RENEWABLE MATERIAL RESOURCE POTENTIAL

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Abstract

Renewable material resources, consist of complex systems and parts. Their sub-systems and sub-sub-systems, have unique, specific, general and common properties. The character of the use that is made of these resources, depends on the availability of knowledge, experience, methods, tools, machines and infrastructure. First and above all, however, the starting point is to identify the prevailing concepts about resource use. Various terms can be mentioned, such as 'full use of resource potential', 'total resource recovery', 'whole crop use', 'integrated usage', and 'cascading' of resources.

Once a part of a renewable resource has been extracted, the highest level of its resource potential should be maintained for as long as possible, and as much of it as feasible should serve the next and many other future processes, applications and products. A hierarchy of resource potential would be: natural functioning – use of functioning – use of total characteristics – use of shape and structure, the physical components – chemical properties – energetic properties – elementary properties.

The various complexes of combined use potentials of a plant and of its parts, should be matched with the hierarchy of elementary needs that people wish to express. Thus, several levels of potential value creation can be distinguished. The paper argues that multi-purpose and multi-uses plants, trees and shrubs can be come an economic source of local and regional creation of sustainable value, well into the future.

Keywords

Renewable resources; potential; sustainable development.

1. Introduction

1.1. Shift away

Renewable material resources are at a central position in international discussions concerning climate change, depletion of fossil fuel resources, security of energy supply in the future and food security (Eickhout, 2008). Gradually a shift is taking place from the use of the fossil resources of oil, gas and coal, to potentially renewable, biomass resources. Worldwide the interest in renewable energy sources such as solar, wind and waterpower is increasing. But rather central in the global debate is the role bio-fuels (bio-diesel, bio-ethanol, biogas) could play as substitutes for gasoline and diesel fuels in cars, trucks and power plants. There is a strong trend from fossil fuel combustion to bio-fuel combustion. Climate change and the urge to strongly reduce CO_2-emissions are used as arguments to make the shift to bio-resources, which are often presented as sources of 'CO_2-neutral' energy use.

It is rather disturbing that many people seem to consider climate change as the central global environmental problem and fuel substitution as the major solution. Not only do they disregard the many environmental effects of mass production of biomass resources for fuel provision, they also neglect the vast potential of biomass for an enormous array of other uses than as an energy source only.

Yet another observation is that the primary resource base of the dominant production and consumption systems is under consideration and is likely to change sooner than the very design of the mostly concentrated production and consumption systems themselves. Other than fossil fuel reserves, the sun and the ecosystems - both natural and cultural - are resources for the future, which are all around us. They present the basic systemic conditions of future orientated, local and regional sustainable development. These ambient resources may change prevailing production and consumption systems into systems that will be virtually all around.

1.2. Natural production systems

Trees, shrubs, plants and algae are solar driven, natural production systems. They are natural structures that capture the energy from the sun, and combine and process input gases, water, minerals and substances from their direct surroundings into a huge variety of internal products such as new structural elements, sophisticated complex substances, fibres, resins, gums, cellulose and lignin, sugars and starch.

These products all can be considered solar products, resulting from many general but also species-specific plant processes, which emerge in response to the contextual local climatic and ecosystem conditions. Plants and their constituent parts, thus consist of stored solar energy at different levels of sophistication. With photosynthesis being the apex of plant life processing. But of course plants represent much more. They are life, the genetic expression of solar induced natural material creation. Rather than being valued for their food and energy contribution only, plants should also be respected for their role in the transfer of their genetic codes to future generations of plants and for future generations of people. They also represent an enormous variety of material resource potential, of evolution-built solar processing experience. Plants should be valued as abundant design inspiration sources for the future.

1.3. Resource alienation

The extraction, transformation and global use of material and energy resources have critical effects on our environment. Raw materials we borrow from the environment will sooner or later, in some form or other, be returned to the environment. However, most of the time they will then have been completely transformed. The character of these materials, their quantity, concentration and location will often have changed altogether. Therefore in many respects it can be argued that the societal throughput of materials presents a process of 'resource alienation'.

This process of resource alienation may be evaluated using knowledge of the presence, availability and properties of material and energy resources. Usually, resources are not considered as inextricably integrated within a geological or ecosystem context. Rather, material resources are most often perceived simply as a vast potential for fulfilling well-established and new product needs. Crude oil for example, is associated with gasoline and plastics, phosphate-containing minerals with washing powder, tropical wood with window frames, and chromium ores with warplanes and nuclear power plants. The prevailing industrial view of resources, it seems, isolates them from their natural and physical context. Also characteristic of this dominant industrial view is the idea of valuing materials purely as collections of certain physical and chemical potential, which may be related to very specific material applications. The same resources that provided (and still do) the evolutionary basis of ecosystems and human kind, merely, in this view, reflect compositions of material science-based coefficients, constants and factors. These, however, only emerged as building blocks for standardised production processes and specific material products.

