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WELCOME TO ICSD 2022

On behalf of the organizing committee, we are pleased to announce that the 8th *International Conference on Sustainable Development (ICSD-2022) held on May 04-08, 2022 in Sarajevo, Bosnia and Herzegovina (Hybrid Conference). ICSD 2022 provides an ideal academic platform for researchers to present the latest research findings and describe emerging technologies, and directions in Sustainable Development issues. The conference seeks to contribute to presenting novel research results in all aspects of Sustainable Development. The conference aims to bring together leading academic scientists, researchers and research scholars to exchange and share their experiences and research results about all aspects of Sustainable Development. It also provides the premier interdisciplinary forum for scientists, engineers, and practitioners to present their latest research results, ideas, developments, and applications in all areas of Engineering and Natural Sciences. The conference will bring together leading academic scientists, researchers and scholars in the domain of interest from around the world. ICSD 2022 is the oncoming event of the successful conference series focusing on Sustainable Development. The scientific program focuses on current advances in the research, production and use of Engineering and Natural Sciences with particular focus on their role in maintaining academic level in Engineering and Applied Sciences and elevating the science level. The conference's goals are to provide a scientific forum for all international prestige scholars around the world and enable the interactive exchange of state-of-the-art knowledge. The conference will focus on evidence-based benefits proven in clinical trials and scientific experiments.*

Best regards,

Prof. Dr. Özer ÇINAR

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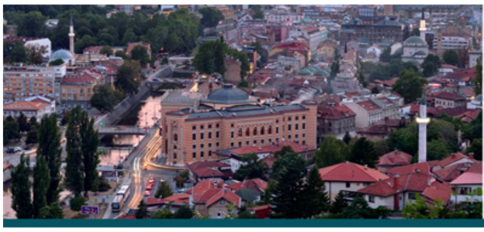

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The Effect of Humic Acid Applications in Different Doses on the Yield and Cluster Weight of Table Grape Cultivar Red Globe

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Abstract

The feeding of the world's population, which has reached approximately 8 billion, is getting harder day by day. For this reason, the necessity of increasing the product taken from the unit area causes intensive agricultural activities with using of more chemical fertilizers. As a result, the natural balance is disturbed, negatively, affecting the environment, food and human health. Sustainable agricultural activities are required for soils to feed future generations. Therefore, it is important to use organic products, soil conditioners and their wastes in agricultural production. Soil conditioners (improvers) are humic acid, leonardite, zeolite, seaweed, agricultural lime, aluminum silicate, liquid fulvic acid, amino acid mixtures, and soil conditioners with enriched structure. Humic acids are the most used soil conditioners in agriculture in recent years. Humic acids have positive effects on the physical, chemical and biological properties of soils. They increase productivity by increasing the cation exchange capacity of soils. Because of their chelating properties, they turn plant nutrients into an absorbable form and reduce the toxic effects of chemical fertilizers. In addition, they eliminate the negative effects of stress factors such as drought, salinity and toxic elements (heavy metals). Viticulture has an important place in Turkey's agriculture, due to suitable ecological conditions and soil properties. In the Aegean Region, Manisa Alasehir region has a large vineyard area; It meets an important part of table and dried grape production.

In the present study, the effect of different doses of humic acid applications from soil and foliar applications on the yield and cluster weight of Red Globe cultivar (Vitis vinifera L.) in Manisa Celal Bayar University Alasehir Vocational School trial vineyard in Manisa-Alasehir region was investigated. It was found that humic acid had a statistically significant effect on the yield and cluster weight of the vine at different doses and methods.

Keywords: Humic acid, Foliar and soil application, vineyard, (Vitis vinifera L.) Red Globe, yield, cluster weight.

1. INTRODUCTION

In recent years, the mankind have been working intensively to increase quality and healthy yield from unit area in agricultural field and food safety. For this purpose, chemical fertilizers, among agricultural inputs, have been one of the most used methods for a long time. Agricultural products meet their nutritional needs with chemical fertilizers, but the chemical fertilizers mixed with the soil in this way are not used enough by the plant, these unused fertilizers cause ecological problems by polluting the soils, underground waters, seas and lakes. Agricultural applications such as fertilizers, growth inducing agents and pesticides in food chain threaten the environment, plants, animals and human health. For this reason, plant nutrition practices that support sustainable productivity (production) and protect the environment in agricultural production are becoming increasingly important in the 21st century. Humic acid, fulvic acid, zeolite, leonardite, seaweed, barnyard manure, amino acid mixtures, aluminum silicate and composts are among the most important organic soil improvers. It is known that these humic substances affect the physical, chemical and biological properties of soils and thus plant growth ([1], [2], [3], [4]. Turkey has 8.4 billion tons of lignite reserves. In order to increase the productivity of our soils, it is important to use humic acid in many areas of Turkey to economically benefit from low-calorie lignite beds [1].

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Humic acids are one of the most used soil conditioners in recent years. Humic acids are heterogeneous natural resources that vary in color from yellow to black, are resistant to degradation, and have high molecular weight [2], [3].
Humic acids increase the cation exchange capacity and productivity of soils, convert plant nutrients into usable form, and reduce the negative effects of chemical fertilizers and heavy metals, pesticides, herbicides and Fe chlorosis because of their chelating feature [5], [6], [7].
They show buffer properties over a wide pH range. Humic acids bind cations since they have negative value, allowing them to be easily taken up by plant roots [3], [7]
Humic substances are divided into three groups; fulvic acids, humic acids and humin. The most important part of humic substances is humic acids ([2], [3]).
Humins are humic structures that are insoluble in neither acid nor alkaline environments. Fulvic acid has a smaller molecular structure than humic acid. Their durability, in the soil is low and they are easily subjected to microbial degradation. Humic acids, on the other hand, are more resistant to degradation. For this reason, it is generally used more in agricultural applications. It has been determined that there is competition for the bonding of metals between functional groups (metal ions, metal oxides, metal-hydroxides, metal-organic complexes) on humic acid [2], [3]; [8].
In addition, humic acids preserve inorganic fertilizers and release as much as necessary to the plants during the vegetative period of cultivated plants [7], [9]. To provide a healthy, high quality (product shelf life, storage) and standard product, humic acids do not pollute the soil and the environment [9], [10], [11]. The positive effects of humic acids on the physical, chemical and biological properties of soils, plant growth, mineral substance uptake, quality and healthy production have been determined in many studies ([10], [11], [9], [4].
Humic acids produced commercially from lignites are in powder or liquid form. It can be applied to the plant, soil and seed, or it can be applied by mixing with pesticides, herbicides and plant nutrients [1]. Humic acids are also economically important by using less chemical fertilizers, pesticides and less water. It reduces stress factors such as drought and salinity [9], [11], [2].
Viticulture is one of the most important agricultural production cultivated in Turkey. Turkey ranks 5th in the world vineyard area and 6th in terms of grape production. In the 467,093 ha vineyard area, 4,175,356 tons of grapes were produced. Approximately 52% of the grape production is for table grapes, 37.5% for drying and 12% for wine grape varieties [12]. In the Aegean region, Manisa-Alasehir region has the largest vineyard area and meets a significant part of both table and dried production. In addition, one of the most grown table grape varieties in the region is Red Globe (*Vitis vinifera* L.) grape variety [13]. Although grapes are mostly used as table grapes, raisins, wine or grape juice, it can also be processed into food products such as vinegar, molasses and jam [14].
Therefore, in the present study, the effects of different doses of humic acid applications onto soil and foliar on the fresh grape yield (per vine) and cluster weight of Red Globe grapes (*Vitis vinifera* L.) in the application vineyard of Manisa Celal Bayar University Alasehir Vocational School in the Alasehir district of Manisa in the Aegean Region were investigated.

2. MATERIAL AND METHODS

The experiment was carried out at the experimental field of Manisa Celal Bayar University Alasehir Vocational School in Turkey-Manisa-Alasehir district. The study was carried out with Red Globe grapes (*Vitis vinifera* L.), which is a table grape variety, as material. The vineyard in which the research was carried out is 2.0, 3-4 m between rows, and has a V high training (6 wire) system. The physicochemical analyzes of the soil sample taken from the trial area are given in Table 1. The physical and chemical analyzes of the soil sample used in the experiment were according to the most commonly used international standard methods [15], [16], [17]., [18], [19], [20] and ICP-AES (Inductively coupled plasma Atomic Emission spectrometer) device.
The experiment was carried out according to the randomized blocks design, one of the TKI-Humas (liquid form) applications, as any control, was carried out from in to the soil and foliar with 4 levels and 3 replications. Every three vine is a replicate. It was obtained from TKI-Humas General Directorate of Turkish Coal company (TKI) in Konya-Ilgin.

Table 1. Physicochemical properties of the trial vineyard soil (0-60 cm)

Analyse	Method	Result	Review
Moisture (%)	Saturation	42.02	Loamy
pH	Saturation	7.82	Slightly alkaline
Total Salt (%)	Saturation	0.07	Non-Salty
$CaCO_3$	Calsimetric	4.79	Limy
Organic Matter (%)	Walkley Black	0.32	Poor
Total N (%)	Kjeldahl	0.04	Very little
P (P_2O_5) (kg da^{-1})	Olsen	3.22	Little

K (K_2O) (kg da^{-1})	ICP	129.04	Enough
Ca (mg kg^{-1})	ICP	3040	High
Mg (mg kg^{-1})	ICP	634.1	Very High
Fe (mg kg^{-1})	ICP	2.05	Moderate
Zn (mg kg^{-1})	ICP	0.19	Very little
Mn (mg kg^{-1})	ICP	0.78	Very little
Cu (mg kg^{-1})	ICP	0.73	Enough

Leonardite is a natural organic soil conditioner containing 12% humic and fulvic acids and a liquid produced from low quality lignites.

TKI-HUMAS applications from soil has been made once (0- 100 ml- 200 ml- 300 ml Vine^{-1}) and foliar applications of TKI-HUMAS twice before and after flowering (0- 100 ml - 200 ml - 300 ml / 100 lt). In the experiment, foliar fertilization was applied with 1 liter humic acid solution per vine with a sprayer. Appropriate amount of wetted agents was added to the prepared fertilizer solutions and the applications were carried out in the early hours of the morning. Only water to which spreader adhesive was added applied to the control plots. Fresh grape fruits were harvested on 28.08.2019. Harvesting was carried out by weighing per vine (kg vineyard^{-1}). The cluster weight (gr) was calculated by taking the weights of 10 healthy clusters taken from each replication (Akin and Alagoz, 2016). Before the TKI-HUMAS application, 15.15.15 compound fertilizer was applied to the trial vineyard as the basic fertilizer, equally per vine (50 kg^{-1}) to all trial plots. The TARIST Package program was used in the statistical analysis of the experiment results [21].

3. RESULTS AND DISCUSSION

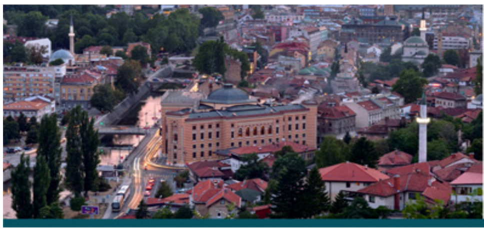
The effects of different doses of TKI-HUMAS (Humic acid) applications from the soil and foliar on the yield and cluster weight of fresh grape fruit are given in Table 2 as the average values obtained from the replications. Accordingly, it was determined that humic acid applications from the soil had a statistically significant effect on yield and cluster weight at the level of P <0.05, while foliar application of humic acid did not have a statistically significant effect (Table 2). When Table 2 is examined, increasing doses of humic acid applications from the soil increased the yield and cluster weight values in fresh fruit compared to the control.

Table 2. The Effect of Soil and Foliar Humic Acid Applications on Yield (kg vine-^{1}) and Cluster Weight (g) of Fresh Grape Fruit

TKI-HUMAS Applications onto Soil	Yield (kg vine^{-1})	Cluster Weight (g)
H_{T0}	12.05 ^{c}	570.50 ^{b}
H_{T1}	13.50 ^{b}	669.50 ^{a}
H_{T2}	13.62 ^{b}	650.70 ^{a}
H_{T3}	14.32 a	676.00 ^{a}
Mean	12.25	641.70
LSD (%5)	0.684*	75.792*
TKI-HUMAS Applications onto Soil	Yield (kg vine^{-1})	Cluster Weight (g)
H_{F0}	13.09	615.75
H_{F1}	11.53	570.25
H_{F2}	12.83	504.75
H_{F3}	14.23	586.75
Mean	12.92	569.35
LSD (%5)	N.S	N.S

a,b : The difference between the means shown with different letters in the same column is significant ($P < 0.05$)
N.S : Not statistically significant
* Significant at 0.05 level

According to the trial results, the highest yield per vine with 14,32 kg vine^{-1} and H_{T3} (300 ml vine^{-1}) application, the lowest yield was obtained from control plots (H_{T0}) without humic acid application. In terms of yield values; there was no significant difference between the second and third doses(H_{T1}=100, H_{T2}=200 ml vine^{-1}). The H_{T3} (300 ml omca-1) application gave the highest or most effective values in terms of yield (Table 2). From Table 2; TKI-HUMAS applications increased in to the soil compared to the control (plots without humic acid application = H_{T0}), such as yield and cluster weights. In the experiment, the highest cluster weight value was obtained in H_{T3} (300 ml vine^{-1}) application with 676 g, while the lowest cluster weight value was determined as 570.5 g in the control plots (H_{T0}) without humic acid application. The application



of humic acid doses of the second,third and fourth (H_{T1} = 100 ml vine^{-1}; H_{T2} = 200 ml vine^{-1} and H_{T3} = 300 ml vine^{-1}) had a similar effect on the cluster weight compared to the control, so the most appropriate dose can be suggested as the second dose (H_{T1} = 300 ml vine^{-1}) (Table 2).

