimed to inform, mobilize and sensitize students, as individuals and as future teachers, in the concept of sustainable mobility based on the principles and values of A.A., to influence their behavior

encouraging more intense use of environmentally friendly means of transport and their educational practices in the direction of promoting sustainable mobility patterns in preschool students.

The application methodology included planning, preparation and teaching theoretical and seminar courses to introduce, inform and mobilize students-future teachers on the concepts of sustainable management of energy and sustainable mobility, workshops in groups preparing the implementation of educational activities to create and promote sustainable mobility patterns, and pilot application by the students in public kindergartens of Primary Education in Thessaloniki and preschool children. The activities that had been properly adjusted in order to meet the needs and the characteristics of children of preschool age (5-6 years old), aimed to raise awareness, to the use of cleaner and more energy-efficient alternatives to the cars, transport modes and mobility, exploiting educational methods such as problem solving, investigation and modification of ideas, role playing, etc.

The effectiveness of the project was evaluated using the method MAXSUMO of the European research project MAX by using appropriately structured questionnaires to the students of the Faculty of Education who participated to the action and also from the written self-assessment of student participation in the program. The method MAXSUMO distinguishes the process of modifying the behavior of the travelers, from the phase of taking information on sustainable mobility until the phase of modifying their behavior and adopting sustainable mobility patterns in their daily lives, in stages (A-I), and evaluates the effectiveness of the action in each of these [(Mobiel21, 2010) (Hyllenius et al., 2009. It had been used four (4) types of questionnaires for the students, according to the model "Before-After» (Pre/Posttest): 1) A questionnaire (first) evaluation of the mobility profile of the participants, which was given to the students 2) A questionnaire (second) assessing the effectiveness of theoretical and laboratory courses 3) A questionnaire (third) evaluation of the change in students' mobility habits as a result of the intervention 4) A questionnaire (fourth) assessing the implementation of actions to promote sustainable mobility, which was completed by the students.

The analysis of the content of the personal expression and self-assessment texts of the students emphasizes the positive experience of their participation in the lab-classes and their involvement in the promotion of sustainable mobility patterns in pre-school students. Students attempt an overall assessment of what they believe to have been useful by describing the majority of changes at both the personal and professional level. Students are assessed as positive elements the acquired knowledge, their awareness on the concept of sustainable mobility and the implementation of awareness raising actions for pre-school children to the use of cleaner transport modes. Indeed, many students report that at the end of the activities many children stated that they will come to school on foot and that they will reduce the car use. The vast majority of the students believe that the thematic of sustainable mobility can be incorporated not only in pre-schools' student education, but also in Environmental Education courses at Faculties of Education of Universities.

The project has succeeded in cultivating positive attitudes towards sustainable mobility in 37 students-future teachers and further enhancing the use of sustainable media for their daily commutes, making them more aware of their use. In addition, it encouraged the modification of student mobility behavior for a more intense use of environmentally friendly modes of transport and the adoption of sustainable mobility patterns and educational practices by themselves that act as role models for students and can contribute through education and example in the gradual shaping of a new culture adopting sustainable mobility patterns in favor of sustainable environmental management in line with the principles and values of sustainable development.

Experiential learning in forest ecosystems using the teaching technique of environmental trails

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Keywords: Environmental education, Sustainability education, Natural environment, Ecological awareness.

Abstract

The absence of personal experience of the nature in the modern technological world and an educational system dominated by lectures and the theoretical approach of indoor learning objects, are factors of worsening the ecological crisis. Familiarizing children with the natural environment is considered to be particularly effective, not only in dealing with the ecological crisis, but also in their integrated development. Many modern studies show that children's experiences with the natural environment have a positive influence on their behavior and influence their attitude as adults towards nature as well. Forests are an ideal place to apply environmental education or education in biosphere sustainability. This training contributes to the development of citizens' awareness and ecological consciousness. The present work clarifies concepts related to children's experiential learning and provides basic directions on the organization and implementation of an environmental education program in the forest, by using the teaching technique of environmental trails.



¹The research work was supported by the Hellenic Foundation for Research and Innovation (HFRI) under the HFRI PhD Fellowship grant (Fellowship Number: 726).

POSTER SESSION

Road: A web-based tool for calculating the environmental footprint of agribusiness

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Keywords: ROAD tool, environmental footprint, BalkanROAD project, Balkan agribusiness, sustainable growth

ABSTRACT

The INTERREG project “Towards farms with zero carbon-, waste- and water-footprint. Roadmap for sustainable management strategies for Balkan agricultural sector - BalkanROAD” aims to provide Balkan agribusinesses with protocols and IT tools developed and conformed to the particularities of the Balkan Peninsula, to assist them in promoting products of high quality and value to the European and international market. The project strongly contributes to the sustainable development of the Balkan region, promoting a common protocol called “Roadmap for prototype farms”, that enhances resource protection and especially soil and water, wastes recycling and reuse and reduction of GHGs emissions from the Balkan farms/agribusinesses. A web-based application is provided in the framework of the project, namely ROAD, that assesses all production and processing stages, that is, from field to the market, able to identify processes that can be improved and provide alternatives for reducing carbon, waste and water footprint of the final marketable products. In this work we describe the ROAD web-based tool for calculating the environmental footprint of an agribusiness, along with its key functionalities.

The Carbon Footprint of the OpenEARTH Conference

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Keywords: CO₂ emissions, conference, Carbon footprint, emission factors

Abstract

The OpenEARTH conference on Climate Change Adaption and Mitigation, took place in Thessaloniki on 12-15 February 2020 and was organized in the framework of the BalkanROAD project “Towards farms with zero carbon-, waste- and water-footprint. Roadmap for sustainable management strategies for Balkan agricultural sector”, financed by the European Union and National Funds of the participating countries, within the framework of the “Balkan-Mediterranean 2014-2020 Programme”. The Conference aimed to address the main issue of climate change adaptation and mitigation in primary and secondary sectors through the promotion of agricultural practices and modern effective technologies. It focused mainly on carbon, waste and water-footprint and aimed to stimulate the interest of scientists and citizens and to inform them about the sustainable management strategies for Balkan agricultural and agribusiness sectors.

In total, the conference attracted the interest of more than 200 participants from 30 countries; 70 with oral presentations, 31 with poster presentations while more than 100 were visitors.

As part of the global commitment of organizing and implementing low carbon footprint actions, the conference set out the target of low footprint right from its initial planning. For this, all participants were properly informed about actions and choices of low carbon footprint, concerning mainly transportation and accommodation options as well as materials use, e.g. printing paper, single use plastics, etc.

Apart from this awareness campaign, the organizers aimed to estimate the total carbon footprint of the conference in order to eliminate it, after its completion, by planting the appropriate number of trees that would sequesterate CO₂, equivalent CO₂ emitted due to conference.

To this end, information was gathered from participants regarding transportation mode (airplanes, trains, boats, cars, public transport) and also the accommodation details. In addition, the consumption of printing paper, electricity, food and fuels was recorded in collaboration with the professionals involved in the event organization (hotel staff, restaurants, suppliers, etc.).

From this data, the total carbon footprint of the conference was calculated, and the number of trees needed to be planted was determined. Planting was held in the area of Naoussa, Imathia, Central Macedonia and oak trees, a forest species growing in the area, were selected for this purpose. In determining the number of trees, it was also taken into account that the oaks enter maturity (which is a period of low CO₂ absorption) after 50 years of life, while each year prior maturity oak trees sequesterate approximately 106 kg of CO₂ annually.

OpenEARTH is an example of a way of thinking and laying the basis for a new way of designing and acting under the pressure of climate change.

National adaption strategy of Cyprus agriculture to climate change

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Keywords: Climate change, agriculture, adaptation, Cyprus, Mediterranean

Abstract

The National Adaptation Strategy of Cyprus Agriculture to Climate Change was developed in the frame of the ADAPT2CLIMA LIFE project, co-financed by the LIFE programme for the Environment and Climate Action (2014-2020) <http://adapt2clima.eu/en/>. It contains a summary of future changes in climate conditions and their impacts on crops and water resources, a strategy for efficient water use in agriculture and suggestions for integrating the results of ADAPT2CLIMA project into the River Basin Management Plans and the National Strategy for Climate Change Adaptation. It also includes implementation and monitoring plan with specific indicators.

The most important adaptation measures addressing climate change impacts on six crops (wheat, barley, potato, tomato, olives and vines) were identified through bibliographic research, prioritized by experts, analysed using Multi-Criteria Analysis and those with the highest ranking were included in the adaptation strategy. Climate conditions expected for the period 2031-2060 under RCP4.5 and RCP8.5 scenarios were estimated using two regional climatic models. The groundwater level in pilot areas, the expected mean variation of groundwater level during the dry period of the hydrological reference year (RCP8.5) and SPEI drought index, were also estimated. Change impacts on crops were estimated using three crop growth simulation models. The impacts of climate change on crop performance, water availability and on the agricultural sector in general, presented through interactive visualization maps and graphs, were estimated using the ADAPT2CLIMA decision support tool <https://adapt2clima.getmap.gr/> developed within the project. The tool could be used to explore the available adaptation options for addressing climate change impacts and their efficiency in increasing the resilience of agriculture.

