

Integration of Local Eco-innovation with Global Problems of Protection of the Natural Environment and Bio-based Green Economy

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Abstract—Sustainable society is connected with common action for better quality of the human environment and life, as well as comprehensive management of the natural resources. The paper highlights 45 years methodological experiences of problem solving training based on interdisciplinary case studies in different regions in a linkage with global environmental problems. Complimentary experiences are connected with 25 years activity of AGH Open University for all age groups. Common action has been connected with the promotion of eco-innovation useful for sustainable development such as laser biotechnology, improvement of bio-energy production from wastes and biomass, and sustainable design in housing architecture. Results of our long term experiences substantiate real prospective of improving the efficiency of wastewater treatment, reclamation of deteriorated areas, progress on energy plantations for the increase of biomass for bio-energy/bio-fuel production. Laser biotechnology is a new tool for better adaptation to climatic change. Renewable source of energy, innovative biotechnology including photobiology in a linkage with geo-engineering will be integrated to construct new generation of ecological houses.

Keywords- sustainability; laser biotechnology; biomass; bio-energy; pyrolysis; catalyst; training; urban design; ecohouses for the future.

I. INTRODUCTION

Creative contribution to global environmental problems requires integration of education about these problems with regional common action for solving these problems on local scale. For environmental bridges for better future for all, integration is a key to success. This integration is related both to transdisciplinary cooperation among experts in natural, social, technical and other disciplines. Modernization of training in this field is the basic condition of success. Therefore useful may be methodological experiences of 45 years problem solving training in Poland for promotion of sustainable development focused on better quality of life. One of authors (JWD) initiated this concept of training based on interdisciplinary case studies for solving real problems in selected regions [1]. The main goals in this long-term activity were;

-Sustainable management of the natural resources for integration action for improvement quality of the natural environment with creation of new green jobs as contribution to sustainable bio-based green economy,

-Early detection of environmental risk factors to human health, biodiversity and protection of nature and cultural heritage,

- Improving the efficiency of primary prevention, based on heuristic approach to innovation of environmental biotechnology focused on more efficient reduction of the rate of emission of pollutants to the air, water and soil by innovative bioprocesses reduction of use of the natural resources and increase of the contribution to renewable sources of energy (including linkage between application of water plants for wastewater treatment, reclamation of areas out of use and application of new sources of biomass production as well as organic wastes for efficient conversion into bioenergy).

-Integration of ecotoxicological survey (including control of the impact of

the environmental pollutants on ecosystems and human food chain on health of consumers), studies of human ecology (focused on individual exposure to different pollutants of both natural environment and in-door environment i.e. living houses, schools, working environment, in areas for recreation etc.) supplemented by environmental biotechnology (including both introduction of JWD in 1972 new sensitive embryonal and juvenile criteria of biological effects of different pollutants for successful protection environmental quality for proper reproduction biological resources and human being and -prevention of congenital malformations e.g.in Minamata disease of civilization as well as prevention against of environmental risk of increase cancer incidence in “cancer houses” and clusters).

-Sustainable design of transport infrastructure, buildings and habitats in linkage with promotion of sustainable development on regional scale.

Interdisciplinary research-developing studies and exchange of good practice were related also to networking of regions promoting sustainable development of e.g.in rivers regions of several European countries (connected

with cooperation several universities and many self-governing and administrative bodies).

Many national and 14 International Conferences on Sustainable development and Ecoinnovation from 1989 to 2012 as well as several national and international Schools on the Human environment., study visits in different countries and Workshops promoting sustainable society in Poland, England, Italy, Spain etc. contributed to exchange complementary experiences [2].

Successful implementation of ecoinnovation on regional scale require common action of experts and knowledge-based society (including integration of all age groups). Therefore 25 years ago one of authors (JWD) started activity of AGH University of Science and Technology Open University with reflection on

the Bruntladt' s Team Report "Our Common Future". Both this Report as well as Report of former general secretary of UN U Thant at 1967 were focused on promotion concept of the sustainable management of the natural resources following concept introduced by former president of AGH-UST prof. Goetel and adopted by IUCN GA in UK in 1956.

Integration of Life Long Learning (especially creative university students and knowledge-based society) focused on efficient cooperation of experts and local inhabitants in linkage to global problems seems to be useful all over the world according to the participants of the WAAS Forum in 2013 and Consortium of the World University 2014 (Dobrowolski' s reports).

II. ENVIRONMENTAL PROBLEMS FOCUS ON WATER SHORTAGE IN SINGAPORE

Singapore currently manages its water supply via four different sources, namely reservoirs as its water catchment areas, import treaties with Malaysia, treatment of wastewater or NEWater and desalination of seawater, of which we are going to focus on the latter two sources. Singapore has received significant success and recognition in its reverse osmosis and membrane technology in its wastewater and seawater treatment [3]. However, more can still be done in this aspect to increase the efficiency while minimising the costs of recycling wastewater or retracting from seawater [4].