In terms of foliar humic acid applications, the highest yield value was obtained with 14,23 kg vine^{-1} from the fourth dose (H_{F3}=300 ml / 100 ml), while the lowest yield value was determined in 11.58 g vine^{-1} with H_{F1}=100 ml / 100 ml application. In the experiment, the highest cluster weight value of 615 g was obtained in the control plots without humic acid (H_{F0}), while the lowest cluster weight value (504.75 g) was determined in the application of H_{F2}, the third dose as 200 ml / 100 ml. It was determined that foliar humic acid applications did not have a statistically significant effect on yield and cluster weight in fresh fruit (Table 2).

Ferrara et al. (2007) applied in to soil and compost-derived humic acid to the vine and found that the yield increased similar to our research results. Ferrara et al. (2007) found that when they applied in to soil and compost-derived humic acid on the vine (*Vitis vinifera* L.) foliar, the amount and quality of the product increased. With the application of humic acid in to the soil (5 mgL^{-1} and 20 mgL^{-1}), an average of 32.2 and 29,9 kg of grapes were obtained, respectively, and this amount was determined as 28,2 kg in the control plots without humic acid. They found that humic acid applications positively affected the size, diameter and weight of grape seed.

It was investigated the effects of humic acid from foliar and soil on the growth and yield of lettuce (*Lactuca sativa* L.). They applied on to leaves (0- 2.5- 3.5- 4.5 ml L^{-1} levels) to the pots in their research conducted as a pot experiment for 2 years under greenhouse conditions. The highest yield (47.863 kg ha^{-}1) was obtained from the application of 1.5 ml L^{-1} in to the soil. They found the highest total soluble solids value at 3.5 ml L^{-1} level of soil application [22].

It was found that humic acid application had no statistical effect on yield, cluster weight, grain weight in Ercis grape cultivar, but had an effect on total soluble solids and total acidity [23].

In a study conducted on Horoz Karasi and Gokuzum cultivars, the effect of control 1/3 cluster tip cutting and 1/3 cluster tip cutting + Humic acid applications on grape yield and quality was investigated. It was determined that 1/3 of cluster tip cutting + humic acid application increased grape yield and grain weight in Horoz Karasi cultivar [24].

A study obtained at highest cluster weight (302.31 g) and seed weight (6.31 g) in the TKI-Humas application from the soil, similar to our study, in their research on the Alphonse Lavallee grapes. Humic acid applications in to the soil generally increase the cluster weights more than the applications of foliar humic acid (Table 2) [25].

Soil and foliar applications of humic acid have been found to have a positive effect on plant development, yield, growth and mineral matter contents in researches conducted with many cultivated plants (grape, eggplant, pepper, melon, wheat, corn, cherry, lettuce) [24], [14], [23], [26], [11], [10], [27], [22].

However, soil conditioners such as leonardite and humic acid increase the nutrient uptake of cultivated plants, thus increasing the yield, plant growth and mineral content of cultivated plants [28].

It was reported that the effects of leonardite and humic acid applications mixed with fertilizers on yield, plant growth and nutrient content vary according to on humic acid sources, concentrations, application method, plant species, cultivar and ecological conditions [29].

CONCLUSION

As a result, one-year soil humic acid applications (TKI-HUMAS) in Red Globe grapes (*Vitis vinifera* L.) had a positive effect on the yield and cluster weight of fresh grape fruit. Increasing the levels of foliar humic acid applications; it was determined that there was no statistically significant effect on yield and cluster weight. With humic acid applications in to the soil, the highest yield was obtained in the fourth dose (H_{T3}=300 ml omca-1) with values of 14,32 kg vine^{-1} and cluster weight of 676.0 g.

The second humic acid dose (H_{T1}=100 ml vine^{-1}) can be recommended in terms of cluster weight for the application of humic acid in to the soil at increasing doses. According to this; in order to increase the yield and cluster weight of Red Globe grapes, application of humic acid in to the soil can be recommended. However, we suggested that it would be appropriate to carry out experiments related to the soil and foliar applications of humic acid at different doses in the same cultivar.

In the light of scientific data, the use of alternative natural soil conditioners such as humic acid and leonardite in the agricultural soils of Turkey, which is poor in terms of organic matter (94% low) and has significant problems in terms of the availability of mineral nutrition elements(generally insufficient in terms of P, K, Fe and Zn), is highly important and for sustainable agricultural systems.

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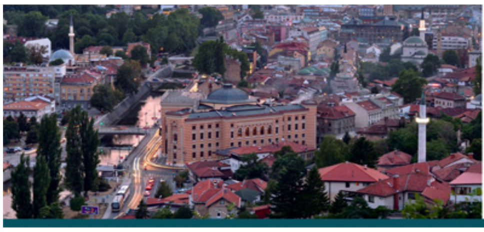

Dialectics of Sustainability: Contrasting Mainstream Neoliberal and Critical Ecosocialist Perspectives on Sustainable Development

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Abstract

The current geological period of Anthropocene is defined by qualitatively new manifestations of negative planetary human impact and environmental crisis. Finally, it is increasingly acknowledged as crucial to contain the self-destructive tendencies of capitalism to preserve conditions for life on earth. Yet, there seems little agreement as to how the necessary transition towards sustainability can be realized. This narrative review explores the respective social science literature. Reflecting the meta-theoretical distinction between sociology of regulation and radical change, dialectic analysis contrasts mainstream functional-normative neoliberal and critical structuralist-antagonistic ecosocialist perspectives. The later deconstruct conventional approaches, such as the United Nations Agenda 2030, as ideological projects of capitalist expansion and legitimization, rejecting claims of green growth, environmental decoupling, and market-solutions of corporate social responsibility. Instead, paradigms of critical sustainability advocate for degrowth and redistribution, de-carbonization, decommodification, and democratization, challenging the exploitative growth logic of capitalism itself. On the organizational level, structural pathologies of corporate social responsibility are contrasted with propositions of democratic socialization. Further, attention is called to sustainability discourses in organizational scholarship, demanding paradigm shifts from managerialist to critical ontologies, realist to relational epistemologies, discipline-focused to interdisciplinary, and from value-neutrality to scholarly activism. Analyzing the sustainability discourse from a critical-theoretical perspective presents opportunities to re-appropriate ecological ideas against degeneration into economistic ideology, counterproductive to the objective of saving the planet from profitable destruction. With seriousness and urgency of the situation providing momentum for social transformation, sustainable development goals and related mainstream concepts need to be reconceived for more radical social and ecological critique, transcending system-justifying neoliberal ideology.

Keywords: Anthropocene, Dialectics, Ecosocialism, Ideological Critique, Sustainability Transformation

1. INTRODUCTION

Widespread agreement across disciplines in the natural and social sciences suggests that the world has entered a new geological era of the Anthropocene—a distinct ecological and socio-cultural period, defined by destructive human domination and its devastating detrimental impact on the planet in its entirety [1], [2]. Hallmark symptoms of the associated ecological decline and deterioration include overburdening pollution of land, air, and sea, depletion of natural stocks and resources, deforestation, land degradation, and other forms of irreversible environmental destruction, accelerating extinction of species, loss of biodiversity, global warming, extraordinary severe weather events, and related manifestations of progressive climate change [3], [4]. These ecological disasters, in turn, proliferate, perpetuate, and potentiate catastrophic social and humanitarian situations in large parts of the world, especially in (but not limited to) the most extremely affected areas of the so-called "Global South", including

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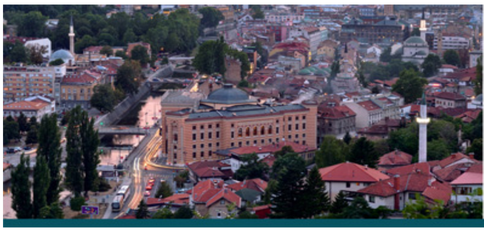
escalating inequality, poverty, hunger, malnutrition, and starvation, hostilities, violence, wars and armed conflicts over dwindling resources, displacement and forced migration of affected populations, spreading of foodborne and infectious diseases, and other public health crises [5], [6]. Whereas, until a few years ago, such predictions were frequently dismissed as alarmist apocalyptic scenarios that could still somehow be denied or averted, their present-day reality and progressing manifestation has been scientifically documented in the most dramatic terms, for instance, in the latest report of the United Nations (UN) Intergovernmental Panel on Climate Change (IPCC) [7]. However, as evidenced by the same document, with most planetary ecosystems so obviously in decline and such catastrophic consequences on the horizon, there finally also seems to be a growing realization among both experts and political decision-makers that a fundamental reorientation of the global economic system is absolutely necessary to contain the self-destructive tendencies of unfettered capitalism in order to preserve the basis of human and non-human life on the planet [8], [9]. Nonetheless, despite this growing consensus, apparently, little agreement, whether in theory or in practice, can be reached as to how the required turnaround towards ecological and social sustainability can possibly (still) be achieved [10], [11]. Addressing this issue based on an exploratory review of selected key publications, this contribution identifies and contrasts two antagonistic approaches crystalizing within the social science literature. Specifically, this refers to the conventional mainstream or "neoliberal" approach versus an emerging radically critical or ecosocialist perspective [12], [13]. These two oppositional paradigms correspond with the division between technical-empirical and critical-emancipatory conceptions of science [14], underlying the meta-theoretical distinction between the sociologies of regulation and radical change [15]. Additionally, drawing on systems theory, society, organizations, and individuals can be differentiated as hierarchically nested levels of analysis incorporated in sustainability transitions. The present review predominantly focuses on selected concepts at the former two levels, specifically, comparing exemplary notions of conventional versus critical sustainability, green growth versus economic degrowth, and corporate social responsibility versus democratic socialization. A case in point, a common reference point on the societal level is the United Nation Agenda 2030 specifying 17 goals for sustainable development. This landmark in sustainability policy has variously been deconstructed as a neoliberal ideological project of capitalist expansion and legitimization through counterfactual claims of green growth, decoupling through innovation, market-solutions to environmental protection, and voluntary corporate social responsibility [16], [17]. Based on this critique, the alternative paradigm of critical sustainability is dialectically developed based on counter-concepts of degrowth, decommodification, radical democratization, and redistribution on all levels of political, economic, and social organizing. From the ecosocialist perspective, critical analysis of the root causes of unsustainability converges with social critique of the exploitative growth imperative inherent to the capitalist systems logic [14], [17]. On the organizational level, structural pathologies of corporate social responsibility are deconstructed and contrasted with radical propositions of socially responsible democratic socialization and social activism. To conclude, demasking the mainstream sustainability discourse from a critical-theoretical perspective presents an opportunity to re-appropriate underlying ecological ideas against degeneration into economistic ideology counterproductive to the goal of saving the planet from profitable destruction. Evident seriousness and urgency of the situation are frequently emphasized as opportunities to raise consciousness and mobilize momentum for social transformation. Lastly, attention is called to how the sustainability debate shapes current discourse in organizational science. Highlighting recent programmatic contributions, deemed necessary are paradigm shifts from managerialist to critical positions, from discipline-focused to interdisciplinary research, from realist to relational epistemologies, and from pretense of objectivity and value-neutrality to engaged scholarship and academic activism. Normative foundations supporting this reconceptualization of the academic self-image include occupational codes of ethical responsibility to prioritize people over profits, ecology over economy, and planetary survival over subservience to vested interests. Sustainable development goals of the Agenda 2030 and related concepts need to be reassessed as vehicles for real-world improvements and basis of more radical critiques of unsustainable social organization in the Anthropocene.