From a perspective of sustainable development, material and energy resources have, what may be called an 'eco-holistic code' - unique to each material. That is, materials have intrinsic environmental properties, which reflect past and present natural phenomena and which also pose future environmental potential. The identification and implementation of such 'eco-holistic codes' for material and energy resources can contribute to a better understanding of the ways in which resources should be used in order to make progress in a sustainable direction. It can stimulate the revaluation of existing patterns of resource use as well as the development of new processes, products and services.

If, for example, 'local availability' is valued as an important part of a resource code, then renewable materials and renewable energy should become central to the local development and manufacture of certain classes of processes and products, as these resources are readily available and can fulfil functions for elementary needs. At the same time it would mean that non-renewable resources present in relatively few, remote and isolated locations elsewhere in the world would be used exclusively for those classes or processes and products that cannot or not yet be realised on the basis of a renewable input.

Non-renewable resources would then be reserved for the exclusive use of globally recognised basic processes and products, meeting the elementary needs for as many people as possible of both present and future generations. Those product development systems in the world, which already reflect these values should be supported and stimulated. Of the existing industrial processes and products, however, only those should be selected for support, which are most promising for a sustainable continuation.

Gradually, in highly industrialised countries, a discussion has been emerging about the necessary reduction in the use of energy and materials if we are to move towards sustainability. New qualitative thinking is required as well. Thinking about sustainability must change the industrial view on resources. Rediscovery of renewable resources will change the view on the importance and future role of local and regional Small and Medium-sized Enterprises (SMEs) (van Weenen, 1999, 2001). Traditional and existing ones will find recognition and totally new ones will emerge, based on decentralised, renewable resources, while focussing on the fulfilment of elementary needs (Benjamin, 2000), (European Foundation, 2006).

The recent global financial crisis has strongly stimulated an international debate about causes of crises, the fundaments of economic systems, measures to counter the consequences and reflections on how to prevent such crises in the future. Clearly the financial and economic issues concerning credit and debt cannot be dealt with in isolation of the credit and debt that has already been created with respect to the world's limited resources, destruction of natural areas, pollution of the atmosphere and the oceans, the unequal distribution of resources, and the remaining potential for the fulfilment of the needs and aspirations of future generations. Therefore the 'credit' and 'debt' debate should also encompass the natural and social capital of the world, as well as the preservation and development of 'future capital'.

The global financial crisis has come at a moment when developing countries considered as a whole are more vulnerable then they have been in the past (World Bank, 2009). This financial crisis should strengthen the awareness and the obligation of the world community to take measures to counter the recent swift growth of world poverty. The crisis could also serve as a stimulus to readdress poverty issues and to reinforce the UN-Millennium Development Goals. In that respect a focus on local and regional sustainable development is crucial. As it is to put priority to the fulfilment of elementary needs. This is an inevitable and immediate requirement in a world that has 3 billion people living on less than $ 2,50 a day. There also is a requirement for the future as the world population is expected to grow from 6,8 billion people in 2010 and exceed 9 billion in 2050 (UN, 2009). Most of this growth will occur in the less developed regions of the world.

The challenge of future needs fulfilment obviously already is huge and most certainly will become one of gigantic proportions. Sustainable product development to meet the elementary needs of the future is an endeavour that will require the best political, scientific, economic and social skills in the world. To that objective sharing of ideas about solutions, across local and regional contexts and cultures is of utmost importance (Chatterjee, 2007), (Mihelsic 2007a, 2007b).

2. Discovery of potential

2.1. Resourcefulness of plants

Locally available renewable material resources should be put central in achieving poverty reduction, economic development, innovation and sustainable development of the local community. In his approach the local community serves as the hub of interaction between local resources, production based on those resources, and consumption activities.

However, the availability of renewable material resources in the rural areas in most of the developing countries is quite conditional as it depends on the character of human influence and intervention. Overexploitation might occur and processes of pollution and degradation may be present. Therefore the precautionary principle applies, but with a sound scepticism concerning human intervention in nature. In addition, some other considerations should be given even higher priority.