Regarding the impacts of climate change on crops and water resources, it is expected that under climate change flowering and fruiting for the six crops studied will be earlier, the biological cycle of plants will shorten, while cereal and potato yields will reduce especially when sowing or planting is delayed. In all pilot areas of Cyprus (Achelia, Kiti, Peyia and Xylofagou) groundwater is already overexploited and seawater intrusion, with the exception of Achelia aquifer, is observed. Further

movement of the sea front towards the land is expected at the Kiti aquifer. Some of the adaptation measures proposed include the use of effective irrigation methods and irrigation programs, development and improvement of extreme weather warning systems, creation of drought and high temperatures tolerant genetically improved varieties, use of local varieties of vegetables, tree crops and vineyards, upgrading the level and network of agricultural advice on crop adaptation, organic soil mulching.

The added value of the Adaptation Strategy of Cyprus Agriculture to Climate Change lies on the fact that it complements that it complements the National Strategy of Cyprus on Climate Change and enables policy makers to integrate some of the adaptation measures in the Action Plan for climate change and the forthcoming Rural Development Plan 2021-2027. A step forward on the overall effort to mitigate the impacts of climate change in agriculture. In addition, it can effectively support the initiative of the President of the Republic of Cyprus on the development of a regional Action Plan for the coordination of the countries of the Eastern Mediterranean and the Middle East on climate change, as Mediterranean region is considered a hot spot affected already by climate change.

Unified National system of digital agriculture in Bulgaria

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Keyword: Agriculture, Digitalization, Strategy, Bulgaria

Abstract

According to the Strategy for Digitization of Agriculture and Rural Areas of the Republic of Bulgaria, the accelerated digitization of the Bulgarian agriculture is a necessary process. In the context of sustainability, it concerns reducing bureaucratic burden, optimising production processes, increasing incomes and yields of farmers, achieving a viable bio-industry, maintaining a steady bio-industry and food safety in the conditions of increased industrialisation and new, unconfirmed technologies, a dramatic increase in competitiveness and increased demand for Bulgarian products at the single European and world markets.

Digitization enables the agrarian economy to realize its high potential and reap the same successes as the high-tech spheres of the economy: increasing productivity,

adding value, improving quality and safety, and thus income and quality of life, drastically reducing pollution to sustainable levels, flexible and rapid response to market trends.

Real-time monitoring of production conditions, precise control of enemies, farm-to-fork tracking, balancing of consumption and other new technologies, easing of administrative burden, accurate prediction of stages in crop development - all this is possible with the application of the modern computer, robotics and artificial intelligence technologies.

This paper presents ideas for the development of a Unified National Digital Agriculture System in the Republic of Bulgaria, referring them to the relevant categories of the Strategy for Digitalization of Agriculture, as a tool for adaptation of the agriculture to the climate change.

Innovative methods for a more effective management of the environment

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Keywords: project, environment, management, circular, economy

Abstract

The cross-border area between Greece and Bulgaria includes some valuable nature territories which are protected by Law. The BIO2CARE Project funded by the Interreg V-A “Greece – Bulgaria 2014-2020” Cooperation Programme addresses the effectiveness of their management through an innovative methodology for sustainability. It aims to enhance the administrative capacities of the management bodies of protected areas for the benefit of biodiversity and of local communities.

Project activities:

- (A) *providing decision-making support for integrated management of protected areas:* completing a study of the two pilot project territories (national Park of East Macedonia and Thrace in Greece and Rila National Park in Bulgaria) - producing knowledge regarding anthropogenic activities and status of nature in the areas; developing and testing a methodological framework for assessing the environmental status of the areas through the estimation of holistic environmental sustainability indicators (carrying capacity, ecological footprint, carbon footprint, water footprint); developing a model assessing the symbiotic potential of the existing and future activities within the examined areas and a comparative study based on the Life Cycle Approach, presenting the benefits

of circular economy for the environment (existing situation vs symbiotic situation);

- (B) *mitigating illegal activities and promoting protected areas' sustainable development - circular economy and green entrepreneurship*: securing a high-tech monitoring system in the areas of interest (fauna/flora & illegal activities); developing pathways for recreational purposes and birdwatching for handicapped and disabled people; providing e-tools for estimating the carrying capacity in the areas of interest (BIO2CARE Calc) and for examining, assessing and proposing potential symbiotic activities in the areas of interest (BIO2CARE Symbiosis), plus smart applications for facilitating and promoting green tourism in the areas of interest (BIO4TOURISM); producing a sustainability labelling scheme including varying certification levels;
- (C) *developing integrated management approach and policy recommendations*: implementing a series of trainings on the BIO2CARE software, biodiversity preservation, circular economy, symbiotic activities and sustainability labelling schemes; testing and promoting the new specialized visitor infrastructure; developing a final Policy Recommendations Report

Project results - benefits of circular economy and others:

The comparative study based on the Life Cycle Approach and made under the BO2CARE Project presents the benefits of circular economy for the environment. It covers methods and examples for Life Cycle Assessment; analysis of existing economic activities and proposed potential symbiotic activities; results from a Life Cycle Assessment of the current situation in project pilot area and conclusions extracted on that basis. The study has shown that socio-economic situation in the research area possesses complex and multi-layer features. Traditional industrial practices are in decline, and the current economic situation is not very favourable towards the local community. There are opportunities for developing new symbiotic activities based on a balanced use of local natural resources. The scientific support potential of the two universities located here is also of great importance. Life Cycle Assessment can be used for managing complex information flows, re-designing local economic patterns and constant optimization of all economic and management systems.

Estimation of carbon stock in Mediterranean agricultural systems

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Keywords: Soil organic stocks, climate change, GHG emissions, LULUCF, multispectral cameras

Abstract

The important role of organic matter in increasing soil fertility and productivity has been known since antiquity as the addition of organic materials was the only practice for improving soil properties and enriching soil nutrients. Nowadays, and under the threat of climate change, there is an urgent need to use organic additives in at least partial replacement of mineral fertilizers for two main reasons, i.e. to promote circular economy principles and to enhance carbon sequestration.

Determination of carbon stocks and flow between carbon pools of a crop system is a challenging and site-specific problem. The calculation of stocks and flows of carbon in agricultural systems requires detailed parameterization, since many different factors need to be considered, most of them being typical of the specific system studied (e.g location, soil type, crop type, climatic conditions, etc). Nevertheless, the definition of carbon stocks in its pools could contribute to the monitoring of carbon released to the atmosphere as well as to the definition of the most appropriate practices to increase sequestration.

The present work, developed in the framework of the LIFE ClimaMED project "Innovative technologies for climate change mitigation by the Mediterranean agricultural sector", aims to develop a methodology for calculating carbon stock changes by measuring the inputs and outputs of the various carbon pools that constitute the organic matter of an agricultural system.

The methodology foresees the definition of carbon stock changes in all pools of an agricultural system e.g. above ground and belowground biomass, plant residues, soil organic carbon etc. A series of parameters were also determined, i.e. the Gross Primary Production (GPP) which is related to CO₂ uptake by photosynthesis, the Net Ecosystem Exchange (NEE), the Net primary production (NPP), and the Ecosystem respiration-RE, in order to develop a model to calculate the carbon stock changes in the ecosystem, referred to as net ecosystem production-NEP. Multi-spectral cameras for the determination of vegetation index, as well as meteorological data (air and ground temperature, photon flux density of photosynthetic active radiation (PAR) were gathered and processed for the determination of GPP, NEE, NPP and RE.

The methodology was implemented at an olive orchard in Rethymnon, Crete. A meteorological station for the measurement of air and ground temperature, solar

radiation, was installed while field data of the past 20 years was collected. The present work reports and evaluates the results of the first measurements using the proposed methodology.

The importance of this study, also in relation to climate change, is the development of a Tier 3 methodology for the quantification of carbon stock changes under Mediterranean climatic conditions, the adoption of which, makes the assessment of different soil and crop management practices in relation to carbon sequestration possible.