2. DIALECTIC EXPLORATION

An exploratory review of key publications in the interdisciplinary social science literature on environmental and social sustainability was conducted with the objective of delineating and contrasting two broader types of approaches, namely, the conventional mainstream (functionalist, normative) "neoliberal" perspective versus an emerging radically critical (antagonistic, structuralist) "ecosocialist" one. These oppositional paradigms, evidence for the existence of which has been suggested in the literature repeatedly [10], [11], [13], reflect the meta-theoretical distinction between sociological traditions of regulation and radical change [14]. The former proposes a view of society based on integration, progress, and consensus; the latter emphasizes domination, power struggles, and conflicting interests. The type of change advocated by the former is incremental, pragmatic, and follows a reformist agenda, whereas the latter stresses the need for fundamental, utopian, and revolutionary transformations [9], [17]. Background of said undertaking is growing interest in alternative approaches through which the necessary turnaround towards ecological and social sustainability can still be initiated, despite the progressing era of Anthropocene, suggesting irreversible environmental damage and accelerating planetary crises. The purpose of the sighted, compiled, and reviewed material was to serve as basis for speaking engagements at several scientific conferences as well as for curriculum development in university teaching. In these academic arenas, sustainability is increasingly becoming an important cross-cutting theme of particular interest. Following principles of narrative and problematizing literature reviews [18], exploratory searches were conducted covering major databases in the social sciences, using various combinations of terms, including “sustainability”, “sustainable development”, “radical environmentalism”, “critical theory”, ”ecosocialism”, “corporate social responsibility” and “critique”. Based on the screening of titles and abstracts, relevant articles were identified and categorized according to various criteria, including article type, disciplinary focus, and level of analysis. Drawing on systems theory, society, organizations, and individuals were differentiated as hierarchically nested levels of analysis and articles allocated to these interdependent tiers. The present review predominantly focuses on the former two levels, specially, three core themes of the current sustainability debate are deliberated in a dialectic analysis. Sustainable development, green growth, and corporate social responsibility are three important concepts in the mandated turnaround of the capitalist economic system that have been portrayed as ideologically annexed and redefined by neoliberal discourse. To counteract this, conventional neoliberal understandings of these concepts are contrasted with radical ecocritical antipodes of a) critical sustainability, b) economic degrowth, and c) responsibility to socialize corporations. For each of these three themes, a limited number (typically three) of selected key publications will be reviewed. Explicit aim of this dialectic exploration of elements of Marxist ecology was to demonstrate the critical potential of ecosocialist perspectives in environmental science as antipodes to neoliberal, market-based conceptions [12], [13], [16], [17]. Core to all three concepts are structures and processes of direct democracy and participation as well as fundamental rejection of the capitalist profit and growth imperatives. A final step explores, how critical conceptions of sustainability and degrowth shape current discourse in organizational science, highlighting some exemplary recent contributions to the debate.

3. CRITICAL SUSTAINABILITY

Although until recently critical conceptions of sustainability have received only limited attention, they are far from completely novel [19], [20]. For instance, almost two decades ago, different philosophies for environmental education have been differentiated and defined as rooted in the empirical, hermeneutic, and critical sciences, concluding that the latter, emphasizing emancipation, self-determination, and critique of ideology and domination, form the basis of radical ecocentric environmentalism [14]. Published about a decade later, the first identified seminal contribution comparing mainstream and critical perspectives on sustainable development [21] starts out by stating that the concept of sustainability, originally introduced to address environmental concerns, has been predominantly defined by the mainstream tradition of neoclassical (neoliberal) economic analysis, characterized by an inherent drive to prioritize economic issues and profits and marginalize or subjugate ecological concerns. This mainstream version of sustainable development, driven by perpetual accumulation requirements of capitalist economics, would aim at sustaining economic growth rather than developing ecological perspectives, supporting weak sustainability propositions at best, and remaining opposed even to the most basic steps towards necessary fundamental changes, which are seen as incompatible with the vested interests of short-term capital accumulation. Thus, the focal essay concludes that, for any meaningful aspect of sustainable development to be attained, fundamentally critical perspectives would be indispensable and need to be more fully developed [21]. Recommended for this purpose is an amalgamation of radical structuralist and poststructuralist approaches. Core to the former, the classic social critique of Marxism combines a shattering political-economic analysis of the exploitative, destructive, and crisis-prone tendencies of the capitalist system with a dedication to radical social transformation and emancipation through revolutionary action. To this end, Marx was interested in analyzing and actively supporting the social forces that could resist and rise up against, and, eventually, were expected to overcome capitalism, establishing a more democratic, just, and sustainable society characterized by socially and ecologically balanced relations of production and consumption—benefitting both the human species and the planet. Specifically, the Marxist concept of the “metabolic rift” provides an ecosocialist basis for analyzing the unsustainable exploitative growth regime of capitalism, underlying its inherent ecological crisis tendencies [19], [20]. This structuralist theoretical basis, according to the focal essay [21], should be enriched with additional traditions of critical analysis, such as the poststructuralist cultural critique of environmental degradation tendencies from other non-mainstream and grassroots perspectives. A decade later, a second identified key



publication [22] extends and elaborates the roles of class, capitalism, and domination in an outlined dialectic analysis of sustainable development from the perspective of critical theory. After providing a brief chronology of sustainability policy-making, starting from the 1987 United Nations (UN) Brundtland Report, the 1992 UN Conference on Environment and Development (Earth Summit) and associated Rio Declaration, to the 2002 (Johannesburg) and 2015 (Rio+20) Summits, the UN Agenda 2030 is reviewed and discussed. Providing the current paradigm for national and supra-national policies, the Agenda 2030 specifies 17 goals for sustainable development. Some of these are, in principle, uncontroversial (e.g., no poverty; zero hunger; gender equality), while others are more ambiguous (e.g., affordable and clean energy; climate action), yet, for some, it seems dubious whether they are compatible with genuine sustainability (e.g., decent work and economic growth; industry, innovation, and infrastructure). Indeed, in light of declining ecosystems, accelerating climate change, widespread and rising poverty, food shortages, global health crisis, and continuing polarization of the living conditions of the rich and the poor, even moderate criticisms have pointed out that the Agenda 2030 has no realistic trajectory towards attainment of these goals. Moreover, more radical critiques have deconstructed the agenda as a neoliberal project of capitalist legitimation and expansion [9], [13], [17]. The focal contribution here [22] takes a balanced approach, acknowledging the progressive multidimensional understanding of sustainability as comprising social, environmental and economic objectives, but criticizing the neglect of the roles of communication and culture as well as of class and capitalism as factors negatively impacting or impeding sustainability. Subsequently, two perspectives are contrasted, debunking sustainability either as economistic neoliberal ideology or reframing it as a fundamentally critical concept. Accordingly, economistic ideologies seek to maintain and increase capitalist profits, while, at the same time, formulating desirable social and environmental values and goals, but without reflecting (or disclosing) how capitalist principles are negatively impacting society and counteracting these stated objectives [10], [11], [13]. The ideological character of the sustainability concept, specifically, is described as sounding positive and allowing diverse groups to project their opposing political goals into it, eventually blocking meaningful change. In contrast, a suggested concept of sustainability based on critical theory addresses the root logic of instrumental reason, treating human beings and living nature as objects to be dominated and exploited by some groups at the expense of others [22]. Unsustainability, it is argued, is based on instrumental reason, striving to justify and rationalize structures of domination and exploitation. Mainstream conceptions of sustainability disregard these systemic aspects of class and capitalism, rendering them apologetic and ideological. In contrast, drawing on Marx as an early theorist of ecology [19], [20], sustainability is understood as the conscious organization of society in a way that allows future generations to satisfy their needs and improves society through participatory democracy and democratic socialism. Based on this utopian vision, critical theory exposes global capitalism's destructive, dominative, exploitative and exclusionary character, its inherent economic, political and cultural antagonisms, and their interaction with patriarchy, racism, nationalism, bureaucracy, and destructive industrialism, as manifestations of instrumental reason, compounding the aforementioned metabolic rift between a society's mode of production and the natural environment. Productive forces thus turn into destructive forces of the social metabolism between nature and society, depleting and destroying rather than conserving and protecting natural resources. Thus, unsustainability correlates with the degree to which economic class interests of elites become the governing principles of a society and its subsystems, particularly, as the poor tend to be most negatively impacted by environmental degradation and crises. However, sustainability would also be able to serve as a useful concept for the critique of capitalism, class and power inequalities. To demonstrate this, the article introduces a differentiated dialectical model of sustainability, consisting of the nested spheres of nature and society, as well as embedded economic, political, and cultural subsystems, reciprocally interacting via technology and human agents in ways that are either conducive or detrimental to various dimensions of sustainability. Due to the complexity of this framework of analysis, the interested reader is referred to the original publication [22] for details. The last of the three selected key publications [23] is a relatively recent and comprehensive review and development of the concept of critical sustainability, summarizing and representing the current state of theorizing. Starting out with the assertion that repeated calls for greater sustainability in the past have been assimilated into capitalist processes and neoliberal narratives that have subdued, counteracted, and perverted their original intentions and environmental impacts, the authors advocate a critical re-conception of sustainability, rejecting prioritization of capital accumulation over ecological integrity and social and environmental justice – focusing not only on socio-environmental relations, but challenging the dominant political economies shaping these relationships according to particular vested interests of wealthy and powerful elites. Echoing the last contribution reviewed above, critical sustainability is portrayed as a new understanding of sustainability, in which class, politics, and class politics truly matter, including recognition of the historical preconditions underlying respective class politics. While recognizing both the material and ecological necessities that sustain life on the planet, critical sustainability rejects the commodification of nature, instead striving for a biopolitical organization of social life that ensures human and nonhuman welfare, based on sociopolitical orientations that support dignity, equity, respect, and rights for all, within the boundaries of ecological systems [23]. This includes acknowledging tensions and conflicts among conventionally distinguished pillars of sustainability (economy, society, ecology), which typically are resolved by privileging profits over people and the planet, thus stifling necessary social change. Capitalist ideologies of exploitation and accumulation are regarded as so heavily intertwined that social justice and ecological sustainability are practically impossible to achieve under the current economic system. Following a central tenet of radical ecosocialism, critical sustainability thus is portrayed as converging with the Marxist critique of social and ecological unsustainability of the accumulation-based capitalist economic system [19], [20], [22], [23]. Emphasizing this point, the authors assert that, while their conception of critical sustainability supports allied versions of justice-oriented environmentalism and deep ecology, it would remain distinctively and essentially Marxist in its direct implication of capitalism as both an external (systemic) and a more subversively internal (ideological) threat to its core impact and ideas.

4. ECONOMIC DEGROWTH

The second thematic category concerns the more concrete and applied antagonism between neoliberal concepts of sustainable economic growth, typically in the form of “green growth” or “greening” capitalism, and antithetical ecosocialist concepts of “degrowth” and “decommodification”. Echoing several of the issues pointed out above, an exemplary critique of the sustainability discourse deconstructs the commodification of nature as a key feature of capital’s response to the ecological crisis [24]. Accordingly, the core problem with capitalisms response to the environmental crisis is that nature and social relations are transformed into economic resources, subordinated to the logic of the market and imperatives of profit, resulting in a progressive deterioration rather than improvement of social and environmental injustice. The concept of “green capitalism”, it is argued, reflects a renewed strategy for profiting from planetary destruction by leveraging the promise of technological innovation and expanding markets, while keeping the institutions of capitalism intact. Concluding that the expansionist logic of the capitalist system itself is not sustainable, strategies of degrowth und economies of subsistence are recommended. Continuing at this very juncture, the next included conceptual contribution sets out to assess the normative justifications for concepts of green growth and degrowth through the lens of critical social theory [25]. Whereas green growth means preserving the current capitalist economic system, and particularly its inherent growth paradigm, proponents of degrowth argue that perpetual economic growth cannot be environmentally sustainable and needs to be constrained and replaced by alternative approaches of a more radical transformation of society through strategies of degrowth. Degrowth is defined as the socially sustainable process of downscaling the social metabolism of society, that is, reducing the overall volume or throughput of material production and consumption, with the goals of preserving the natural environment and increasing human well-being and social equity [26]. In contrast to notions of green growth, degrowth requires a reduction in natural resource use, production and consumption, by decreasing the quantity of household goods, such as entertainment, information and communication technology, private cars, transportation, and energy use. Although a decline in the gross domestic product is not a goal by itself, it is an inevitable consequence of the need of developed countries to radically downscale their economies. Dialectically delineating the antagonistic approaches of green growth versus degrowth, the article concludes that, despite evidence that the claims of the former regarding growth without environmental impact through innovation and “decoupling” are largely counterfactual, it is the latter that still remains mostly marginalized in both academia and practice. The authors argue that the expected impact of degrowth's principle of prioritizing environmental preservation has a much stronger validity and normative justification and should be the preferred option. Thus, the reviewed article [25] seeks to contribute to the ongoing debate by establishing normative grounds for focusing efforts for environmental sustainability on the necessity for economic degrowth rather than the counterfactual fantasy of green growth. Addressing the actual implementation of mandated degrowth-strategies, the third identified key contribution [27] presents a systematic review of 128 previously published peer-reviewed articles on degrowth, analyzing a total of 54 proposals for action, based on both an a priori (theoretically constructed) and an emergent (empirically derived) conceptual framework. The former includes the categories of: a) Geographical focus (international, national, local); b) Type of approach (top-down/expert-led and bottom-up/community-led); and c) Ecological economics policy objectives (sustainable scale, fair distribution, and efficient allocation). Whereas sustainable scale strategies reduce the absolute throughput threatening to overload the carrying capacity of an ecosystem (e.g. resource use, pollutant emissions), fair distribution strategies seek to change the supply of goods among people, including the division of environmental costs and justice (e.g. transfer payments, broadening public participation). Efficient allocation strategies address resource flows between alternative uses to maximize generated welfare per unit of resource use (e.g. energy efficiency, investments in environmental conservation). Based on this classification, three more specific goals of degrowth proposals were extracted, based on the analysis of core topics and keywords: 1) Reducing the environmental impact of human activities (topics: consumption, production, and trade impacts; ecological conservation; infrastructure; pollutant emissions); 2) Redistributing income and wealth both within and between countries (topics: access to goods and services; equity; global governance; socioeconomic opportunities); and 3) Promoting the transition from a materialistic to a convivial and participatory society (topics: community building, education, and value change; democracy and participation; free time; voluntary simplicity and downshifting). These three goals correspond with related approaches of radical environmentalism, recommending decommodification, redistribution, and democratization as sustainability interventions into the interactions among nature and economic and cultural societal systems [22]. Based on their analysis, the authors conclude that the majority of degrowth proposals are national top-down approaches, focusing on government, rather than local bottom-up initiatives, emphasizing topics related to social equity and environmental sustainability [27]. However, largely neglected remain topics related to implications population growth and consequences for developing nations. Lastly, future research on how degrowth proposals would act in combination is called for. Overall, the review provides a most valuable starting point to explore the scope and range of approaches, topics, and goals of degrowth proposals and thus is highly recommended to the interested reader.