As Tromp (1997) concluded, renewability is a theoretical characteristic of resources, which does not guarantee actual renewal. Actual renewal of a renewable resource depends on human influences, it has a spatial aspect, and involves all ecosystem cycles of which the resource is part. As part of the ecosystem, entire living trees, crops or plants are the relevant form of this resource. In general they can be utilised without extraction because they can serve to provide various functions such as regulation, carrier, production and information functions (De Groot, 1992). Thus the process of natural renewal implies the conservation of nature, dealing with nature and its basic functions as a sanctuary of biodiversity for the future, and developing nature in order to enlarge and prolong its capacity and renewability potential well into the future. The highest level of natural renewable resource potential is the living natural ecosystem, with all of its integrated subsystems, interactive processes and interconnected relations. Therefore, rather than only valuing the results of annual growth of renewable material, such as the yield of pruning, much more value is or may (in future) be derived from the ecosystem functioning as a whole. This holistic approach also applies to individual trees, shrubs, plants and algae. The date palm, for example, is a complex material system, with an enormous variety of interconnected potential for human use. Since ancient times, humans have interacted with this plant and based on very many generations of iterative experience, they have developed complex multipurpose use systems that relate to the date palm as a complex living system (El-Mously,1997).

In research on various trees, shrubs and plants, and especially about multi-purpose ones, it was striking to find a great number of words referring to the variety of potential properties, functions, products, uses and applications, beginning with the character 'f'. A list emerged of some forty words demonstrating that plants are very resourceful indeed: fabrics, factory, fats, farm, felt, fertiliser, fibres, field, figs, figures, fire, firm, fishing, fixative, flat, flavour, fence, fleet, flesh, float, floor, flour, flora, flowers, flute, fodder, foliage, food, forage, forest, fort, foundation, fragrance, frame, frond, fruits, fuel, fume, fun, fungi, furniture, future (van Weenen, 2001). This list demonstrates the broad variety of applications which might be useful for education purposes. This idea, however, is far from new. In his research on elementary education at Nippur, Veldhuis (1997) deals with lexical lists used in Mesopotamia in the 18th century B.C. One scholastic exercise he describes was to use lists of trees and wooden objects for writing practice on tablets of clay. These were thoroughly structured in sections and sub-sections. Such lists served as a way of passing on the writing system to future generations. Veldhuis gives a list of more than 700 words for trees and wooden objects, as one of the elementary practices of that time, which was part of a broader educational system. He considers it highly probable that the teacher knew the text by heart and even in two languages.

Nowadays, research and education on renewable material resource systems are just as valuable as they clearly were in Mesopotamia at that time. However, the knowledge concerned, may currently not be as thorough, well established and ambient as in the civilisation of Mesopotamia. Developing a vision on renewable material resources not only presents a challenge to engineers and to science in general, as is the urgent need for the development of sustainable systems of production and consumption, for sustainable education and for local and regional sustainable development participation.

2.2. Resource potential

Renewable material resources, consist of complex systems and parts. Their sub-systems and sub-sub-systems, have unique, specific, general and common properties. The character of the use that is made of these resources, depends on the availability of knowledge, experience, methods, tools, machines and infrastructure. First and above all, however, the starting point is to identify the prevailing concepts about resource use. Various terms can be mentioned, such as 'full use of resource potential', 'total resource recovery', 'whole crop use', 'integrated usage', and 'cascading' of resources (Benjamin, 2000, p. 17).

Once a part of a renewable resource has been extracted, the highest level of its resource potential should be maintained for as long as possible, and as much of it as feasible should serve the next and many other future processes, applications and products. A hierarchy of resource potential would be: natural functioning - use of functioning - use of total characteristics - use of shape and structure, the physical components - chemical properties - energetic properties - elementary properties (van Weenen, 1990, p. 109).

Some basic notions are that it is important to identify unique properties, a hierarchy in potential uses may be defined, and then repeated and subsequent use could be taken into account, while the duration of usage also is a consideration, of course.

The various complexes of combined use potentials of a plant and of its parts, should be matched with the hierarchy of elementary needs that people wish to express. Thus, several levels of potential value creation can be distinguished. Once sustainable science, knowledge and applications are more developed, more value, more added value, multi-times of value and multiple-types of value can be derived. On that basis, multi-purpose and multi-uses plants, trees and shrubs can be come an economic source of local and regional creation of sustainable value, well into the future.

Some considerations, however, might even amplify this potential. It is worth wile to develop new concepts that address the complexes of properties of plants on the one hand and the complexes of basic needs requirements on the other hand. The rather primitive and indiscriminate primary input of renewable material resources solely for energy purposes, should - unless the mere survival of people is concerned - wherever possible be substituted by a much more sophisticated system of material and properties usage for various subsequent needs, through lengthy phases of application and time. Thus a maximum of benefit may be derived from the renewable material sources concerned. This then is likely to lead to less pressure on the extraction and provision of primary renewable material resources at the front-end of the material use cycle. The stored solar energy may ultimately still be tapped, at the back-end, and after all.