Development of a solid coffee grounds (SCGS) sustainable management strategy in the framework of circular economy

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Keywords: Circular Economy, Spent Coffee Grounds (SCGs), Antioxidants, Compost, BioEnergy, Dietary Fiber, bio-sorbents, biochar

Abstract

Coffee is considered the second largest traded commodity after petroleum and has been growing steadily in commercial importance, not surprising considering that it is the most popular beverage in the world. According to the International Coffee Organization (ICO), coffee production (by all exporting countries worldwide) is estimated up to 148 million bags (each bag=60Kg), with world consumption estimated at slightly lower to 151.3 million bags, which gives a global deficit of 3.3 million bags. Statistics regarding Coffee in Cyprus given by the ICO for year 2015, shows a total consumption of 86,000 bags. Per capita consumption is increasing the last 10 years, from 4.53(Kg) for 2012 to 6.1 (kg) for 2015. In reverse series the per capital consumption is: Finland (9.6 Kg)>Norway (7.2 Kg)>Netherlands (6.7Kg)>Denmark (5.3 Kg)> Germany (5.2 Kg)>Italy (3.4 Kg)> France (3.2 Kg)>Spain (3 Kg)>Greece (2.4 Kg) > Cyprus (2.1 Kg). Coffee imports in **CYPRUS** for 2015 (60kg bags) were 17312 for green coffee, 10450 for roasted coffee and 61339 for soluble coffee. Also, Cyprus runs in the 4th place behind Japan, Italy and Portugal that pay the most for their coffee. Furthermore, data from the Statistical Service of Cyprus (on 2015) reports that there are 615 cafeterias and 515 coffee shops, which account more than 1100 establishments that produce SCG. A great amount of waste is produced from this

famous commercial product, mainly of Spent coffee grounds (SCG), which refers to coffee grounds after they have been used. These are the primary coffee waste by product (45%) generated in coffee beverage preparation and instant coffee manufacturing, e.g. by the espresso coffee extraction process. Within these processes, raw coffee powder is contacted with hot water or steam, under conditions which favor the release of aroma compounds and other coffee-bean constituents into the liquid. Due to these processes, SCG has a high humidity content (80% to 85%), fine particle size, organic load and acidity [6]. Its' chemical composition (content in wt%) reveals a product rich in proteins (6.7-13.6%), oil (10-20%), lignin (25-33%), cellulose (8.6-13.3%), hemicellulose (30-40%), polyphenols (2.5%), caffeine (0.02%), arabinose (1.7%), galactose (13.8%), mannose (21.2%), ashes (1.6%), organic matter (90.5%), Nitrogen (2.3%) C/N ratio 22/1 components, which are valuable if they are obtained from SCGs and used in other applications, such as in bio-fuels, compost, dietary fiber, bio-sorbents and enzymes, in bio-energy and in other food and health applications. Possible methods of the exploitation and use of this waste have been investigated in recent years, emanating from the need of waste reduction and environmental protection. Until recently SCG had been discarded as solid waste and were considered not to have any commercial value.

Facing the challenges of climate change to the vine and wine value chain in the Mediterranean: The project MEDCLIV

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7. Cyprus University of Technology / ΤΕΧΝΟΛΟΓΙΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΚΥΠΡΟΥ
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Keywords: grapevine, wine, climate change, Mediterranean, Living Labs

Abstract

The impact of climate change on the sustainable land use of rural areas and its effects on the vine and wine value chain (VWVC) has been widely discussed in recent decades. The sector is crucial for the Mediterranean region, due to its strong economic

and cultural impact, spreading its influence to landscape and tourism, expressing its full integration in the Mediterranean life-style. In regions where grapevine cultivation is part of the agricultural, economic, and cultural heritage, changes in the VWVC may heavily affect socio-economic aspects, unless adaptation measures are taken.

The Orchestrated Ecosystem built in project "Mediterranean Climate Vine & Wine Ecosystem – MEDCLIV" (co-funded by EIT Climate KIC) aims at applying a common, interdisciplinary, cross-cutting approach to the awareness of the climate-induced challenges and on the development of collaborative and innovative solutions. The idea is to bring together the different players of the VWVC in order to share the know-how, ideas, solutions, perspectives and approaches, about the common problems, already showing in the most prone areas, but not preventing the disclosure of new chances for areas not yet fully exploited. An initial "core" consortium, made up of institutions, will broaden its partnership to the "demand owners" (some already present as "third parties") during its lifetime. The countries involved are Cyprus, France, Italy, Portugal, Slovenia and Spain.

The project will carry out a preliminary survey, a necessary step to map climate-related risks and solutions to problems. These data will contribute to an extension of the platform Agrisource, which will create a sub-category of the geographical database, specifically devoted to viticultural and oenological matters for the Mediterranean countries. "Agrisource MEDCLIV" will thus become the "virtual" meeting point for the whole vine and wine supply chain (VWSC), also implementing new features, like social channels. An innovative approach for managing problems and solutions is the organization of "Living Labs", hosting national events where different stakeholders' points of view will be compared and confronted with each other, fostering cross-fertilization of ideas. They will be a breeding ground to establish fruitful collaborations among the different players, particularly giving voice to problem owners. The "levers of change" will be powered by such events, as well as by the knowledge dissemination and learning events; particularly, citizen-oriented events will have the aim to spread the awareness of the climate-change issues in the VWVC.

The future proofing for the subsistence of these Mediterranean Climate Vine & Wine Hubs will be a major importance for the project team, which will work from the start towards the generation, evaluation and application of business models, to ensure the survival of the hubs after the project end.

Land cover change detection in Crete island, Greece, using change vector analysis

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Keywords: Land cover, Change vector analysis, Biophysical index, Landsat, Crete

Abstract

This work constitutes part of the research project named with the acronym “5DARE”. In general, “5DARE” aims to develop an advanced 5D (3D + time + scale) multi-purpose system for integrating and managing various types of information concerning soil erosion in the island of Crete, Greece, with means of Earth Observation (EO). Modeling techniques will be applied to assess the impact of changes of influencing factors such as climate and land cover/use or vegetation cover on the quantity of erosion at various spatial scales (farms, catchments and entire island) and time levels (present, near and far future). The results of soil erosion assessment will be then upscaled from farm to island level by the calibration of models. Relative spatial data of different quality/resolution, obtained from available datasets or derived from satellite imagery processing and field experiments, will be used for modeling. In terms of this data acquisition, the present work focuses on the land cover change detection in the island of Crete for the last two decades, 1999–2009 and 2009–2019. Thus, corresponding Landsat 8 images were incorporated in the study and were atmospherically and radiometrically corrected. Following, using the combination of two different biophysical indices representing both the vegetation and soil properties of land surface, a change detection technique like change vector analysis (CVA) was carried out. CVA is a robust change detection technique which can provide rich quantitative and qualitative information with respect to spatio-temporal land cover dynamics in a given region. The indices, namely soil adjusted vegetation index (SAVI) and bare soil index (BSI), were estimated by using the images captured in 1999, 2009 and 2019. Based on the multi-temporal metric difference between the two indices, CVA produced results for each of the periods indicating the magnitude and type (direction) of land cover changes, respectively. By an evaluation process resulting to the estimation of accuracy statistics (kappa index and overall accuracy), promising results were provided for both examined periods revealing the potential of CVA methodology to support effectively Land Use / Land Cover studies.

Acknowledgments: This research has received funding from the Hellenic Foundation for Research and Innovation (HFRI) and the General Secretariat for Research and Technology Hellas (GSRT) under Agreement No 651.

Estimation of Soil Organic Carbon using Satellite Data. A case study

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Keywords: Soil Organic Carbon, Remote Sensing, Climate Change, Bare Soil Index

Abstract

Soil Organic Carbon (Soil Organic Carbon - SOC) is an important factor for soil quality and plays a key role in soil productivity in agricultural ecosystems. In the present study, the SOC was estimated using Sentinel-2A satellite data in the Prefecture of Fokida. More specifically, 67 soil samples were collected for soil analyses, regarding organic matter concentration, through which the SOC was calculated.

Copernicus Open Source Sentinel-2 (S2) cloudless images have been available since 2016. The image products used were Level-2A (Bottom of Atmosphere Reflection - BOA), which has been atmospherically corrected with the Sen2Cor algorithm and the PlanetDEM digital terrain model.

A multiple linear regression model was used to estimate the spatial distribution of SOC. In this model, the well-known Normalized Difference Vegetation Index (NDVI) vegetation index and the Bare Soil Index (BSI) were examined.

Bare soil refers to soil which is not covered by grass or other coverings such as pebbles, rocky areas, etc. The BSI is a numerical indicator that combines channels: blue, red, green and near infrared, to record soil changes. It is an indicator that enhances the recognition of bare soil areas. In addition to these indicators, the model showed a better fit when all the satellite image channels were included as well as the soil properties: texture and total salts.

The present effective management of agricultural ecosystems can be enhanced by the assessment of soil properties through the contribution of satellite data. Indeed, the assessment of soil organic carbon is very important, as it has an impact not only on crop productivity and efficiency but also on climate change mitigation. Lastly, the contribution of agriculture to climate change mitigation is important since the implementation of appropriate agricultural practices has an impact on carbon capture and therefore on the sustainability of soil and water resources.

An overview of remote sensing derived indicators for Integral Coastal Zone Management of the Bulgarian Black Sea coast

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Keyword: Remote sensing, Satellite data, Earth observation, ICZM, Bulgarian Black Sea

ABSTRACT

A wide variety of natural hazards and anthropogenic pressure have an impact on the Bulgarian coastal zone that may cause environmental changes with adverse social and economic consequences. New knowledge and advanced technologies are required to improve the effective management of coastal zone resources. A particular problem related to the Integral Coastal Zone Management (ICZM) is the scarce availability of high-quality geospatial data. Remote sensing (RS) and Earth Observation (EO) can contribute to overcoming the considerable data gaps in spatiotemporal information. Recently, Copernicus program services and products have become operational and freely available to the stakeholders and end-users.