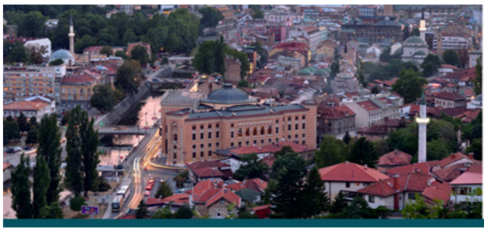
5. SOCIALIZING CORPORATIONS

The third category refers to the organizational level, contrasting the neoliberal mainstream with critical and radical propositions on the socialization and democratization of private corporations. Literature on corporate social responsibility (CSR) is vast and diverse and only examples are referred to here [28], [29]. A common understanding of CSR refers to voluntary activities aimed at including social and environmental concerns in business operations and interactions with stakeholders [30]. Different ambition-levels of CSR are distinguished, ranging from compliance-driven (laws, regulations), profit-driven (markets, reputation), caring or green (values, principles), synergistic (integrated, embedded), and holistic (universal responsibility). However, apart from personal convictions, the basis for higher-level CSR ambitions remains as questionable as their economic viability. Similar limitations apply to the overlapping concept of corporate sustainability – a version of CSR focusing on environmental issues [31]. A recent seminal contribution offers an insightful analysis of systemic pathologies of CSR [32]. Accordingly, instead of proliferating responsible business practices, CSR predominantly serves market expansion, indoctrination, and legitimation. These pathologies are elaborated in terms of their functions of spreading the reach of capitalism to areas previously not under economic valorization and exploitation (material expansion; new markets for "green" products), contributing to the dissemination of capitalist rationality and neoliberal discourse by consolidating a "business ontology" (symbolic expansion; public faith in markets and managers), and meeting legitimation requirements of capitalism by diverting attention from corporate misconduct and negative externalities (obscuring destructive effects of industrial production). Pathologies are analyzed with regard to corresponding CSR activities (codes of conduct, stakeholder dialogue, CSR reporting), primary recipients (customers, society, employees, academics), dysfunctional effects, capitalist dynamics that underlie those (commodification, indoctrination, legitimation), and steps towards systemic change. Potential contributions of critical CSR research refer to efforts towards "de-commodification", exploring ways of serving society beyond market transactions, and "de-naturalizing" and "de-legitimizing" capitalism, revealing its downsides and propagating alternatives beyond prevailing ideologies. Dysfunctional pathways and feedback loops between pathologies of CSR are developed in a multi-level model of individual, organizational, and systemic dynamics (e.g., negative side effects of material and symbolic expansion compounded by CSR; increased legitimation requirements addressed by CSR). The article [32] concludes that failure of CSR is inevitable, insisting on change on the systemic level of capitalism, and suggesting ways how critical CSR research can contribute to this political endeavor—transcending mainstream neoliberal discourse of CSR as a system-justifying ideology embodying rather than addressing the underlying pathologies of capitalism. The final article reviewed here [33] contributes to the debate by elaborating the structural incommensurability of profit goals with social and environmental concerns, and, subsequently, introducing a new concept, termed, not without humorous irony, as the "Responsibility to Socialize Corporations" (RSC). The author argues that the dominant discourse on CSR naturalizes capitalism, hiding irresponsible business practices, legitimizing corporations and neoliberal deregulation, and depoliticizing the search for a responsible economy, strengthening corporate power rather than containing it. Distinguished are four perspectives within the CSR discourse regarding the relationships among economic and social (including ecological) objectives: a) *Reductionism* frames social and environmental issues as profit opportunities (green marketing); b) *Projectionism* pretends that responsible business practices and profit-orientation can be combined (business ethics); c) *Dualism* separates the two domains (corporate philanthropy); and

d) *Dialectics*, which recognizes the structural incommensurably and antagonistic nature of profit goals and social responsibility. The first three approaches instrumentalize the social, idealize the economic imperative, or isolate the economic from the social, obscuring the real interrelations between the two domains and failing to draw necessary conclusions regarding the structural problems of CSR. The dialectical perspective problematizes structural antagonisms between profit motive and social responsibility, concluding that the concept of CSR needs to be turned “off its head to its feet”, resulting in the notion of RSC, as a societal alternative based on democratic ownership of the means of production and socialist organization of politics, from private to common property, from elitist to participatory decision making, and from particularistic to universal interests in the common good. For this transformation towards socially responsible economic alternatives, a battery of measures is discussed [33], including efforts to restrict corporate power (economic regulations, control of capital flows, nationalization of banking systems, public institutions monitoring corporate crimes) and to democratize workplaces (strong worker rights and mandatory direct involvement in decision-making; strong labor unions and worker ownership). Activities on the organizational level would need to embedded into changes at the societal level, aimed at strengthening democracy (public funding of civil society and social movements, direct participation in political processes), reducing poverty and socio-economic inequality within and across national states (redistribution of wealth, guaranteed income, public health care, pensions, and education, minimum wages, reduction of the working week, laws against child labor, cancellation of debts), and strengthening tendencies beyond capitalism based on the idea of the common good (abolition of intellectual property rights, support for the open source movement, alternative organizations). Overall, what is demanded here [33] amounts to radical reformism combining social movement activism, bottom-up alternative projects, and various structural reforms to create a socially responsible and ecologically sustainable society based on the radically democratic organization of the economy and politics as an alternative to the current system of corporate capitalism.

6. PRELIMINARY CONCLUSION

Aim of this exploration of Marxist ecology, unorthodox economics, and critical organizational theory was to demonstrate the potential of alternative ecosocialist perspectives as antipodes to neoliberal (market-based and corporation-focused) conceptions [19], [20]. The three exemplary mainstream concepts of sustainable development, green growth, and corporate social responsibility were contrasted with radical (eco-)critical antipodes of a) critical sustainability, b) economic degrowth, and c) responsibility to socialize corporations. Core to all three are structures and processes of direct democracy and bottom-up participation as well as a fundamental rejection of the dominant capitalist profit and growth imperatives, emphasizing the need for radical changes at the systems level [5], [14], [9], [10]. A common reference point on the societal level, the United Nation Agenda 2030, a landmark in policy-making, has been deconstructed as a neoliberal ideological project of capitalist expansion and legitimization, incorporating counterfactual claims of green growth, decoupling through innovation, market-solutions to environmental protection, and voluntary corporate social responsibility [16], [22]. The ideological nature of these system-stabilizing (rather than system-transcending) concepts is seen in the fact that they negate or obscure the fundamental contradiction between the inherent destructiveness of economic productivity and profitability, on the one hand, and the realization of social and environmental sustainability, on the other [13], [22], [34]. In the interdisciplinary literature, an alternative paradigm of critical sustainability is currently emerging, based on the development of antagonistic counter-concepts of degrowth, decommodification, radical democratization, and egalitarian redistribution of resources on all levels of political, economic, and social organizing [26], [27]. From the ecosocialist perspective, critical analysis of the root causes of unsustainability converges with the social critique of the exploitative profit and growth imperatives inherent to the capitalist systems logic [4], [5], [20]. On the organizational level, structural flaws of CSR were deconstructed as systemic pathologies and contrasted with the radical proposition of democratic socialization [32], [33]. Core to all dialectically contrasted concepts are structures and processes of direct democracy and participation and fundamental rejection of the capitalist profit and growth mechanisms as drivers of unsustainability. In an additional step, it was explored, how critical conceptions of sustainability influence current discourse in organizational science. In this context, attention is called to how the sustainability debate shapes academic accounts of alternative forms of organizing and doing research in the era of Anthropocene. Highlighting an exemplary recent programmatic contribution [35] mandated are paradigm shifts from managerialist to critical ontological positions (e.g., from corporate interests to ecological welfare), from discipline-focused to collaborative interdisciplinary research (e.g., from specialization to systems-thinking), from realist to relational epistemologies (e.g., from simplistic causality to dynamic interdependence), and from pretense of objectivity and value-neutrality to a principled and committed stance of engaged scholarship and academic activism (from neutral observation and



analysis to facilitating social change). Each of these paradigm shifts is detailed by the authors and integrated into a matrix for guiding organizational sustainability research in the Anthropocene, identifying challenges, topics of interests, and future steps for more responsible and engaged scholarship. A number of these recommendations are illustrated in a recent special issue on organizations and organizing in a post-growth era [36]. To conclude, deconstructing the sustainability discourse from a critical-theoretical perspective presents opportunities to re-appropriate ecological ideas against degeneration into economistic ideology counterproductive to the goal of saving the planet from profitable destruction. Seriousness and urgency of the situation are emphasized as opportunities to raise consciousness and mobilize momentum for social transformation among the public as well as political decision-makers [9], [11], [17]. Normative foundations that need to be further developed to support this reconceptualization of the academic self-image, include occupational codes of ethical responsibility to prioritize people over profits, ecology over economy, and planetary survival over subservience to vested interests. The literature reviewed above as well as described paradigm shifts for radical academic engagement in the field of organizational studies [35] offer promising venues for such an undertaking. Future research needs to redeploy the sustainable development goals of the Agenda 2030 as vehicles for actual real-world improvements and as basis of more radical critiques of unsustainable social organization in the Anthropocene. Referring again to the disturbing latest scientific evidence on climate change [7], the urgent need for a dramatic turnaround to preserve the conditions for life on the planet should be out of question. At present, the conventional interpretation of the Agenda 2030, along with notions of green growth and CSR, functions as ideologies to obscure the structural antagonism and negative dialectics between capitalist expansion and ecological sustainability, inhibiting real transformative change, thus, indirectly contributing to the destruction of the foundations of life on earth [11], [22], [34]. The fantasmatic vision of sustainable development within the logic of the current system is frequently portrayed as a "light at the end of the tunnel". Referring to the catastrophic ecological and social consequences of the current planetary trajectory discussed at the outset of this essay, this false promise more accurately resembles the headlight of a train approaching from the opposite direction [5], [6]. Considering the truly alarming state of affairs, radical alternatives of critical sustainability beyond conventional neoliberal ideology, are more desperately needed than ever [9]. This contribution hopes to call attention to some underlying issues and the emerging body of literature, and to raise consciousness for the need to fundamentally alter the prevailing understanding of sustainability from incremental quantitative adjustments towards a qualitatively different utopian vision of radical social and economic as well as psychological and behavioral transformation.

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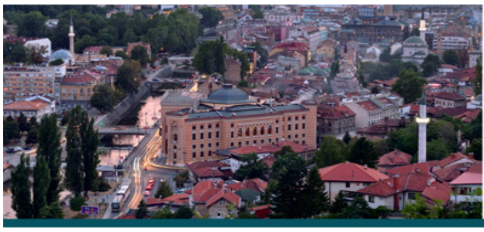

Quality of the Line Reproduction on Environmentally Friendly Pressure Sensitive Labels Facestock

Katarina Itrić Ivanda*[1], Zrinka Jakopčević[2], Marina Vukoje[1], Rahela Kulčar[1]

Abstract

Pressure Sensitive Labels (PSLs) can be found on the wide range of products, from food items and beverages to perfumes and other household products. Given their prevalence, there is a clear initiative to reduce the proportion of synthetic polymer facestock in favor of biodegradable materials. The design of PSL is becoming more and more attractive, so it is necessary to examine the quality of the printed line on biodegradable facestock materials, and to investigate whether an equal amount of applied ink gives a satisfactory result as on synthetic polymers which are commonly used. Yellow ink lines of various widths and orientations were printed on seven different commercially available PSLs, three of which are fiber based with high content of recycled paper and agro-industrial by products. Study showed that the lines printed on environmentally friendly PSLs can compete in quality (width, raggedness, blurriness, contrast, fill and darkness) with those printed on polyethylene.

Keywords: Pressure Sensitive Labels, Line Quality, Sustainable Printing

1. INTRODUCTION

Today's label market is one of the most represented branches of the press, which will certainly continue to grow in the years to come. The label represents the first contact of a potential buyer with the offered product. Precisely because of that, label has no longer just an informative role, but its goal is to make a difference with its design and appearance when choosing a product. Previous research has mainly focused on the possibility of replacing classic synthetic polymer labels with biodegradable ones [1], while our research will focus on the possibility of printing details on biodegradable substrates, as well as their comparison with prints generated on commercial synthetic polymers.

The way millennials choose the products is significantly different from the way previous generations have done it. Elliot et al. [2] have determined on the example of wine bottle selection that millennials choose non traditional products whose design is characterized by bright colors and non standard layout with modern typeface. At the same time, millennials are much more environmentally aware than previous generations and choose sustainable products when they have the opportunity [3], [4].