While Singapore's water management strategies may be considered successful from an international viewpoint, efforts are ultimately still limited within a few players such as the government's water utilities authority Public Utilities Board (PUB) and a few firms like Hyflux, Keppel and Spring Singapore [5]. As such, more can be done in this aspect to promote integration of these key players with the general public. For example, trainings provided by associations like the Singapore Water Association on these water management projects could be a good avenue for the involved experts to reach a common consensus to share and learn from one another's biotechnologies for a common goal of bettering the quality of the environment and human life. Furthermore, students and interested members of the public could be invited to these conferences so as to encourage intellectual exchanges of ideas between

individuals of different backgrounds. Online courses on the related topic and plant tours could also be organised for these interested members of the public. We believe that education is a large resolving factor to almost every problem faced by the societies today; even though it requires a long-term effort that is dependent on how ready the audience is to accept this information.

Also, we would like to include laser-treated water plants like algae into Singapore's current membrane technology so as to further increase the efficiency of these wastewater treatment processes in Singapore [6]. Detailed research and development could be carried out to investigate suitable laser algorithm so as to optimize the efficiency of such water plants to assist in the microfiltration step to remove any particulates that may be present in these water. The possibility of utilizing biological reactors can also be explored within the various research institutes in Singapore so as to reduce the cost of operations of these wastewater plants, since less capital is needed for the regular maintenance of machines.

III. THE MAIN APPLICATIONS OF LASER BIOTECHNOLOGY

Successful adaptation of organisms to environmental stresses require energy to maintain homeostasis. Low power lasers are proper source of coherent light for efficient biostimulation due to high energy density.

Better adaptation of different plants to various air, soil and water pollutants including applications for agriculture and animal breeding to green house effect,[including prevention against both desertification as well as flood incidence] as well as significant increase of fixation of CO₂ by laser stimulated plants in energy plantations and also in aquatic ecosystems and water plants [1].

Reclamation of contaminated and deteriorated areas, and development of energy plantations would be new sources of biomass and bio-energy.

Better management of the areas alongside main roads by acceleration of formation of protective high fences and stimulation biomass production by industrial plants in areas under the influence of traffic output.

More efficient bioremediation of toxic metals and biodegradation of petrochemical pollutants from contaminated soil [7], as well as better bio-treatment of waste water followed by higher biomass [2] and bio-energy production (following Life Cycle using best available technology BAT).

Real perspective of applications of laser biotechnology both in human and animal medicine (stimulation of reproduction in particular) as well as in innovative studies on border with bionano technology and for biohydrogen and biofuels production.

IV. APPLICATION OF ECO-FRIENDLY LASER BIOTECHNOLOGY FOR MORE EFFICIENT INCREASE OF BIOMASS FOR BIO-ENERGY PRODUCTION VIA PYROLYSIS

One of the most promising alternatives to meet the increasing demands of the human population for energy

sources is the production of bio-energy from biomass of plants.

Laser biotechnology is a new area of environmental biotechnology, in which coherent laser light is used for the optimization of natural processes involved in bioaccumulation of metals or bioremediation of xenobiotics, as well as for energy support needed for better adaptation. In addition, laser biotechnology could be used for more efficient sewage treatment, reclamation of contaminated soil, increased growth rate of irradiated plants and their resistance to pollutants in the air, water and soil [1,2,7,9]. This technology has been initiated by Dobrowolski since 1978.

There is a growing worldwide interest in the development of technologies allowing the exploitation of renewable energy sources, both for environmental and economical reasons. In particular, because of the continuous rise of the cost for the fossil energy resources, biomass looks as one of the most promising and viable alternatives. Hence, application of environmentally friendly Laser Biotechnology could be an efficient mechanism for the increase of biomass for bio-energy production via most promising updated technology as Pyrolysis [8].

Increased biomass production by laser photostimulation of different land and water plants under suboptimal conditions, e.g. in contaminated environments, could promote low carbon energy production and sustainable development. Application of new sources of coherent light may be recommended as the best available technology contributing both to progress in bioremediation as well as in biomass and bioenergy production [9].

Long term research experiences emphasize that pyrolysis is one of the alternative methods for municipal solid waste treatment, and this method offers many benefits. In the pyrolysis process, organic matter thermally decomposes in an environment that is devoid of any oxygen. A heat source is required for the pyrolysis process, but no heat source is needed for gasification, because this process is self sustaining thermally. When both pyrolysis and gasification processes occur at the same time, the gasification combustion reactions can provide the heat source needed for the pyrolysis process to perform the reactions. In this process no heat source outside of the gasification process is needed for pyrolysis [10].

Since the mid-1980s, interest has grown on the subject of catalysis for biomass of MSW pyrolysis (gasification). The advances in this area have been driven by the need to produce a tar-free product gas from the pyrolysis (gasification) of MSW, since the removal of tars and the reduction of the methane content increases the economic viability of the MSW pyrolysis (gasification) process. The literature in this area ranges from papers on bench-scale reactors to those on the use of plant-scale gasifiers. Research on catalysts for use in the process is often carried out specifically in relation to gasifier design or MSW feed type [11].