A set of remote sensing derived indicators is needed to address national needs and priorities for sustainable coastal development. This presentation provides an analysis of the satellite EO data which can successfully integrate into the framework of ICZM to tackle environmental issues of the Bulgarian Black Sea. A review of the ICZM remote sensing indicators related to Sustainable Development Goals (SDGs) such as GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action, GOAL 15: Life on Land, is made. The indicators are identified based on satellite images comprising the data archives since the beginning of the 90s of the XX century and data from EU Copernicus initiative till now covering the western Black Sea area. The review will contribute to implementing RS and EO data more inclusively into Bulgarian program and strategies harmonized with the EU policy such as ICZM and Marine Spatial Planning on a local, national and regional management level. Geospatial data provide valuable and vital information needed for implementing the Black Sea Strategic Research and Innovation Agenda and achieving SDGs until 2030.

Application of DPSIR framework to identify sustainability issues of beekeeping sector in Cyprus: the case of Mitsero area

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Keywords: Beekeeping sector; Climate change; DPSIR; Sustainability

Abstract

The present research applies the Driving forces–Pressures–State–Impact–Responses (DPSIR) framework in order to identify issues related to sustainability of the beekeeping sector in a representative area of Cyprus. The framework examined the natural environment of Mitsero area with an emphasis on bee flora plants and the yield from beekeeping for the past five years, and the problems faced by beekeepers in the area. The problems are based on the statements of 5 beekeepers who preserve their beehives the most time of the year in Mitsero.

Reduced rainfall, rising temperatures and difficulty in dealing with Varroa destructor are characterized by beekeepers as the main issues they have to deal with. Other major problems are the presence of migratory bee-eaters in the area, the destruction of wild flora for unnecessary purposes, the presence of “foreign” beekeepers in the area in order to supplement honey quantities and the increase of amateur beekeepers due to the economic crisis which probably threatens the carrying capacity of the area.

The application of the DPSIR framework proved to be a useful tool for identifying areas in need of improvement and various measures for improvement are proposed. Also a major problem is identified through the application of the DPSIR framework, which is the lack of existing measured data of environmental indicators (especially those regarding the area’s bees carrying capacity and the limit of acceptable Varroa destructors impact on the bees and on the pollination) so they could be used as evaluating tools and adopting responses measures where it would be needed.

Nowadays, beekeeping at Mitsero, according to a simple financial analysis (income/outcome) per hive, seems to be viable, but the lack of the existing measured data of environmental indicators limits the conclusions regarding sustainable beekeeping. According to the international goals of "Agenda 2030", pressures in the wider environment and particularly in the Mitsero’s environment, could be hopefully stabilized considering that they are far away from the target. In addition, with the contribution of European and national socioeconomic responses, such as the continuing beekeeper’s training and co-financed programs, sustainable development of beekeeping at Mitsero is getting more achievable.

Contribution of the planted fields of the lignite center of western Macedonia to climate change mitigation: Dynamic and long-term approaches

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Keywords: climate change mitigation, forest restoration, Eddy covariance, CO₂ fluxes, forest biomass, Ecophysiology

Abstract

Forest plantations generally act as a net sink for CO₂, thus contributing to climate change mitigation by removing atmospheric CO₂ and storing it into different carbon pools (i.e. plant biomass, soil, dead organic matter, litter). The accurate estimation of the carbon pools identified by Intergovernmental Panel of Climate Change (IPCC) Good Practice Guidance for Land Use, Land Use Change and Forestry (IPCC-GPG) along with the ecosystem CO₂ fluxes is fundamental for the assessment of tree plantations' contribution to the global carbon cycle. The Lignite Center of Western Macedonia initiated planting activities for restoration purposes in the 80s and nowadays the established tree plantations occupy an area of about 2,000 hectares. The dominant planted species is the black locust (*Robinia pseudoacacia*).

The aim of the COFORMIT project is the estimation of the carbon dioxide assimilation and storage from the plantations of the Lignite Center of Western Macedonia for both long term and dynamic time periods. To this direction, a holistic approach is being used. First, we estimate total carbon in the five carbon sinks (aboveground and belowground biomass, standing and lying dead wood, fallen leaves and soil carbon) by performing a systematic sampling. Moreover, we estimate CO₂ and H₂O fluxes based on micrometeorological methods (eddy covariance technique), as well as remote sensing using field cameras and satellite images.

The five carbon pools will be quantified in a number of already established monitoring plots. The above ground biomass has been estimated by building an allometric model for black locust. Furthermore, its distribution along the planted areas was determined using geostatistics and kriging regression. The belowground biomass will be estimated both by means of direct measuring of excavated root systems in selected trees as well as by indirect calculation by means of applying established allometric equations, based on aboveground tree traits.

The dead wood carbon pool was measured in all monitoring plots used for the aboveground biomass. Moreover, litter traps have been established at 1m above ground and litterfall will be selected on a regular basis during one year. Accumulation of the litter on the forest floor will also be determined by conducting litter sampling

close to the litter traps. Therefore, leaf dry mass per unit of ground area will be estimated. Soil organic C pool will be measured in samples obtained from the upper 60 cm of soil which will be collected close to each litter trap.

The seasonal fluctuation of primary productivity of the studied tree plantations, in terms of CO₂ assimilation, will be assessed with the eddy covariance technique for a six months' period.

Analysis of the main environmental factors' effect, i.e. photosynthetically active radiation (PAR), air temperature and vapour pressure deficit (VPD), on primary productivity will also be performed, in order to assess the way these abiotic parameters affect ecosystem fluxes.

Acknowledgements

This research was funded by Single RTDI state Aid Action Research –Create – Innovation with the co-financial of Greece and the European Union (European Regional Development Fund) in context with Operational Program Competitiveness, Entrepreneurship and Innovation (ΕΠΑΝΕΚ) of the NSRF 2014-2020 (project Contribution of the tree planted land of West Macedonia lignite center to protection of environment and to mitigation of climate change T1EDK-02521).

Sources of particulate matter pollution in Limassol coast area

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Keywords: Particulate Matter (PM), Pollution, Limassol coast area

Abstract

The necessity of the present study arises from the frequent and disastrous occurrence of airborne particulate matter (PM) incidents and aims to help reduce their impact on the natural and anthropogenic environment. The specific objective of the present work is to identify, study and assess the degree of PM pollution incidences, with the ultimate aim of preventing and reducing them.

The study is being implemented on the coastal front of Limassol, a developing city in the sensitive Mediterranean region that finds it difficult to follow the EU standards for air quality. Initially, there was a need to identify locations in areas of interest at the coastal front at specific times, showing increased levels of PM concentrations at the three aerodynamic diameters of 10µm, 2,5µm and 1µm (PM₁₀, PM_{2,5} and PM₁). Towards this, outdoor surveys were scheduled using a manual

DustTrak meter that records the concentrations of PM₁₀, PM_{2,5} and PM₁ for the detected pollution incidents and uses a recent version of Microsoft Excel software, in which the data from the meter is stored, as a key analysis tool. The different factors that contribute to the respective incidents such as location, time, weather and season period are recorded, presented and discussed, along with the measured PM concentrations.

The field campaigns revealed a strong incident during "Tsiknopempti" (meat roasting festival) in a square reaching an average of 535 µg/m³ for PM_{2,5}, followed by many other anthropogenic incidents such as at a cement factory and on a dirty road both by the beach, on a seaside asphalt road, at a construction site in marina, at a burning and repaired tire factory and during a dust incident. Coarse particles (PM₁₀) predominate on the construction site (302 µg/m³ average) and on the road (191 µg/m³ average), while fine particles (PM_{2,5}) gathered from the balcony of the area on an intense background and primarily on the "Tsiknopempti" event (535 µg/m³ average), at the factory (87 µg/m³ average), the dirt road (207 µg/m³ average) and the cement plant (386 µg/m³ average), with worrying results towards finer particles that lead to even more alarming values with high rates and concerns for PM₁. In addition, seasonal variability was observed, with summer concentrations being higher than spring and during the rain falling (3 µg/m³ average) to fall sharply. The present findings are in agreement with the gathered data by the public's sector air quality fixed station.

The overall output is to provide with essential and valid information all stakeholders, who intend to study and protect the atmospheric environment of the Limassol coastal front and in general to create a flexible decision-making tool that could be applied to other similar areas. The noticed events confirm the necessity for denser and continuous air measurements.

Oil bio-desulfurization as a solution for reducing air pollutants

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Keywords: Air quality; Biodesulfurization; Oil; Pollutants; Sulfur compounds

Abstract

Sulfur compounds in liquid fuel are undesirable and their levels in diesel fuel is strictly regulated in the last 15 years from the European Union. The stringent

regulations are imposing an urgent requirement for fuel terminals to produce fuels having ultra-low sulfur content due to environmental concerns. Refineries or end users' terminals that do not have the ability to convert the fuel oil into higher quality products with low S will struggle to remain profitable as this big outlet for lower-quality fuel disappears.