Precisely because of that, if we want an attractive label design with clearly defined details, it is necessary to examine the possibility of printing on environmentally friendly labels, and to investigate whether it is possible to get the same quality print as in the case of commercially available polyethylene. There are visual attributes that describe image quality of offset prints like micro-uniformity, macro-uniformity, color rendition, text and line quality, gloss, sharpness, and spatial adjacency or temporal adjacency attributes [5].

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Line quality is defined according to its width, raggedness, blurriness, contrast and fill within ISO13660 norm [6]. Line width measurement is carried out through reflectance measurement. If the reflectance of the paper substrate is Rmax, reflectance of the print is Rmin, counters of the line profile of the edge is defined as the point of 60% transition between R_{max} and R_{min} according to equation:

$$R_{60} = R_{max} - 0.6 \cdot (R_{max} - R_{min}) \tag{1}$$

Raggedness is defined as the geometric distortion of an edge from its ideal position. It is measured as the standard deviation of the residuals from a line fitted to the edge threshold of the line under study, calculated perpendicular to the fitted line.

Blurriness measures the average distance between the inner and outer boundary edges. It is defined in the standard as the distance between the R_{10} and R_{90} thresholds.

Contrast is defined as the relationship between the darkness of a line segment and it's field and it is calculated according to

$$contrast = \frac{R_{field} - R_{image}}{R_{field}} \tag{2}$$

Where R_{field} stands for mean reflectance factor of the surrounding field (paper substrate) and R_{image} denotes mean reflectance factor within the inner boundary edge of the line.

Fill is the appearance of homogeneity of darkness within the boundary of a line segment. It is obtained as a ratio of the area with 75% relative reflectance value or more within the inner boundary to the total area within the inner boundary.

2. MATERIALS AND METHODS

2.1. Properties of the Pressure Sensitive Labels used in the study

Seven different pressure sensitive label (PSL) materials commercially availble on the market were used in the study due to their various facestock characteristics (paper/film). Four PSLs have a fiber based facestock, two filmic materials comprise of bio-based polymers as facestock, while the remaining one is conventional synthetic material (Table 1).

Table 1. Properties of used PSL given by the manufacturer [7]–[11]

		Facestock		**Liner**		**Total laminate**
Substrate grade	**Abbreviation**	**Basis weight ISO 536,** g/m²	**Caliper ISO 534,** µm	**Basis weight ISO 536 ,** g/m²	**Caliper ISO 534,** µm	**Caliper ISO 534,** µm
Fasson ® rCRUSH BARLEY FSC S2030-BG45WH FSC	B	90	110	70	61	190 ±10%
Fasson ® rCRUSH GRAPE FSC S2047N-BG45WH IMP FSC	G	90	114	70	61	192 ±10%
Fasson ® rCRUSH CITRUS FSC S2030-BG45WH FSC	C	100	130	70	61	210 ±10%
Fasson ® PE85 BIOB CLEAR S692N-BG40WH FSC	PEC	78	82	59	53	152 ±10%
Fasson ® PE85 BIOB WHITE S692N-BG40WH FSC	PEW	82	82	59	53	152 ±10%

Fasson ® THERMAL TOP K8 FSC R5100-BG40BR	TT	76	82	55	47	147±10%
Fasson ® 772 BRUSHED CHROME S697-HF125	CH	70	51	126	126	196±10%

Fiber based facestock of PSL used in this research are produced with 15% agro-industrial byproducts (grape fibers obtained from wine making processes, citrus fibers collected from citrus mash after juice production, and barley fibers from brewing beer and malt whiskey), 40% post-consumer recycled paper and 45% virgin wood pulp in order to form a high-quality natural paper [9]–[11]. Bio-based polymers facestock is made mostly from sugar cane ethanol, certified under the Bonsucro® scheme, which is converted in a similar way to conventional polyethylene (PE), and available in white and clear performance [12]. Facestock of thermal top is white woodfree, top coated thermal paper [13], while chrome has a conventional filmic facestock [14]

Adhesives used with paper laminates are permanent adhesives, both emulsion acrylic and rubber based. The glassine liners used in this research are FSC certified, fossil-free and recyclable. Glassine liner used with recycled content fiber based PSL materials is white, supercalendered glassine paper, with basis weight of 70 g/m2 and thickness of 61 µm. Glassine liner used with filmic recycled content PSL materials is white, supercalendered glassine paper, with basis weight of 59 g/m2 and thickness of 53 µm. As for glassine liner used with woodfree, top coated thermal paper based PSL material, it is brown, supercalendered glassine paper with basis weight of 55 g/m2 and thickness of 47 µm, while the glassine liner used with conventional filmic facestock is one-side coated, bleached kraft paper with basis weight of 126 g/m2 and thickness of 126 µm.

Printing process

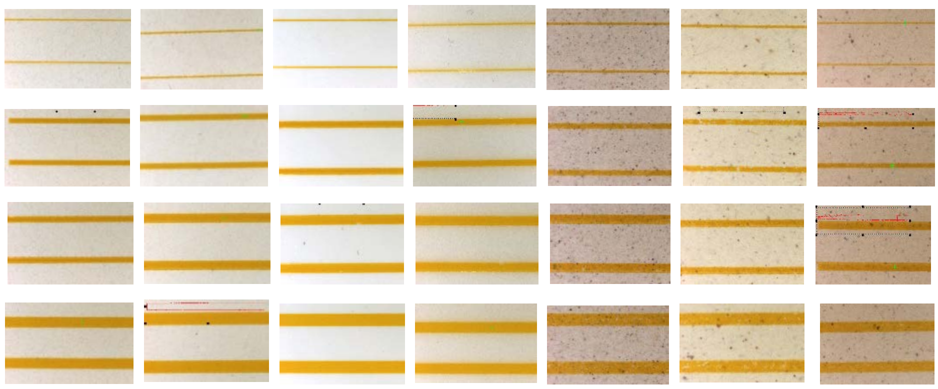
Prints were generated with yellow UV offset ink on commercial offset machine for label printing. Vertical lines (0.5 pt and 1 pt nominal width) in the machine direction, and horizontal lines (0.1 pt and 0.7 pt nominal width) perpendicular to the direction of printing process were obtained on all seven substrates.

2.2. Image analysis

Quantitative analysis of the horizontal and vertical printed line samples was conducted with PIAS II (Personal Image Analysis System). It consists of a measurement head housing a high performance digital camera and an optical modules. The operating principle of PIAS is discussed in following articles[15]–[17].The standard optical arrangement is 45/0 geometry, typical for reflective, densitometric measurements. PIAS software has a built in ISO13660 norm regarding the quality of the line reproduction. The results are displayed in both numerical and graphical form. The user can display contours, bounding boxes, center marks, and ROIs for the image features analyzed. Length of the line for raggedness measurement was 15 mm.

3. RESULTS AND DISCUSSION

Pictures of the selected horizontal and vertical lines are given in Figure 1. All of the pictures were rotated and aligned parallel to each other for easier visual analysis. Differences in the print appearance and line width are clearly noticeable and expressed. This can primarily be explained by different optical (brightness, colour, opacity, gloss) and mechanical (weight, thickness, density, two-sidedness, smoothness, permeability, rigidity, roughness, porosity) properties of the facestock substrate.



a) b) c) d) e) f) g)

Figure 1.Printed lines on a) CH, b) TT, c) PEW, d) PEC, e) G, f) C, g) B

(top to bottom: nominal line width 0.1 pt, 0.5 pt, 0.7 pt,1 pt)

Numerical data of measured line width depending on nominal line width are given in Figure 2. Prints made on polyethylene white (PEW) facestock show the highest reproducibility related to line width; they are closest to the nominal values regardless of their value in prepress.

Prints generated on polyethylene clear (PEC) facestock show a slightly higher values for 0.1 pt, 0.5 and 0.7 pt lines of nominal width and infinitesimal decrease when it comes to 1 pt line. Lines printed on fiber based facestock (C, G, B) show higher deviations compared to polymer based facestock although there are significant differences between them. For the 0.1 pt line width printed on barley facestock the measured line width is the closest to the nominal, while the lines generated on grape and citrus based facestock are almost twice as wide.

On the other hand, all three paper based facestocks showed the same level of deviation (drop of 20 %) from the nominal for 0.5 pt line. For the 0.7 pt lines, barley again stands out as a paper based facestock that can be competitive, in terms of line width reproduction to polyethylene.

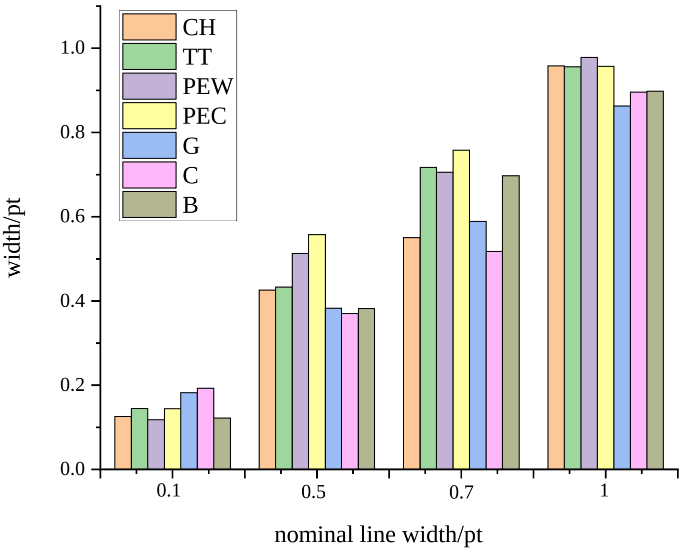


Figure 2. Dependence of measured line width on nominal line width for all seven substates

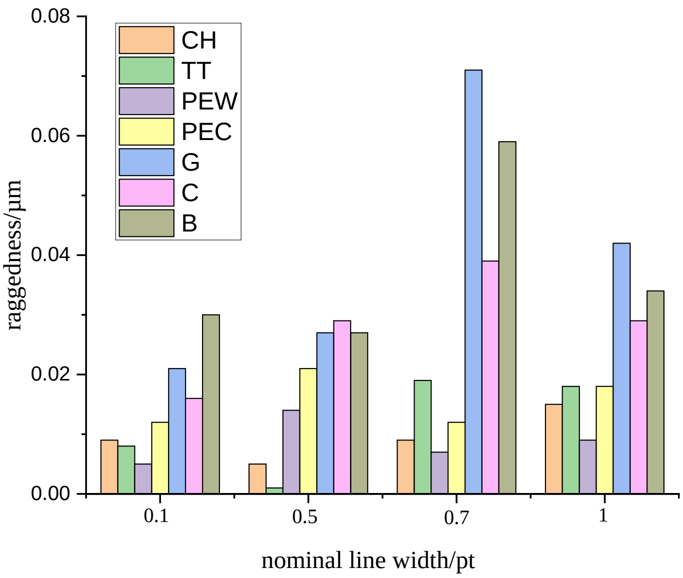


Figure 3. Dependence of measured line raggedness on nominal line width for all seven substates

Grape and citrus based facestock show a much lower line width. If we take into account the direction of printing, vertical lines (0.5 pt and 1 pt nominal width) showed consistent width reduction for paper based facestock (0.120 ± 0.007) pt regardless of the nominal line width. Horizontal lines (0.1 pt and 0.7 pt), on the other hand, due to the fiber structure within the substrate show significantly larger deviations within the paper based facestock for citrus and grape based PSLs, while horizontal lines, as a rule, show line width increase, while the vertical lines widths are reduced.

Since raggedness is related to the ink penetration and bleeding which are controlled by the fiber direction within the substrate it is not surprising that lines printed on citrus, grape and barley based facestock show a higher degree of raggedness (Figure 3). Also, in comparison to white woodfree, top coated thermal paper (TT) facestock made from agroindustrial waste shows significantly higher raggedness values. If we consider the influence of the direction of printing, horizontal lines (0.1 pt and 0.7 pt nominal width) have higher raggednees levels. Lowest raggedness, regardless of the dimensions of line width can be assigned to polyethylene white facestock. It is interesting to compare raggedness values for two filmic facestocks, chrome and polyethylene white. Namely, polyethylene white facestock is of superior quality.

Polyethylene clear based facestock stands out with the highest level of blurriness (0.43-0.75 µm) (Fig. 4). On the other hand, other bio-based polymer facestock (PEW) shows the lowest blurriness value of 0.15 µm and the highest of 0.3 µm. If we compare the line blurriness generated on lines printed on paper based facestock it can be seen that TT shows the lowest raggedness values (0.05-0.15 µm) while citrus, grape and barley range from 0.18-0.4 µm for citrus based facestock, 0.2-0.75 µm for grape based pressure sensitive label facestock and 0.28-0.6 µm for barley based facestock. Line blurriness for prints generated on commercial filmic facestock (CH) has the smallest deviations 0.15-0.25 µm.