The pyrolysis process is endothermic strengthened by increasing temperature. Therefore, the reactor temperature had a significant influence on pyrolysis process. Higher

temperatures would favor tar decomposition and the thermal cracking of gases to increase the proportion of CO gas significantly [10]. Thus, as the reactor temperature increased, the gas yield sharply increased, while the oil and char yields decreased, the similar tendencies can be found by Williams and Horne [12, 13]. It was because that the reactor temperature influenced the heating rate and the pyrolysis process, which determined products distribution [10]. Volatiles are more sufficiently released from MSW particles as the reactor temperature increased. The extent of secondary reactions is affected by reactor temperature. At the higher temperature (>500 °C), The main occurring secondary reactions, such as the cracking of cyclanes and the breaking of the long chains of macromolecules, the reaction rate of which increases with the increase of the temperature, result in an increase of the gas yields and a decrease of the tar production at the higher temperature [10].

According to Tursunov (2014), calcined dolomite revealed significant catalytic performance on increasing gas yield and decreasing oil yield and char yield compared to non-catalytic pyrolysis process. Hence, the experiments illustrated that the newly developed dolomite catalyst in MSW pyrolysis was promising, with more than 99% tar removal at 750°C and gaseous product yield markedly increased over 56.7 vol% due to the presence of catalysts.

Moreover, carbon monoxide is gas utilized as a feedstock in the production of chemicals ranging from acetic acid to polycarbonates to polyurethane intermediates. Therefore, authors would like to propose better integration of output of pollutants with their application for useful production following ecosystem's function.

V. ENVIRONMENTAL ASSESSMENT OF THE RESIDENTIAL AREA IN SELECTED CITIES OF PODKARPACIE AFTER THE "TRANSFORMATION" IN THE FIRST DECADE OF THE TWENTY-FIRST CENTURY

21st century architectural thought is directed toward pro-health solutions taking into account the principles of ecology and sustainable design, for which the well-being of the contemporary man and future generations constitute dominant values.

The awareness of the protection of the wider and better use of the renewable energy sources and natural elements increases. It especially concerns biological components, so important in the living environment of man, for whom one of the most significant needs is a possibility of a permanent contact with the nature, including access to the greenery.

This paper will present the results of the case study and personal research, including urban analysis, concerning the evaluation of the quality of the living environment in terms of conditions facilitating the improvement of physical health and psychological well-being of the residents, interested in ecological, sustainable design, on the example of small urban centers located in Poland, in the Subcarpathian province, as area for recreation and sustainable tourism [14].

VI. CONCLUSIONS AND RECOMMENDATIONS FOR THE FUTURE

Promising creation of environmental bridges for the future areas of cooperation seems to be integration of interdisciplinary and international pilot projects with training of experts and education of whole society on:

Better adaptation to climatic change, reproduction of the biological resources, food production, water management and protection of health of consumers and biodiversity,

Improvement of indoor and urban environment by sustainable eco-design (including sustainable bio-based industries, energy-efficient and healthy buildings, green vehicles, qualified tourism and education)

Recommended clean low energy technologies based on renewable energy sources, we propose integration of biomimetic (based on application of biocatalysis), environmentally friendly biotechnology with ecological engineering and system approach to sustainable management resources for the future and promotion of bio-based economy and many new green jobs .

Training towards new trends in science and technology, let us to propose by taking into consideration sustainable management of the natural resources under extreme conditions, prevention against pollution by nanoparticles, protection of the outer space connected with the future industrial activity in special station on the Earth's orbits, on the Moon, on the Mars etc. Training should be focused on protection of the natural environment of uncontaminated areas on the Earth, in the outer space and the biosphere against possible contamination by both modified in the outerspace Earth anaerobic microorganisms, against risk of contamination of the natural environment, and humans by genetically modified microorganism including synthetic bacteria (especially in the laboratory in areas under risk of earthquake).

Following inhabitants' expectation of big cities eco-modernization of habitant is connected with promotion of green areas. The authors do hope that application of new outerspace technologies and experiences would be useful to improve the quality of human life on case study of Eco-Buildings in linkage to design of Manned outspace Crafts for long-term missions (e.g. on the Mars by introduction Life-supporting Ecosystems for wastewater bio-treatment and recycling of wastes, fixation of carbon dioxide and production of oxygen based on photosynthesis of algae. For wellbeing and health of inhabitants, we propose underground gardens and application of contemporary biotechnology for production of pollutants free vegetables etc. Our team would like to initiate such kind of interdisciplinary, international and long-term activity focused on pilot projects for contemporary cities such as Singapore. We propose integration of new achievements in complementary fields of science and technology like human ecology and plant physiology including photobiology with

geo-engineering and new system of low energy lighting good for photosynthesis (based on removable sources of energy in linkage with application of innovative biotechnology for multiplication of plants cells and laser biotechnology for more efficient treatment of wastewater including CO₂ fixation by plants and O₂ release by water photolysis, biomass production and conversion of both biomass and wastes into bio-energy, application of innovative biotechnology for underground production of pollutants free vegetables. This way could save a lot of surface by underground wastewater treatment, waste management and gardens (including both vegetables, aquaculture and decorative plants as an attraction in building houses and eco-hotels in megapolises).

Development of life-long learnign education for common action of experts and knowledge-based society focus on better quality of life (following 25 years experiences of Open University, AGH UST).

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