More than 200 sulfur-containing organic compounds have been identified from crude oils; these compounds include sulfides, mercaptanes and thiophenes. One of the technologies commonly used to tackle this problem is the hydrodesulfurization (HDS) that requires high temperatures and pressures and the exposure of crude oil fractions under severe conditions; however, this decreases the value of the fuel. Typical conditions are temperatures between 200 and 350°C and pressures from 5 up to 10 MPa, depending on the desulfurization severity required. In addition, with HDS is difficult to remove heterocyclic sulfur compounds. As legislative limits on sulfur emissions have become tighter, the need to remove heterocyclic sulfur compounds from fuel has become more pressing.

A promising "Eco Technology" is to employ Biodesulfurization (BDS), a process where the bacteria (liquid phase) are mixed with oil at ambient temperature and pressure and remove selectively organosulfur from oil fractions without degrading the carbon skeleton of the compounds. Biodesulfurization is considered as an environmentally friendly process, because of the mild process conditions (low pressure and temperature) and no of chemicals addition.

Research to develop alternative desulfurization technologies resulted in a biotechnological strategy to eliminate sulfur from thiophenic compounds via serial reactions known as the 4S pathway. The 4S pathway provides a nondestructive oxidative process used by the cells to obtain the sulfur required for growth, which involves the transformation of Dibenzothiophene (DBT), the model compound for sulfur heterocycles present in oil and refractory to HDS, into 2-Hydroxybiphenyl (2HBP) and sulfite. Through this pathway, the carbon skeleton of DBT is released intact resulting in no calorific value loss of the fuel. The pathway is called "4S" in reference to the four intermediates formed (DBT sulfoxide, DBT sulfone, hydroxyphenyl benzene sulfonate, sulfite), and takes place through successive oxidations of DBT that is metabolized to 2-HBP (2-hydroxybiphenyl). The complete removal of sulfur from DBT requires four enzymes (*DszC monooxygenase*, *DszA monooxygenase*, *DszB desulfinase*, *DszD flavin reductase*).

None of the existing approaches in the literature has succeeded in developing a biocatalyst suitable for a commercial oil biodesulfurization process. The failure to develop an exceptional biocatalyst, is that the primary factor limiting the activity of the 4S pathway is the end-product inhibition of the 2-HBP to biodesulfurization microorganisms. Nevertheless, reducing of sulfur content in fuels, will result to a positive impact to air quality and associated health effects.

Inorganic impact on the properties of biochars prepared by pyrolysis from grape marc

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Keywords: chars, inorganics, pyrolysis, grape marc.

Abstract

Grape marc waste generated from agro-industries have large deposit in the world (Celma, 2012). To minimize environment impact and to recycle such harmful residue, several recovery methods have been proposed. In particular, grape marc waste can be used as starting material for the production of added value products (i.e. alcohol, tartar, yeast, phenol compounds, oil, pharmaceuticals and cosmetics), as decontaminant for metal rich (copper and nickel) effluents, as feedstuff and organic fertilizer for soil. A promising way for grape marc recovery is the char's production using pyrolysis technique. These chars that can be applied in different applications including adsorption for gas and water pollutants removal, hybrid composites formulation.

Grape marc, as all lignocellulosic biomass, consists mainly of cellulose, hemicellulose, and lignin and contains small amounts of minerals. These latter include significant amounts of alkaline and alkaline-earth species such as potassium, sodium, magnesium and calcium, which are essential nutrients of plants. Various studies have examined the effect of the inorganic elements on the pyrolysis process and reported many contradictory results on their catalytic effect (Khelfa, 2013) (Hwang, 2015) (Eom, 2012). In this context, the present investigation has been conducted with the aim to study the effect of minerals, and more specifically the role of potassium and magnesium species, on the pyrolysis process of grape marc as well as on the properties of chars which are key parameters for defining the suitable recovery process.

Concerning the char yield production at the various pyrolysis temperatures, a decreasing in char production can be noticed for the washed biomass. Such result can be of course due to the presence of a lower amount inorganic residue at the end of the pyrolysis process, but it can also be connected to the fact that inorganics display a catalytic effect that promotes specific reactions during the char production. This last explanation is also supported by the FTIR results that shown the formation of C=C bonds (formation of aromatic compounds). The different samples showed the same carbon structure, as noticed by comparing the Raman spectra that in each case display two well defined D and G peaks. By increasing the temperature, the G band moves towards higher wavelengths, due to the formation of more complex aromatic systems in the char structure. No dramatic differences were found in the morphology of the chars prepared in presence of K and Mg species, but the stronger interaction of Mg-species was clearly evidenced by SEM microscopy.

In conclusion, the low amount of deposited salt presents only a slight impact the physico-chemical properties the char produced, but modification in the

mechanism and kinetics of pyrolysis can be expected. A deep analysis of the TG analysis realized for the different biomass will clarify this point by comparison of the thermogravimetric curves and activation energies of the different biomass samples.

Acknowledgements - The authors would like to thank the Carnot Institute MICA for supporting a part of this study in the frame of the Carbovit project. All physico-chemical analyses were performed on the technical platforms of IS2M.

Scoping calculations of nutrients and organic matter from olive oil mill wastes in Mediterranean

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Keywords: Olive mill wastes, biochar, hydrochar, fertilizer, soil remediation.

Abstract

Spain, Greece and Tunisia are among the largest worldwide producers of olive oil. Olive oil extraction technologies generally belong within three categories: the traditional extraction system, the three-phase extraction system, and the two-phase extraction system. The three-phase extraction system, while prohibited in Spain, represents about 70% and 80% of the Greek and Tunisian olive mills. The three-phase extraction system generates large amounts of olive mill waste water (OMWW) and also olive mill solid waste (OMSW), while the two-phase system creates only OMSW.

The management of these wastes represents a major challenge and efforts have been made in order to develop systems for treatment or disposal of olive oil mill wastes, including uses for agriculture (production of bio-fertilizers, soil conditioners), uses for biomass energy (as combustion material in boilers for heating purposes, brick production, agropellet production etc.), uses for biogas production (during anaerobic co-digestion of both solid and liquid wastes), uses for animal feed and uses for irrigation.

Biochar, produced from olive oil mill wastes through pyrolysis, is used as a soil improver in agriculture to enhance the soil fertility and crops production as well as to mitigate and remediate contaminated soils. It is a C-rich organic material produced during slow exothermic decomposition of biomass under low oxygen conditions and at temperatures ≤ 700 OC. Biochar application in agricultural soils can increase nutrient release as well as emerging pollutants retention.

One of the main goals of the FERTICAR project (<https://fertichar.net>), which includes partners from some of the most important olive and olive-oil producing countries (Spain, Greece and Tunisia), is to use nutrient-enriched biochars/hydrochars produced from olive mill wastes as amendments in agriculture for the improvement of the productivity of agricultural systems and their sustainability.

In the present study, the first task consisted of gathering existing data on cultivated olive lands, olive oil production, olive oil extraction techniques and the corresponding generated wastes in Greece, Spain and Tunisia. Afterwards, representative solid and liquid samples from each country were physico-chemically characterized in order to optimize their applications in agriculture as carbon-rich fertilizers and soil amendments. After compiling the quantities of wastes generated in Greece, Spain and Tunisia and analyzing representative samples, estimates of nutrients and organic matter contained in these waste streams were assessed.

Olive mill solid wastes had around 55-60% carbon contents, and 1% nitrogen contents, giving these materials mid-range C:N values (~ 50). The values for OMSW within and between countries were also very similar. OMWW C:N values were lower (~ 20). NO_3^- was the dominant inorganic species in liquid samples, with a large range of 35-2262 ppm. Soluble phosphorus was also in greater concentrations in the solid samples. Extractable P in solid samples was between 260-1090 ppm, while in the liquid fractions it was between 3-300 ppm.

Concerning the macro- and micro-nutrient metal content of the wastes, in three-phase wastes the proportion of metal elements found in the aqueous phase varied greatly, from 1-2% (Al and Fe) to 38% (K). The quantities of K in Tunisian wastewaters and solid wastes were of particular note, representing 0.6% of total mass. Concerning P, Spanish solid wastes had the highest contents (0.1%).

Based on the analysis results, OMSW properties are more similar between countries and processing plants than OMWW. Their conversion to biochar may be of interest as soil conditioners or amendments to improve physical properties and biological activities of degraded or low-organic matter soils in Mediterranean countries. Mineral ash is also relatively high in the olive mill wastes, yielding impressive total quantities, so these materials may be useful ingredients in tailor-

made bio-based fertilizers for the stable earth alkali metal and/or phosphorus contents.