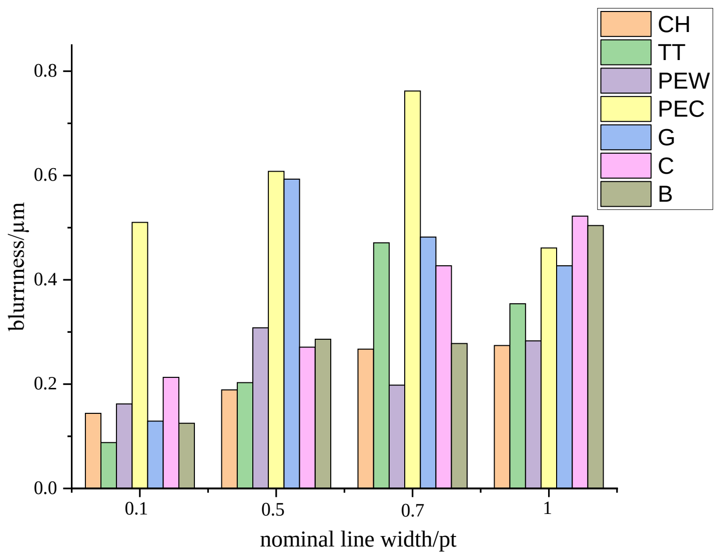


Figure 4. Dependence of measured line blurriness on nominal line width for all seven substates

From fig. 5 it can be seen that the line contrast is the lowest for the thinnest line (0,1 pt) with the min value of 0.15 for prints made on barley based facestock. For all samples, lines printed on polyethylene clear PSL facestock show the lowest contrast values due to its clear performance which directly affects the contrast measurements. Line contrast is similar for 0.5, 0.7 and 1 pt nominal line widths and ranges in values from 0.25

to 0.35. The color of the liner material affects the overall appearance of the print and consequently contrast measurments. In this regard, it might be more reliable if all labels were affixed to the same substrate material during the contrast measurements. Since most of the PSL facestock substrates are used in the study are yellowish, the choice of printing yellow lines is more than justified because our goal was to examine the limit values of line widths that can be printed on given substrates, while maintaining reproducibility which is crucial for attractive detailed design.

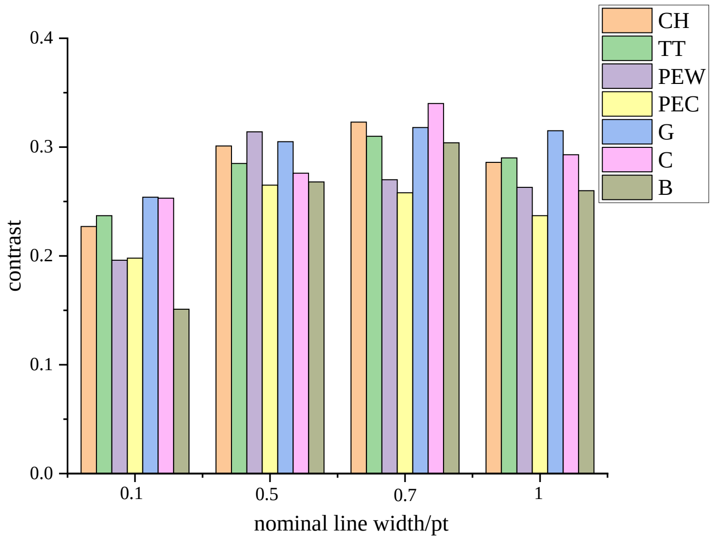


Figure 5. Dependence of measured line contrast on nominal line width

4. CONCLUSION

The aim of the study was to examine the quality of the line reproduction on environmentally friendly pressure sensitive labels facestock. PSL materials are dedicated for labelling of primary labels used on high and premium goods with a natural appearance e.g., wine, spirits, specialist foods. Yellow ink lines (UV offset ink) of various widths and orientations (0.1 pt, 0.7 pt-horizontal lines, 0.5pt, 1 pt-vertical lines) were printed on seven different PSL facestocks (four fiber based, three filmic). Three fiber based facestock of PSL used in this research are produced with 15% agro-industrial byproducts (grape fibers obtained from wine making processes, citrus fibers collected from citrus mash after juice production, and barley fibers from brewing beer and malt whiskey), 40% post-consumer recycled paper and 45% virgin wood pulp in order to form a high-quality natural paper, while the remaining one is made from white woodfree, top coated thermal paper. Two bio-based filmic polymer facestocks are made mostly from sugar cane ethanol, while remaining one is conventional polyethylene.

Study showed that the lines printed on environmentally friendly PSLs can compete in quality (width, raggedness, blurriness, contrast) with those printed on conventional polyethylene. Bio based polyethylene (PEW) facestock shows the highest reproducibility related to line width. Facestock made from barley stands out as a paper based facestock that can be competitive, in terms of line width reproduction to synthetic based polyethylene facestock. Further research will aim to examine the possibility of protecting the print on environmentally friendly labels in order to prolong its shelf life.

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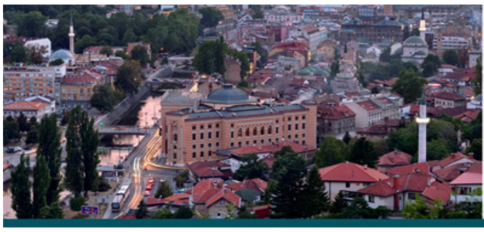

ICSD Hybrid Event
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Possibility of recycling textile residues into paper-based products

Marina Vukoje*[1], Željka Bartolić[1], Katarina Itrić Ivanda[1], Rahela Kulčar[1], Sonja Jamnicki Hanzer[1]

Abstract

Despite the growing social trend of sustainability in the textile and modern industry worldwide, there is an urgent need to reduce the amount of waste generated by the global fashion industry. Numerous initiatives are being taken in Europe to address the sustainability of the fashion industry. And the textile industry is defined as a priority sector in which the EU can open the way for a carbon-neutral, circular economy. These key challenges could be addressed by making cellulose fibers from materials derived from textile waste. These fibers are biodegradable and therefore they are considered more environmentally sustainable than synthetic fibers. Also, textiles and clothing made from these fibers can be used as raw materials in recycling processes at the end of their life cycle, thus contributing to the development of the circular economy. New approaches to textile waste recycling are constantly evolving. Textile waste in the form of cotton fabrics proves to be a sustainable source of cellulose for paper production or as a material for the adsorption of toxic compounds. The aim of this paper is to explore the possibility of using textile waste as a raw material in the paper and packaging industry in order to support the circular economy.

Keywords: circular economy, textile waste, recycling, cellulose fibers

1. INTRODUCTION

Wood is the main source of raw material used for the production of paper while non-wood fibres and recycled fibres (made from post-consumer waste paper) are increasingly finding their application in commercial paper production. The increased demand for paper and paper-based packaging, as well as increased deforestation, has encouraged the paper industry to seek new sources of raw materials for fiber isolation. It resulted in the numerus research of fiber isolation from new materials such as agricultural residues (bagasse, rice, straw, cotton stalks). These raw materials can be of major importance for the paper industry, in the areas where the wood is not available or due to other environmental concerns. Other non-wood fibres such as jute, hemp, flax, and cotton are natural materials widely used in textile industry. Cotton fibres are extensively used raw material in the textile industry, and their use in pulp and paper is very limited and mainly oriented to the production of specialty paper (currency paper) [1].

The textile and fashion industry are one of the leading environmental polluters due to the growing need and demand for textile products and economic development [2]. According to the Roadmap of the EU strategy for sustainable textiles by the European Commission, the Europeans consume an average of 26 kg of textiles per person per year and each item is used for a short time, resulting in the rejection of 11 kg of textiles per person per year, known as a “fast-fashion” phenomenon)[3]. This makes the textile industry a priority sector in which the EU can pave the way toward a carbon-neutral, circular economy, and announced an EU Strategy on textiles [3]. The textile industry is a significant polluter of the environment (high raw materials consumption and high

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levels of greenhouse gases emission) and therefore it should strive for sustainable development by using natural materials that can later be reused, recycled, or used as raw material for the production of some new products [4]. The textile waste recycling process can be categorized as chemical and mechanical recycling methods [5]. The new approach in many different industries is being transferred from the old linear economy to a circular model, where waste streams can be used to their maximum potential [5]. Different studies have shown the possibility of using different textile waste for the different purposes, for example, the production of new raw materials such as cellulosic ethanol [5], paper [6], as a material for the adsorption of toxic compounds [7]–[9] or as a material for a reinforcement of the composites materials for different applications [10], [11]. Primary recycling technologies, in which fibers are converted to new fibers, are preferable [12]. Pre-consumer and post-consumer textile waste can be produced from natural materials (silk, cotton, linen, hemp), synthetic materials (polyester and nylon), and regenerated materials (produced from natural polymers through processing - rayon, viscose) [5].

Textile waste made from natural fibers, is a promising source of cellulose [13]–[15]. Cellulose fibers recovered from waste textiles are the promising raw material for the production of paper and paper-based packaging. This fact is confirmed by the technological innovations and patent developments in this area [16]. According to Sanchis-Sebastiá et. al (2021) cellulosic fibers cannot be indefinitely converted to new fibers due to a reduced degree of polymerization in the pulping and regeneration process, which in the end degrades the mechanical properties of the fibers [12]. In addition, the authors claim that not all used garments are suitable for such a recycling process due to the lower quality of the fibers as a result of their use [12].

Using this waste as a raw material instead of the most common disposal technique - incineration, significantly reduces the impact on the environment. Textile waste used as a raw material resource, encourages the development of a circular economy in several industrial sectors (textiles, forestry, paper industry) while improving the sustainability of these industries. However, there is a certain awareness among people about the impact of these products on the environment, as well as what can be changed to reduce pollution. The development of the circular economy in the textile industry would contribute to the solution of disposal and usefulness of textile residues generated during the production of clothes. The isolation of cellulose fibers for example from textile wastes made from natural fibers which are biodegradable and therefore more environmentally friendly, can be a promising solution for problems caused by textiles waste generation in the environment. In order to improve this, the environmental policies worldwide should encourage the separate collection and proper sorting of all waste streams. European Commission in their Roadmap of the EU strategy for sustainable textiles emphasized the role of extended producer responsibility in promoting sustainable textiles and treatment of textile waste in accordance with the waste hierarchy and the implementation of the legal obligation to introduce a separate collection of textile waste by 2025 in European member states [3].

2. EXPERIMENTAL PART

2.1. Materials

For the purposes of this study, textile residues from small-scale clothing production were used. Natural materials such as denim, felpa, viscose, and render that contain a certain percentage of elastin were used. The used viscose material consists of 97% cotton and elastane, and commonly it is used for the production of T-shirts (Figure 1a). The material of denim consists of 100% cellulose fibers, denim was additionally treated with fabric bleach and therefore it is white (Figure 1b). There are different types of felpa material used to sew tracksuits. In this work, a 100% organic red cotton pile was used (Figure 1c). The fourth pink material is cotton render, which consists of 95% cotton and 5% elastane (Figure 1d). Elastane is a synthetic stretchy fiber, which is mostly used in textiles, as an additive to make them more elastic [17]. To make paper from textile material, first, it is necessary to manually chop the textile residue into smaller pieces with scissors (Figure 1a-d).

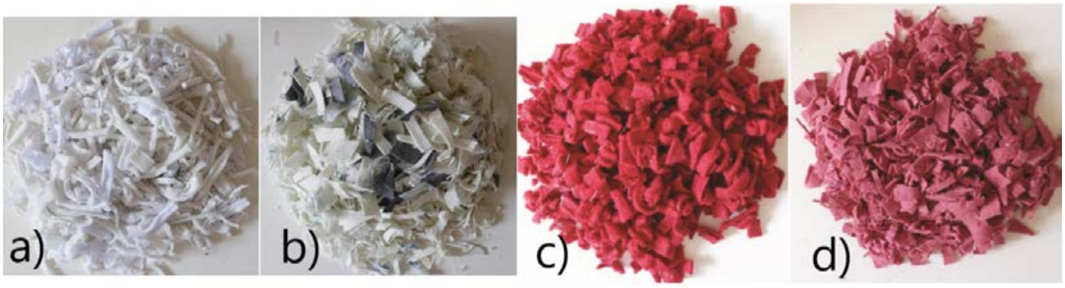

Figure 2. Chopped pieces of used textile materials: viscose (a), denim (b), felpa (c) and render (d)

For the preparation of paper samples, two types of materials were used: pure viscose waste residues (Figure 2a) and the mixture of all four materials (viscose, denim, felpa, and render) mixed in equal proportions (Figure 2b).

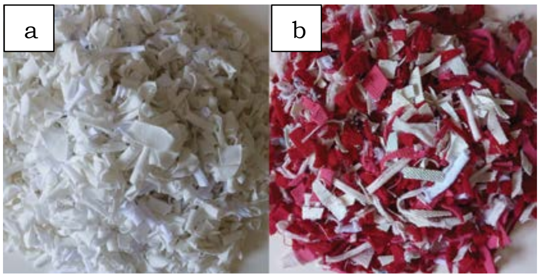

Figure 2. Chopped pieces of textile materials used for further preparation of paper from: viscose (a), and mixed materials (viscose, denim, felpa, and render) (b)

2.2. Methods

After shredding the textile materials, the materials were prepared for alkali cooking. The process was conducted by placing the waste textiles in 1 wt.% sodium hydroxide (NaOH) solution at a ratio of 1:2. The mixture was then heated to boiling and cooked for 2 h. After pulping, the pulped fibers were washed with deionized water until a neutral pH was achieved. Due to the lack of professional equipment and devices for mechanical processing of textile residues, an alternative approach for textile processing was used, i.e. a blender was used to separate and grind textile fibers. During mechanical processing using a mixer, the textile fibers are separated. In addition, a disintegrator was used after the blender, which in this case was used for mixing of produced textile pulp. The resulting pulp was stirred using a disintegrator (Enrico Toniolo) for 10 minutes in 2L of water to further separate the fibers within the pulp.

Paper samples were made on a laboratory manual machine for the preparation of laboratory paper sheets (A4 format), i.e. papers made of viscous material and papers made of a mixture of four materials: viscose, denim, felpa and render (Figure 3).

Figure 3. Preparation of laboratory paper sheets

Laboratory sheets of mixed textile and viscose paper, made on a manual paper sheet-making machine (Figure 3), were used to determine the tensile properties and tear resistance of the produced paper. In addition, FTIR spectroscopy was used for the evaluation of the chemical composition of prepared samples as it is the most acknowledged analytical technique in the analysis of textile fibers [17].

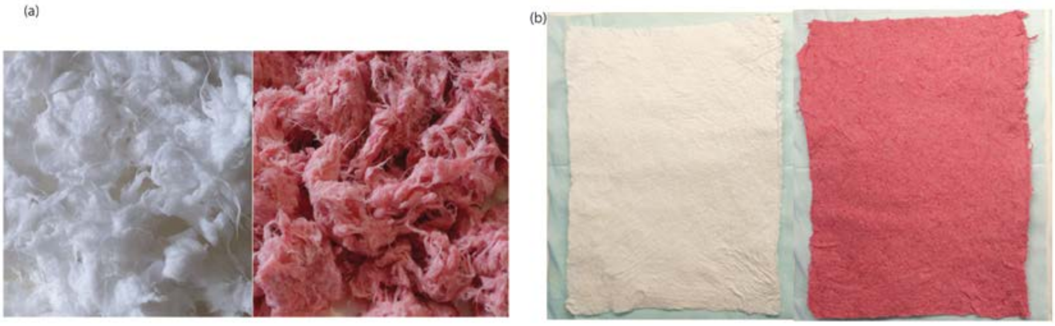

Figure 4. Visual presentation of textile fibers after the alkaline process and blending (a), and laboratory paper handsheets made from textile residues (b)

2.2.1. Determination of mechanical properties

Prepared paper samples for mechanical characterization were conditioned according to ISO 187 standard. The basic weight of produced papers was determined according to ISO 536.

Determination of Tensile breaking properties was performed using the Frank testing device. Testing was carried out according to ISO 1924-1 standard. The papers are cut into strips 15 mm wide and up to 250 mm long. The results were obtained from the average of 10 tested samples.

Tensile Strength (σ_T^b) is the tensile force required to produce a break in a strip of paper or paperboard, expressed in kN/m. It is determined according to equation 1, as the ratio of the mean breaking force $\bar{F_t}$ (N) and the width of the sample b (mm), and is expressed in kN/m:

$$\sigma_T^b = \frac{\bar{F_t}}{b} \quad (1)$$

Tensile index σ_T^w (Nm/g) is the ratio of tensile strength σ_T^b (kN/m) and paper's basis weight m_a, expressed in grams per square meter (g/m^2). In this way, the tensile index allows the comparison of the results measured on paper samples of different weights.

$$\sigma_T^w = \frac{\sigma_T^b}{m_a} \quad (2)$$

Tearing resistance is the force required to tear the paper from an initial cut. The tear resistance of paper was carried out in accordance with the standard HRN ISO 1974 Paper - Determination of tear resistance (Elmendorf method) using the Elmendorf Tearing Tester (Frank PTI). The results were obtained from the average of 10 tested samples. The test was performed on samples measuring 65 x 80 mm (2 pieces) which were cut using a template. The scale is calibrated so that as a result it gives the mean force in millinewtons (mN), which needs to be applied to tear 16 sheets simultaneously. To measure the tearing resistance of papers that have higher strength properties, the measurement can be performed on a smaller number of samples, but then the measured value should be recalculated according to Equation 3.

$$F = \frac{16}{n} \cdot F_n \quad (3)$$

Where:

F is the tearing resistance, expressed in mN;

F_n is the mean scale reading, expressed in mN, which refers to the number (n) of sheets thorn simultaneously;

n is the number of sheets torn simultaneously.

The results of the test are further expressed as the tear index (*X*) which is the tearing resistance (mN) of the paper divided by its basis weight (g/m^2). The result is expressed in millinewton square meters per gram (mN·m^2/g) and can be calculated according to Equation 4.

$$X = \frac{F}{m_a} \quad (4)$$

2.2.2. Fourier Transform Infrared Spectroscopy (FTIR Spectroscopy)

The ATR spectra of the paper samples produced from textile residues were measured using the Shimadzu FTIR IRAffinity-21 spectrometer (Shimadzu), with the Specac Silver Gate Evolution as a single reflection ATR sampling accessory with a ZnSe flat crystal plate (index of refraction 2.4). The IR spectra were recorded in the spectral range between 4000 and 600 cm^{-1} at 4 cm^{-1} resolution and averaged over 15 scans.

3. RESULTS AND DISCUSSION

Due to the absence of professional equipment required for the isolation of cellulose fibers from the textile wastes, this was the most difficult part of the process. Despite that, cellulose fibers have been successfully isolated from the used textile wastes which was confirmed by the FTIR spectroscopy (Figure 5).

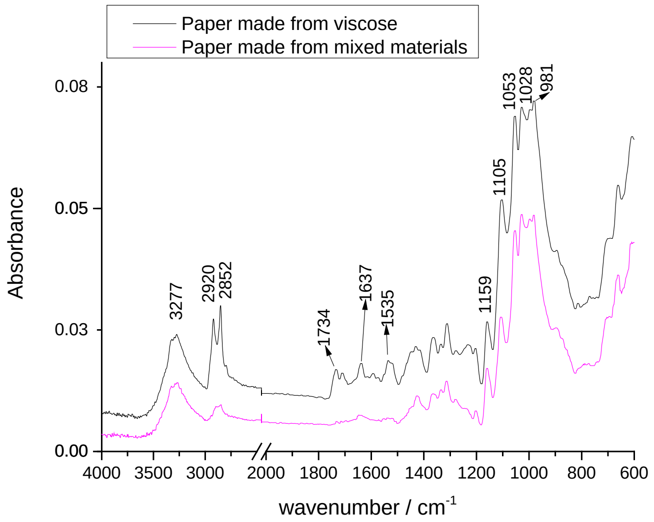

Figure 5. FTIR spectra of laboratory paper handsheets made from textile residues

Changes in the chemical structure of papers made from textile residues were examined by ATR-FTIR. Figure 5 shows the spectra of papers made from viscose and mixed materials, respectively. The obtained spectra correspond to the cellulose structure, but another vibrational band can be seen as well. The cellulose characteristic bands are present in both samples. The O–H stretching vibrational band (3600–3100 cm^{-1}) and the bands between 900 and 1200 cm^{-1}, covering glucose ring stretching (981 cm^{-1}), CO stretching (1053 and 1028 cm-1), glucose ring asymmetric stretching (1105 cm^{-1}), and C-O-C asymmetric stretching (1159 cm^{-1}). Moreover, the FTIR spectra of studied samples differ significantly in the spectral range 1800 – 1200 cm^{-1}, and in the spectral range 3000 – 2000 cm^{-1}. This points to the presence of elastin in viscose-containing paper [17]. Elastane, namely synthetic fibers containing at least 85 wt% of high molecular weight segmented poly-urethane resin, is mostly added in textiles to make materials more elastic [17],[18]. The vibrational band at 1734 cm^{-1} is carbonyl stretching vibration. In the spectral range between 3600 and 2600 cm^{-1} is displaying broad hydrogen-bonded N–H stretching peaks from the urethane bond in the elastane fibers. This band overlaps with the –OH stretching from cellulose. The C–H stretching peaks from aliphatic and aromatic groups originate from the elastane fibers. This region shows a band related to the: amide I at (C=O) 1636 cm^{-1}, amide II (N–H) at 1535 cm^{-1} [18]. The FTIR spectra of paper made from mixed materials is similar to the spectrum of cellulose. In addition, the he C-H stretching vibration in the spectral range from 2920 – 2850 cm^{-1} is registered [17].

Tensile strength and tearing resistance of paper are one of the most important paper properties and indicate the behavior of paper in various end-use situations. These properties are an important factor in packaging performance as well. These properties are affected by the different parameters, such as the length of cellulose fibers and their orientation, the degree of compression of the sheet during production or finishing, the ratio of length to fiber diameter, fiber direction, character, and arrangement of connections between fibers and by various factors related to the production of sheets of paper (surface sizing, additives), drying stresses created in the dryer press section of the papermaking machine. Beating/refining of the pulp tends to improve tensile strength because it increases the interfiber bonding. The orientation of the fibers in the paper is related to the running direction of the web, which is customarily referred to as the machine direction (MD), and the lateral direction as the cross-machine direction (CD). Tensile strength of paper is the highest in the paper direction of the main fiber orientation while tearing resistance is greater in the CD because the tear goes across the fibres and is lower in the MD where the tear propagates along the fibres [19].

The results of the mechanical resistance of paper samples (made on a hand-made machine) show that the resistance of viscose paper samples is slightly higher than that made of mixed paper samples. This may be caused by the presence of elastane in the produced viscose paper, i.e. the elastane gives a stretchy property to paper during tear strength test. With the absence of elastane in the paper, the tensile strength is reduced (in the case of paper made from mixed materials). It is important to emphasize that in this study, for the obtained paper samples typical fiber orientation, which is seen in machine-produced papers, is absent. This can also affect the paper's mechanical properties. Moreover, the obtained paper are missing the additives which are usually added in the paper production. Thus, the results obtained are significantly lower than the results of mechanical properties of commercial papers, commonly available on the market. To improve paper mechanical properties, additional process optimization is required. Paper with mechanical properties such as those presented in the Table 1 wouldn't be good to use in the printing process where high speeds and rotations are present. The runnability of the paper in the printing press is crucial for the productivity of the printing process. Good runnability assumes that the paper passes through the printing press without any web breaks (reel paper) or stoppers (sheet paper). This requires sufficient strength of the paper (tensile strength, tear resistance) and bending stiffness.

Table 1. Mechanical properties of papers made from textile residues

Property	**Paper made from viscose**	**Paper made from mixed materials**
σ_T^b **(kN/m)**	0.077826	0.071286
σ_T^w **(Nm/g)**	0.298184	0.293358
F**(mN)**	283.33	217.33
X **(mN·m²/g)**	1.085555	0.894362

4. CONCLUSIONS

This paper presents the possibility of using textile waste made from natural fibers for the isolation of cellulose fibers and its use in paper production. The results of the mechanical properties determination showed clear shortcomings of the textile fiber paper. The mechanical properties determination showed slight variations between the two studied samples. The results of tensile index of viscose paper and paper made from mixture of materials is almost the same, while slight differences are observed for the tear index, whit somewhat higher values for viscose containing paper. With this result, we can conclude that for both groups of paper it is necessary to improve the mechanical properties by further process optimization, but also to determine the flow direction of the fibers which in the end influence the mechanical properties of paper. In addition, the mechanical properties of paper can be influenced by the length of the fibers as well. The absence of technical equipment for the processing of textile waste was an additional limitation of this study, but despite that fact, this paper has shown that there is a possibility of recycling textile residues made from natural fibers to produce new raw materials. i.e., a paper which is otherwise obtained from other natural resources. This can be an example of the circular economy within the textile industry, where the association of larger or smaller textile and fashion industries is formed with the aim of disposal of textile residues generated during production. The designed system of textile waste recycling for the purpose of processing new raw materials encourages additional association with other industries. Also, this paper presents an adequate solution to reduce environmental pollution during small or big production within the textile and fashion industry. It is important to emphasize that a preliminary study was presented here, which included only one small segment of the textile industry. To develop the production of textile fiber paper in a higher percentage and a higher scale, the process itself requires further research and optimization. For this reason, the optimal concentration of alkali and duration of alkali treatment of textile fibers should be further analyzed. It is also necessary to find the optimal ratio of the textile fibers and alkali in the process, in order to obtain good quality fibers. The process itself also requires the selection of the ideal technology for chopping large textile pieces into smaller ones, which proved to be the most demanding step in this study.