Passive Thermal Frost Protection Using Pellets with Phase Change Materials

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Abstract

Mediterranean climate change will result in extreme weather, and the region already has begun experiencing more episodes of severe cold in an unprecedented fashion which result in important losses in agriculture. As regard to frost damage, although climate change and increasing temperatures will diminish the occurrence and severity of spring frost events, which should reduce frost damages, however, as counterpart, plants flower and leaf out earlier than they used to and as a result the incidence of frost damages will increase. In fact, frost is already the most important threat to Greek farmers since it accounts nearly 50% of the total losses due to weather related phenomena and therefore new mitigation anti-frost techniques adapted to the new challenge of climate change are required. In this work consideration is given to a passive self-control and passive technique to prevent frost damage. The idea is based in the use of inexpensive small pellets or pebbles scattered in the crop and containing phase change material inside which are able to storage thermal energy as latent heat during the day to gently release during the freezing episodes. The pellets or pebbles will be thermally recharged during the day with solar energy and then acting a passive technique where the continual intervention of the farmer is not required as in many of the current traditional anti frost methods. Additional R&D is required in order to arrive at a reliable practical and safe design of the pellets.

Whey as a nematicidal and a soil enhancer

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Keywords: Meloidogyne spp., soil microbes, soil free-living nematodes, soil enzyme activities

Abstract

This research addresses a global need for alternative and environmentally friendly strategies for root-knot nematode control in the frame of sustainable agriculture, by evaluating the use of whey on soil with drip irrigation. At the same time, we study the effect of whey on soil functionality by evaluating its effects on soil organisms and enzymes. Whey is already reported as plant promoter, but it has never been studied for its effects on soil communities. Additionally, whey is registered as a fungicidal basic substance, but it has never to date been studied as a nematicidal against the root knot nematodes under field conditions. Herein we pinpoint whey EC50 value on *Meloidogyne javanica* and affirm the efficacy under field conditions. In extends, by estimating PLFAs and enzymatic activities, soil free-living nematodes, J2 nematodes in soil, root infestation and plant growth parameters, we assess the impact of the whey both on agricultural productivity and on soil health and fertility.

Physio-chemical properties of hydrochars produced from olive-mill by-products for possible application in agriculture

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Abstract

Olive oil production in the Mediterranean basin has been practiced since the dawn of times until becoming an essential activity in the economic structure of the region. Nonetheless, with a 95% of the worldwide production of olive oil, substantial issues related to the sustainability of the production process have gradually emerged. In fact, the extraction of oil from olive fruits leads to the generation of two by-products, namely olive pomace and olive mill wastewater. Given the possible environmental consequences related to the bad management of these wastes, their treatment *via* multiple technologies was the subject of exhaustive number of research papers. Nevertheless, these studies were mainly oriented towards the elimination of the contained pollutants without considering their possible reuse in the agricultural field. In this context, this research investigates the conversion of these mixed by-products into carbon-nutrients-rich bio-fertilizers using hydrothermal carbonization process.

Herein, four precursors were used, namely raw olive pomace (ROP), olive mill wastewater (OMWW), impregnated ROP with OMWW (IROP) and finally ROP with OMWW used as moisture source (ROP+OMWW). The effect of applying three carbonization temperatures (180, 200 and 220°C) on the physio-chemical properties of the resulting hydrochars were investigated in terms of final carbonization yield and their mineral composition.

The experimental results showed that the carbonization yields decreased with the increase of the used carbonization temperature. The highest hydrochar production yield was obtained for a carbonization temperature of 180°C when using IROP as a precursor (56%). The obtained hydrochar yields were more important compared to other carbonization methods, i.e, slow pyrolysis. On the other hand, the nutrients contents of the produced hydrochars was intimately affected by both the nature of the used initial precursor as well as the carbonization temperature. Indeed, the hydrochars' NPK contents were relatively important when using OMWW as a moisture source. Moreover, these contents decreased while increasing the carbonization temperature (Table 1). This could be attributed to the possible

degradation of the solid fraction present in the OMWW and the migration of the minerals towards the liquid fraction. After impregnation, the migration rate of the minerals decreased considerably, and they seem to be better retained in the solid lignocellulosic matrix. The fate of the carbonization by-products in the liquid fraction is currently investigated using GC/MS and ICP apparatus.

Table 1: Mineral content of the produced hydrochars at different carbonization temperatures

Samples	K (mg/Kg)	P (mg/kg)	N total g/kg dry matter
ROP	6100	118	6.95
IROP	5400	173	6.69
OMWW	44000	2034	17.6
180 - ROP	1350	81.3	7.33
200 - ROP	1650	52.2	7.93
220 - ROP	950	9.21	9.26
180 - IROP	750	14.1	7.73
200 - IROP	800	7.14	8.58
220 - IROP	1150	15.4	10.2
180 - ROP + OMWW	8000	110	13.7
200 - ROP + OMWW	9000	50.8	12.2
220 - ROP + OMWW	1450	31.4	5.29
180 - OMWW	20000	618	6.76
200 - OMWW	3350	66.7	8.22
220 - OMWW	2000	34.8	6.43

Study of photocatalytic and photo-fenton degradation of organic water pollutants in the presence of ultrasound

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Keywords: organic pollutants, azo dyes, sonophotocatalysis, Fenton, ultrasound

Abstract

Pollution-related problems have attracted much attention as organic pollutants, like CFCs, PCBs, PAHs and antibiotics are among the most harmful substances for the environment. One of the main pollution sources of water are azo dyes. Azo dyes are widely used in industry, accounting for nearly 70% of the world dye production. Production reaches 70,000tn/y and a large percentage of those dyes escape in the environment, causing various problems regarding both human health and soil contamination. During the coloration process, a large percentage of the dye does not bind to the fabric and is lost to the wastewater stream. Approximately 10-15% dyes are released into the environment during dyeing process making the effluent highly coloured and aesthetically unpleasant. Wastewater from textile dyeing also affects plant life in the water, as photosynthesis is hindered. Clothing industries demand durable dyes that can withstand discoloration due to daily use. Since they are highly durable and harmful to the environment, water contaminated with organic pollutants needs to be properly processed. Currently, advanced oxidation processes (AOPs) are employed, by utilizing ozone, H₂O₂, Fenton reagent and ultraviolet (UV) light in order to mineralize azo dyes. Another interesting approach is the use of ultrasounds, which promise high reaction rates and short treatment times.

Six azo dyes were selected from the weaving and leather industry. Their degradation was examined via UV illumination, by using the TiO₂ (Degussa P-25) semiconductor as a catalyst, Fenton/photo-Fenton reaction and via ultrasound irradiation at low (20 kHz) and high frequencies (860 kHz).

In this work we used the above mentioned AOPs in order to reach the best results taking advantage of the synergistic effects of photocatalysis (TiO₂) and Fenton/photo-Fenton reaction as well as ultrasound irradiation. Parameters like the duration of photocatalysis, the time and frequency of ultrasound irradiation, and the ideal pH of the solution were varied during the investigation. The radiation power, the temperature, the amount of TiO₂ semiconductor and the amount of Fenton reagent remained constant.

The quantity of catalyst (TiO₂) in the photocatalysis experiments was 0.04 g / L and the quantity of Fe²⁺ in the Fenton experiments was 10mg / 350 ml H₂O / 1 ml H₂O₂. The ideal pH for the Fenton/ photo-Fenton reaction found to be at pH=3. In the experiments with simultaneous action of the ultrasound and the photocatalytic activity, the ultrasound reactor was placed inside the photocatalytic reactor. The same method was used for the combination photo-Fenton / ultrasound.

Due to their different molecular structure each azo dye showed different degradation in a different combination of AOPs. Different frequency of ultrasound means specific energy, which is absorbed by the dye and smaller molecules are created from its disintegration. Here, we report on the degradation of different azo dyes. As an example, for the dye with trade name Dermacid Red, the photocatalytic synergy with a 20kHz ultrasound irradiation gave a 48% degradation. The combination of photo-Fenton with 860kHz ultrasound irradiation for the same dye gave a 80%

degradation. Experiments have shown important efficiencies during the first two hours. After that threshold, the reaction rate is decreased. For photo-Fenton experiments the mean time decreased in 1 hour.

Estimation of cadmium (Cd), lead (Pb) and nickel (Ni) deposition in protected and ecologically sensitive salt marshes around Larnaca Airport – Cyprus

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Keywords: GIS, Environmental Impacts, Impact Assessment, Egnatia

Abstract

Heavy metals, such as cadmium, nickel and lead, belong to the category of the direct toxic metals for ecosystems. Their adverse effects on both human health and the wider natural environment, even at low concentrations, are alarming because of their toxicity, as well as their long-term degradation. It is indicative, that relevant past studies have classified heavy metals as the most important toxic pollutant in aquatic ecosystems.

Although heavy metals are found in nature through geochemical processes of rocks, they are also added to the natural environment by a variety of anthropogenic inputs. Among others, one source of origin and deposition of heavy metals in the environment, is the non-road transportation, including airports and their operational activities.