ACKNOWLEDGMENT

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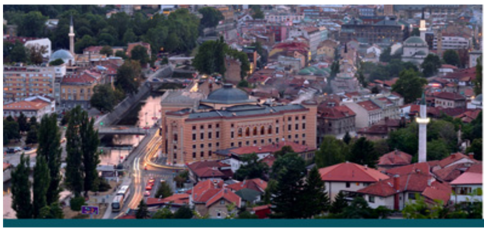

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May 04-08 2022 I Sarajevo

Effect of Tree Locations in a Square during Hot Summer Period

***Ivana Bajšanski**[1]*

Abstract

Location of trees in urban areas has large influence to mitigate overheating of horizontal surfaces. Most used urban areas for rest and enjoyment in the city during the summer period are squares, and it is necessary to create comfortable conditions for their usage. The aim of this paper is changing location of trees by using parametric approach to determine optimal position of the trees in order to decrease insolation in a square horizontal surface. The research is conducted on Liberty square design in the City of Novi Sad (Serbia). A temporal analysis is performed for the summer period using appropriate climate data in the Ladybug software. The results of the analysis showed number of hours of direct sunlight. Also, the results indicate that different trees locations can mitigate overheating of the horizontal surface up to several percent. The parametric approach used in this paper can contribute to developing urban guidelines for comfortable squares during summer period.

Keywords: insolation, Ladybug, square, trees, urban areas

1. INTRODUCTION

In the previous decades, urbanization process has large influence to increase temperature of urban surfaces. As a consequence of this effect are uncomfortable outdoor conditions to stay on urban spaces, such as squares, parks, parking lots, courtyards etc. The high growth vegetation, especially trees, can be used to provide effectively shade which contributes to mitigate overheating in the urban areas [1]-[4].

Squares surfaces in urban spaces represent potential overheating areas, because they occupy large surface covered by concrete, bricks or any other material which contribute to increase surface temperature [5]. The insolation in an urban surface can be changed by placed trees in different locations [6], [7]. In previous research, in order to decrease surface temperature, the design guidelines are proposed, which implies various orientation of the buildings or its position on the square. Some research do not have any urban modification, but analyzing the insolation and thermal comfort condition in the squares and comparing various arrangement of trees in various squares [8], [9]. By taking into account the lack of the researches which conducted by using various trees locations, this research implies the possible tree locations and measure insolation in an urban square. The rapid development of digital technologies in the field of architecture and urbanism allows large opportunities to measure insolation level of any urban area, with appropriate conditions. In contemporary practice, software for parametric modeling enables the interaction between 3D computer graphics and software tool suitable for solar insolation level [10], [11].

The aim of this paper is to create and propose an algorithm for changing trees location on the predetermined rectangle surface in order to mitigate overheating of square urban area. The algorithm uses input data such as 3D models of built environment of the Liberty square in Novi Sad and climate data for mentioned city. Thanks to appropriate software packages and parametric modeling, which allows fast processing, this is the way to optimize greenery in the square and enable cooling of the space.

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2. METHODOLOGY

The algorithm created in this paper proposes locations of any given number and geometry of trees on a square surface in order to mitigate insolation level. The algorithm methodology is elaborated upon.

The proposed method takes into account next phases:

- 3D modeling of the built environment of the Liberty square
- Climate data for Novi Sad
- Number, shape and size of trees to be placed in square surface.

Built environment of the Liberty square is represented by 3D model of the square flat surface terrain, spatial orientation, rectangle of square paved surface, surrounding buildings that influence the solar insolation level. Climate data for Novi Sad considers characteristics about air temperature, wind speed, relative humidity, and diffuse, direct and normal solar radiation. Number of trees are arbitrary, shape of the tree consider shape and size of crown and height of the trunk.

By using all mentioned data as input data in appropriate software package, the algorithm can solve insolation level for given location. 3D models of surrounding buildings and square surface was created in Rhinoceros, CAD modeling software. In the Grasshopper, software for parametrization of 3D model and add-on of the Rhinoceros, shape and size of trees was parametrized and connected with square surface in which trees have to be placed. Parametrized shape and size of trees are representing as 3D model in Rhinoceros on the square surface rectangle. The trees 3D models are simplified, as sphere. In the Ladybug, software for solar analysis, add-on of the Grasshopper, the weather data are inputted in order to solve solar simulation analysis, by using geometrical input data for the square.

2.1. Algorithm

Algorithm presented in this paper is divided into three phases.

The first phase includes geometry input which cast shade, such as surrounding buildings and existing trees near the buildings. The rectangular shape of the square is area which is exposed to sun (Figure 1). The geometry characteristics are consists of buildings heights, base geometry and width of buildings. Trees geometry is created by using size of tree crown, spherical shape of the crown and height from the base to center of the sphere. Rectangular shape of the square is approximately placed in the center of the square that is the most used space for resting.

All mentioned above geometrical elements are created in Rhinoceros and referenced in Grasshopper in order to use it in the further process of algorithm.

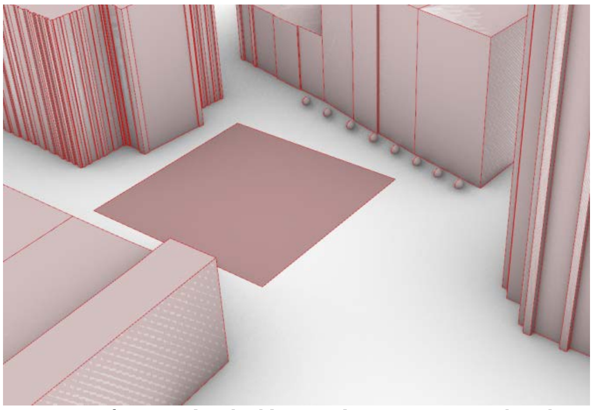

Figure 3. Geometry of surrounding buildings and existing trees in the Liberty square

The second phase of the algorithm is a part with trees in the rectangular shape and possibility to random change its positions. Several parameters are created to determine sphere locations. Firstly, the rectangular shape are populated with random points. The user can choose the number and height of points. These points are presented as centers of the spherical shape which presented trees (Figure 2). Also, in algorithm is enabled to user to change the size of sphere radius. Taking into account all these parameters, the random component is connected and allows random shuffle of the spheres. By changing number on the number slider, the spheres random change its locations.

Spheres will be used as solid forms that casts full shadow in the rectangular plane.

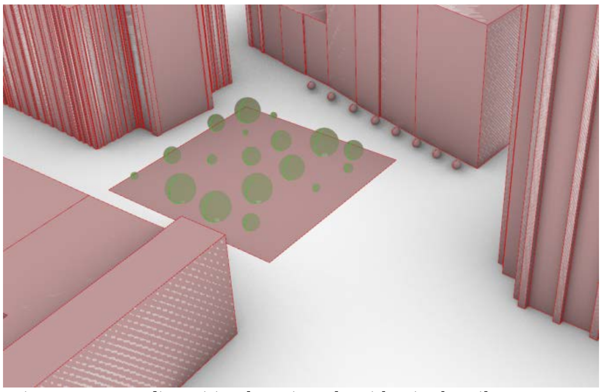

Figure 4. Trees disposition by using algorithm in the Liberty square

Third and the last phase of the algorithm is solar simulation analysis. For this analysis the Ladybug software is used, suitable to calculate hourly solar simulation. Geometry from the first and the second phase is input parameter that cast shadow, while the rectangular plane of the square is exposed to sun. Also, the climate data are taking into account, for specific period of the year and day. Final results are presented in hours (Figure 3).

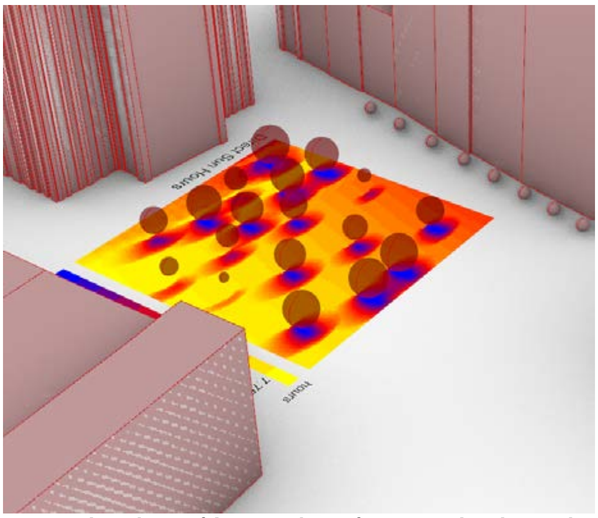

Figure 5. Color scheme of direct sun hours for rectangular plane with trees

2.2. Climate data

Solar insolation analyses are performed in Ladybug, by using appropriate geometrical data, which are the input data for solar simulations.

Climate data which are used consider weather data for Novi Sad measured in 27 different locations by meteorological sensors within Urban-Path European international project [12]. Data which are necessary for solar insolation, used in this paper, are air temperature, wind speed, relative humidity, and diffuse, direct and normal solar radiation for summer period. Stations measure the values every minute and every 10 min send the readings about climate and other technical information to the main server. The stations times are in Universal Time Coordinated (UTC) and are regularly synchronized by the main server (located at the University of Novi Sad, Faculty of Science – UNSPMF).

The algorithm enables user to select and input specific period of the year, months (1-12), days of the months (1-31) and period of the day (0-24). In this paper, the most problematic period during the hot summer period is June 21st, from 9 pm to 7 am. Also, this is most commonly used period when people spent time on the square during the summer.

3. RESULTS

Results suggest that method presented in this paper can be used for mitigation of insolation in square space based on trees locations. The result of the current situation shows that square space is sunny 6.41 hours per day. By planting trees and randomly disposition by using algorithm this value is lower substantionally. The small difference is when the trees have lower radius and amounts 5.6 sun hours per day (Figure 4) and larger difference of 5.24 sun hours per day is when the trees have higher radius (Figure 4) compared to current situation.

The improvement of the sun hours in rectangular square space is noticed when the trees disposition are changed. Depends on the trees position, the results are different and it is in a range from 5.19 to 5.48 sun hours per day. By using all random seeds in Grasshopper, the final best result is obtained and its value is about 5 sun hours per day (Figure 6). Also, the same results can be obtained for different trees disposition.

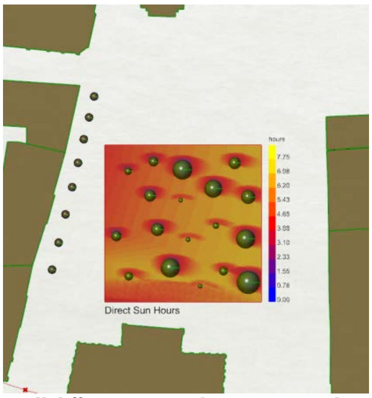

Figure 6. The small difference in sun hours compared to current situation

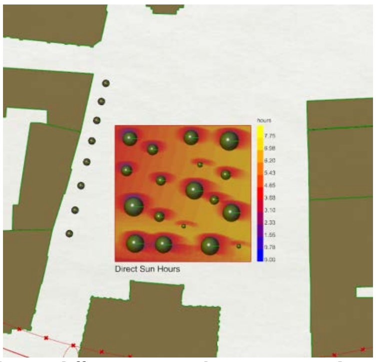

Figure 7. The larger difference in sun hours compared to current situation

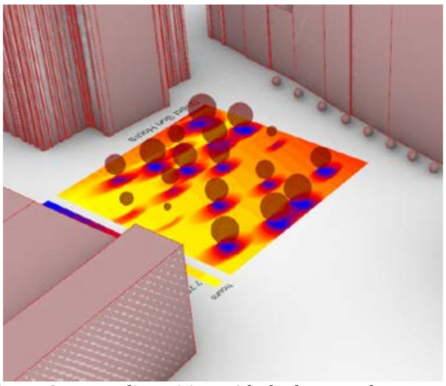

Figure 8. Trees disposition with the best sun hour result

4. CONCLUSION

This paper has shown that insolation level on square surface can be mitigated by changing trees disposition in various ways. Taking into account built environment, climate data and trees geometrical characteristics, simulations of insolation are performed. Method proposed in this paper is applicable on any world location, with appropriate weather data for precise location. Also, by using any paved surface and any tree geometrical characteristics the insolation mitigation can be noticed. This algorithm can contribute to better outdoor thermal comfort and allows optimal conditions for staying at the square space.

Integration of different software packages, Rhinoceros, Grasshopper and Ladybug enables very fast processing of solar simulation results. The results of this research are significance because provide the importance to understanding trees planting during summer period in the open urban spaces. This paper can improve the understanding of the management of tree shade, that provide to urban planners to predict comfortable urban places.

The limitation of this research is that there is no possibility to take into account real trees characteristics such as leaf density and transparency. There is only possible take trees as a solid form, that casts a full shadow at the ground. This algorithm and this method can be applied at any urban surface with any geometry with problem of overheating in the city.

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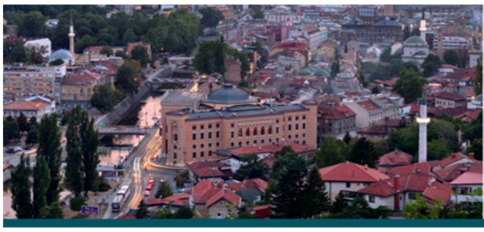

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BIOGRAPHY

Ivana Bajšanski received her Ph.D. degree from the Department of Architecture, Faculty of Technical Sciences, University of Novi Sad, Serbia. She has experience and Assistant Professor at the Department of Architecture. Her field of research is focused on the performance-based design in architecture and urban planning. She is highly experienced in 3D and parametric modelling, visual programming, solar as well as CFD simulations. As a member of Digital Design Center, she has experience in many research interdisciplinary projects. She is an author and co-author of many scientific publications, such as articles in international journals and conference proceedings.

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