The primary objective of the present study is to calculate the concentrations of cadmium (Cd), lead (Pb) and nickel (Ni) in the ecologically sensitive Larnaca Salt Lake District (Cyprus) from the nearby international airport. An additional objective of the study is the spatial distribution of the results. From the existing salt lakes cluster that is found around the airport, the study selected the Salt Lake which is located at the southern exposure of the airport named Orphani. From the area, soil samples were taken and analysed in laboratory by the Department of Soil Science of ELGO – DIMITRA. The results were mapped and visualized using the free software Qgis Geographic Information Systems version 3.6.0.

Concentrations were found for all three examined heavy metals, with their general appearance pattern following the Ni>Pb> Cd series. The enrichment factor index as well as the geo-accumulation index, were used to better assess and evaluate the pollution levels. Finally, as a further measure for the comparison of the final total concentrations of the three heavy metals, the European Community Directive 86/278 / EC was chosen.

Correlation between emissions of pollutants and the land use. The case study of the city of London

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Keywords: GIS, Remote sensing, air quality

Abstract

Land use and land cover activities directly affect air quality by emitting anthropogenic and natural pollutants. These pollutants are dispersed by local, regional and global airflow and greatly affect health, safety, operating costs and other areas of land use and land cover activities. Thus, as a significant contribution to pollutant emissions in the atmosphere, land use can also degrade the quality of the environment. In order to assess the impact of spatial planning on the atmosphere, the present paper aims at deriving a correlation between emissions of pollutants and the land use of London.

Through the change of land use, there has been a profound impact on the regional climate[4]. Emissions are linked to air quality and air pollution and climate change affect each other through complex interactions in the atmosphere. These relationships are strongly related to many factors and vary with local conditions. The purpose of this paper is to contribute to the review of current understanding of the interaction between land use change and atmospheric chemistry, focusing on short-term atmospheric pollutants.

London is an extremely sensitive area to the air pollution. The issues London faces due to atmospheric pollution began to take shape in the 1950s and 1960s with the famous London smog that covered the city and caused many deaths. Pollution control legislation had already been in force since 1306. Since then, there have been some changes over the years.

The use of Geographic Information Systems (GIS) and geo-spatial technologies in general, in land use management is well established and diverse, with extensive applications related to agriculture, forestry, wildlife, outdoor recreation, energy development, transportation and urbanization. GIS technology through the management of statistics and spatial data is able to provide tools that show the

relationship between air quality and human and environmental health. Due to the above, in this paper, GIS tools have been applied to draw conclusions on the relationship between land use, air quality and climate change.

Spatial and time relating analysis through GIS could offer a deeper look into the evolution of pollutant emissions in a specific area and changes taking place according to seasons. Both mapping and spatial analysis shows that it is possible to use these kinds of tools and apply it to complex urban land use to produce a useful field map for further future fieldwork and research. Although air pollution appears to recede from time to time, as inferred from the results, London can be described as an area suffering from air pollution, that is directly related to the traffic and the pollutants, often exceed legal limits.

Preparation, modification and characterization of composites for photocatalytic waste water treatment applications

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Keywords: Photocatalysis, Waste treatment, Sonochemistry, Methylene Blue, Nanoparticles

ABSTRACT

By photocatalysis we refer to the process of the degradation of pollutants of various sewage via visible or UV illumination. Over the last few decades, photocatalysis with transition metal oxide nanoparticles (NPs) has proven to be useful for the degradation of pollutants. It essentially works to convert organic pollutants into inorganic compounds such as CO₂, H₂O and inorganic acids. The photocatalysis is divided into two reaction systems, solutions and immobilized systems.

Over the last few decades, photocatalysis with transition metal oxide NPs has

proven to be useful for the degradation of organic pollutants. Photocatalysts are a class of materials that have made remarkable progress in recent years due to their important role in environmental pollution control and waste management. Semiconductor nanoparticles have attracted great attention due to their unique size-dependent optical properties. In addition, the disadvantages of individual components can be compensated by semiconductor composites, since they induce a synergistic effect, such as efficient charge separation and improvement of photostability.

In the present work, sonochemically synthesized nanoscale semiconductors TiO_2 , CdS, CdS- TiO_2 , ZnO, ZnO-CdS, CdS- TiO_2 -Au were studied as solid phase catalysts during the degradation of Methylene Blue, via UV illumination. CdS has been observed to be a remarkable photocatalyst, while Zn and Ti, as transition metals, can have a beneficial effect on it. This effect can be further optimized by decorating with noble metals such as Au. However, Au is an inhibitory factor in the photocatalytic activity of the CdS- TiO_2 catalyst. In conclusion, several semiconductors were synthesized in the presence of ultrasounds in shorter reaction times compared to conventional techniques and acted as high performance photocatalysts.

Nutrients leaching from an agricultural Mediterranean soil amended with biochars derived from impregnated solid olive wastes by olive mill wastewater: batch and column investigations

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Keywords: olive solid waste, biochar, nutrient leaching, soil

Abstract

Olive cultivation is considered as a key economic sector in the Mediterranean region. Spain, Italy, Greece and Tunisia are the highest olive oil producers with average

percentages of 43.3%, 10.6%, 9.4% and 6.3%, respectively (IOOC, 2018). However, olive oil production generally generates huge quantities of olive solid wastes (OSW) and olive mill wastewaters (OMW) that are considered as highly polluting by-products. For instance, for the three phase extraction systems, used basically in Tunisia and Greece, the production of 1 m³ of olive oil generates about 2070 Kg of OSW and 4340 Kg of OMW (Avraamides and Fatta, 2008). The integrated management of these wastes is considered as an important defy for the sustainability of the olive oil industry (Doula et al., 2017).

One of the methods that have been tested recently consisted on the impregnation of the OSW by the OMW and the pyrolysis of this resulting solid phase for the production of biofuels (bio-oil and biogas) and biochars (Jeguirim et al., 2020). The produced biofuels could be valorized for energetic purposes and biochars for environmental and agronomic applications as adsorbents and biofertilizers, respectively.

Agricultural soil amendment by biochars has shown significant improvement of soil properties since they could significantly contribute to the increase of the soil water retention capacity, the decrease of its acidity, the enhancement of its cation exchange capacity, subsurface nutrients and pesticides retention, the improvement of microbial activity as well as plants growth and productivity. The main goal of the present investigation is to study nutrients leaching from biochar derived from olive solid wastes (OSW) impregnation amended to a Tunisian agricultural soil in batch and columns mode. The static experiments consisted in five successive leaching experiments for a cumulated time of 10 days. The dynamic essays were performed by using Plexiglas columns filled with an agricultural soil amended with the produced biochars at doses of 0% (blank test), 1% and 5%) for a total duration of 20 days. These columns were daily rinsed by 400 mL of distilled water.

The batch experiments results prove that this biochars could be considered as a significant additional nutrient source. Indeed, significant amounts of nutrients, especially potassium which was released at about 28 mg/g for only the first day. Furthermore, the used biochars acted as a slow release fertilizer since these nutrients continue to be released with relatively high kinetic even after a contact time duration of 10 days.

Regarding the laboratory column tests, the experimental results showed that the nutrients leached amounts have increased with the increase of the used biochar dose (1% and 5%). Compared to the bank test, these increases were assessed to 490%, 161%, 107% and 119% for potassium, ammonium, sodium and magnesium respectively. However, a fairly considerable amount of the leached calcium was retained.

Are Environmental Education Centers ready to combat Climate Change?

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Keywords: environmental education, climate change, SWOT analysis, environmental education centers

Abstract

Environmental education is playing a crucial role in today's societies, given the environmental problems they face, as for example climate change. The adoption of environmental education as an inert part of the educational system is a necessity in order the Environmental Education Centers (EEC) to be able to provide knowledge, values, and skills so that both students and the society through awareness raising, and activation to become active and environment sensitized citizens.

The idea of setting up and operating EEC was directly related to the emergence of integrating environmental education in the educational systems of the various countries in the 1970s and 1980s. During the international conferences in Tbilisi (1977) and Moscow (1987), the theoretical framework of the EEC was established and the need for their operation was highlighted and expected to contribute to the education of societal groups in order to develop the sense of shared responsibility, implement actions and improve quality of life through the rational use of the environment and natural resources. In line with this, EEC are anticipated to play a crucial role in climate change adaptation and mitigation.

Educators, students, and other members of society in Cyprus and Greece participated in a survey that asked them to fill out a questionnaire specifically designed for each category regarding their knowledge of climate change, by refuting the citizens understand the issue. After collecting and processing questionnaire data, useful conclusions were obtained regarding the capability of the EEC in both countries to contribute to behavioral change and improve knowledge of the students and the wider society regarding climate change mitigation and adaptation. Thereafter, a strategy was developed for both countries, based on SWOT analysis that will help develop the most appropriate plans for adapting or improving new or existing structures and training programs on climate change.

Attitudes to Genetically Modified Foods over time: The role of public opinion in the decision making for biotech products

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Abstract

According to the European Council's Decision, of 25th October 1993, concerning the conclusion of the Convention on Biological Diversity, Biotechnology can be defined as "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use". It is well known that biotechnology is used in many applications.

For many years, plant breeding has been performed using phenotypic selection and even though, this approach is still being used, many traits that could not be modified by classical breeding techniques have been introduced by genetic engineering, allowing the breaking of species barriers. These genetically modified organisms (GMOs) are a subject of on-going scientific, political and social discussions in Member States of the European Union (EU) concerning their use, benefits, risks, safety and limitations.

The role of public opinion on GMOs, is considered in the context of risk perceptions and attitudes, public trust in regulatory institutions, scientists and industry. It is important to note, that the role of the stakeholders (such as environmental and nongovernmental organizations, parties, politicians, etc.) their attitudes and interests have a significant influence not only on public opinion but also on the decision-makers.

The concept of risk is a key factor taken seriously into consideration in the creation of policies. Three theoretical frameworks that describe risk perception inspired this study: Theory of Social Representation (TSR), the Cultural Theory of risk, and the Social Amplification of Risk Framework (SARF).

Between the scientific risk assessment and the public perception, a controversy is often observed.

In the meantime, at least in the European Union (EU), the precautionary principle (PP) has been invoked in relation to GMOs, which has slowed down GMOs adoption. However, as of January 2015 rather than an EU-wide policy, each member state can decide whether to continue with the restrictions that stem from the application of the PP. At this stage it is relevant for each member state to understand the acceptability of GMOs within their borders.

Different studies show wariness of GMOs in Europe. According to the Eurobarometer on Biotechnology (2010), there is an overall suspicion, amongst the European public, with Cyprus having one of the highest negative consensuses on it. Cyprus, as one of the smallest countries in the European Union and the only de

facto divided island, has specific reasons to develop its own political culture which is reflected on the attitudes, beliefs, and sentiments of the citizens.

As such, we argue the importance of national public policies informing the public in general and potential consumers as to the certainties and uncertainties, costs and benefits of GMOs. An informed population can make informed choices concerning not only national policies such as maintaining the restrictions or not, supporting more or less permissive regulation but, also consumption choices in the marketplace. Furthermore, informed consumers with stable preferences can make certain investments by firms in (non-)GMOs more or less viable.

Evidently, there is a need to develop communication strategies that explicitly address public concerns rather than exclude them. It is strongly recommended that new methods should integrate public values more effectively into risk analysis processes. Public acceptance is crucial to the success of the products of any new technology, including GMF.

A web-mobile tool for collecting and analyzing survey data. The case of GAP analysis in INTERREG BalkanROAD project.

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Keywords: Gap analysis, Survey123, ArcGIS Online, web mobile tool, survey

Abstract

In present days, data collection for several purposes, is a demanding task. The large volume, the complexity and the source diversity of data, make the collection and the analysis a difficult to operate work. Therefore, in present study, a productive, user friendly and easy to use customized web-mobile application is developed for surveying purposes. The main objective was to preserve the integrity, the interoperability and the flexibility of querying collected data.

The area where the study conducted, was the Balkan region in the framework of INTERREG BalkanROAD project focusing on the agri-business sector of five countries (Greece, Albania, North Macedonia, Bulgaria and Cyprus). With a purpose to adopt sustainable agricultural and products processing practices on behalf of agricultural enterprises, a GAP analysis was performed acting as a basis to assess the present status and for further development in the next steps of the project. Gap Analysis is a means of comparing current conditions and practices in order to identify gaps and areas in need for improvement with regards to compliance to the relevant standards.

Forms for the GAP analysis input data were developed using the open standard XLSForms in the interface of Survey123 Connect for ArcGIS and published in ArcGIS Online (AOL) which creates feature services based on the study's form specification

for data collection. Once the forms have been published, the AOL was used to register members and the Survey123 website to share the forms. Members can answer the questions, in the forms, using the Survey123 field app or the Survey123 website. The Survey123 field app can be also used for analyzing the tables of the collected data, as well as for exporting the survey results. The app can be downloaded and implemented in mobile devices like smartphones and tablets (iOS, Android, Windows) for extending its functionality.

As proven in this study, internet and customized mobile tools constitute an attractive suite of methodologies for effective and user-friendly collection and analysis of survey data.

Carbon stock in agricultural soils of south Senegal

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Keywords: soil organic matter, sandy soils, texture, climate change

Abstract

Climate Change and Global Warming are associated to the increment of anthropogenic net emissions of CO₂ (IPCC, 2018). Soils are the major terrestrial organic carbon stock and soil organic carbon (SOC) is the main component of soil organic matter (SOM). As an indicator for soil health, SOC is important for its contributions to food production, mitigation and adaptation to climate change, and the achievement of the Sustainable Development Goals (SDGs) (FAO, 2017). It has been very important the loss of organic matter in soils for centuries (Lal, 2004). The loss of organic matter differs depending on the geographical position and management.

Feller et al. (2012) indicated for tropical soils that through interactions among the different compartments of the ecosystem (soil, atmosphere, hydrosphere, biosphere), the soil impacts many ecosystem services that are relevant at local (farmer level) as well as global scales (society level). Moreover, according to terrestrial biosphere and climate models projections, both climate and land cover changes might cause a net SOC loss, particularly in tropical regions (Eglin et al., 2010).

In this sense, tropical and subtropical regions are in risk due to climate change, loss of organic carbon in soils and as a consequence, desertification. It is important to

determine the amount of SOM and the relations with soil characteristics in these regions. Most of the time, it is not easy to take samples and analyse them in a local well-equipped laboratory. For this reason, several methods to estimate the soil properties for developing countries in field conditions have been proposed (FAO, 2011).

The main objective of this work was to study the SOM content of agricultural soils, situated in two geographical positions, the plateau and alluvial plain, in the South of Senegal (Kédougou region). A hundred soil samples (arable layer) from different agricultural fields (composed by five-pointed star form and composited to make one sample for laboratory analysis) were analysed. The relations between organic matter content estimated by loss-on-ignition (Goldin, 1987) and texture measured by hand texturing (NSW, 1998; FAO, 2006) and pH (in soil-water extraction 1:2.5 w/v) were determined.

The results showed that, according with the texture, the fine texture soils of this area gave higher SOM, probably due to the clay size particles-humus interaction. All of the soils of this lateritic region have an acid pH. The trend observed was a diminution of the organic matter content when decreasing pH. Moreover, the soils of the area are mainly Leptosols in the plateau, and Regosols and Gleysols in the plain (ISRIC-FAO, 2008). In these cultivated soils, no statistical differences in SOM content were found among the types of soil although Gleysols gave the minor mean value of SOM (3.1 % dw).

Finally, relating to the geographical position in the region, there were no statistical differences between agricultural soils situated in the plateau and those in the plain. The main conclusion was that texture play an important role in the area. The amount of SOM in the soils were between 3.1 to 7.0 (mean values in soil types), which means an important stock of SOC. The determination of hand texturing could help to understand the possibilities of SOC sequestration by agricultural soils in subtropical and tropical areas. This work has partially supported by the Generalitat Valenciana (Spain) and the UMH and was done in cooperation of the Jane Goodall Institute of Spain.

A2UFood - Avoidable and Unavoidable Food Wastes: a holistic managing approach for urban environments

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Keywords: food waste, household food waste, hospitality sector, circular economy

Abstract

The A2UFood Project aims towards a holistic management system of the food-waste, which, in Greece mostly ends-up unexploited in the landfill. The proposed system covers all aspects of the “reduce-reuse-recycle philosophy”, namely the overall reduction of food-waste and the utilization of both the avoidable fraction (e.g. food that can be still safely consumed, but it has no outlet) and the unavoidable fraction (e.g. peels). Through the conservation of natural resources, the strengthening of the social fabric, and the creation of new value chains, AU2Food strives to apply Circular Economy concepts in practice. The goal of the A2UFood is to reduce the amount of food-waste wherever possible. The main tools in this direction are informative actions for citizens and professionals in the hospitality industry. Two smart tools are being developed: a) a mobile phone application providing users with information to assist full consumption of their food before its expiration date, including, but not limited to, useful tips and recipes for purchased food and left-overs, and b) an intelligent weighing system that helps the hospitality units’ managers to measure and realize the level and cost of food-waste produced in their kitchen at all times and assists the kitchen managers to better calculate served portions and therefore mitigate losses.

Comparative evaluation of monitoring tools for food waste prevention in the hotel sector

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Keywords: food waste, monitoring tools, hospitality sector, prevention

Abstract

The issue of food waste has gained significant importance in the last decade, due to its highly negative effects on ecological, social and economic sustainability. Stenmarck et al. (2016) estimated that in the EU-28, $87,6 \pm 13,7$ million tonnes or 173 ± 27 kg/ca of food waste were generated in 2012. Households had the largest share with 53%, while the food services were associated with 12% of this amount.

It has been observed, that within hotel management the awareness for avoidance and recovery of food waste has risen, since it induces cost reduction and also image improvement (Pirani and Arafat ,2014). Professional monitoring tools are already available on the market. This paper provides a comparative overview of the most widespread tools currently available, namely, Waste mapping guidance (Cyprus), WRAP, Leanpath, Resource Manager-FOOD, Winnow and KITRO.