Some parts of renewable resources, such as fibres, can be used to make structures, for which otherwise complete plant structures would have to be used. Particles can become panels by using natural glues, resins and polymers (Onchieku, 2000). Three-dimensional products can be shaped from paper mash (Packer, 1995). Paper, in turn, can be made from non-wood sources and from new, alternative fibre sources such as the fibre plant Kenaf (van Weenen, 1999, p. 54). This would contribute to a practice in which virgin wood is no longer used for papermaking but rather at its almost highest natural potential, which is that of structural applications.

In research on renewable material resource systems for sustainable SMEs, various tree and plant use systems were studied and one of the conclusions was that a vast potential exists of combining different plant use systems, old and new technologies, and indigenous and traditional knowledge (van Weenen, 2001). This in fact is the vast natural inheritance that biodiversity and many generations of human experience represent. It presents an inheritance that can serve as roots for sustainable development worldwide.

2.3. Resourcefulness of people

The current, highly centralised, non-renewable resources-based world economy has largely been built on unsustainable technologies. Therefore the transition to a new, bio-based and future-orientated world economy will inevitably require the development of new sustainable technologies. Of course, existing technology can be adjusted and adapted, but also new technology has to be developed which fits the renewable material resource concerned. An example of that is the tree-free paper technology developed by Rymsza (2004). Under the prevailing tree-paper dominated technology regime he was forced to develop his own kenaf paper technology fit for this particular fibre plant (van Weenen, 1999, p. 54-55). Clearly, it is the variety, diversity and variability of renewable material resources that do and will challenge engineers. New dimensions of the technology to be developed will be 'CO_2-reduction', 'context', 'scale', 'logistics' and integration'.

In her ph.d.-study on sustainability and the indigenous materials heuristic, Pearce (2001) defines indigenous materials as all materials which remain in their bioregion, from harvesting, through processing, and on to incorporation into a built facility or artefact.

She considers a bioregion to be a geographical area containing groups of ecosystems which are related to each other and which may or may not be dependent on exchanges of matter and energy for coexistence. The most common reason cited, for using indigenous materials, she notes, is minimisation of the transportation portion of energy embodied in the material.

Another reason given is the idea that using materials generated within a bioregion to meet the needs of the bioregion increases its robustness and stability. Pearce shows that 'indigenous materials in general use fewer energy and material resources for transportation and processing "overhead" than their non-indigenous counterparts, especially when the infrastructure for harvesting, processing and transporting those materials is already in place. The potential for environmental degradation is highly dependent on the scale of material harvest and use as well as the context in which the harvest occurs. For example, within a relatively sparsely populated region, harvesting some of a particular material may be well within the carrying capacity of the material within its ecosystem and thus the harvest may be sustainable'.

However, as Pearce (2001) also points out, increasing the scope of the harvest may push the ecosystem beyond its carrying capacity, rendering the harvest unsustainable. Positively, she argues that an important effect on ecosystems which results from indigenous resource use is the psychological and physical self-interest people have in the health of the ecosystems by which they are directly affected: 'If resources come from the same ecosystem in which the people themselves are located, the people may structure their use of the resources so as to minimise environmental degradation of that ecosystem'. Yet another important consideration of Pearce is that from an ethical standpoint, indigenous materials act as a socioeconomic equaliser. 'When materials are available locally and can be harvested at little or no cost by the people who need them, these indigenous materials may solve the problem of intra-generational equity by providing the means for otherwise underprivileged people to construct housing and other facilities for themselves without other technological or economic intervention'.

Furthermore, Pearce (2001) argues, using indigenous materials empowers individuals by reducing their reliance on externally manufactured products for which they have to pay directly.

She finally concludes that no clear answer currently exists to the question of whether the use of indigenous materials is more sustainable than current patterns of material use: ‘The importance of context is paramount in deciding the answer to this question, particularly in terms of the existence of infrastructure for harvest or transportation. What can be clearly stated, however, is that it is more sustainable to use materials which: 1. Have the lowest possible life cycle consumption of matter and energy; 2. Have minimal net negative effects to the natural environment; 3. Maintain some reasonable level of human satisfaction’.

Pearce makes a plea for policy initiatives to impose minimum standards on individual material harvest efforts. And furthermore she advises: ‘Beginning with mechanisms for monitoring and tracking individual harvests, the proposed sustainability standards must ensure that individuals do not intentionally or unintentionally compromise the health of ecosystems by harvesting beyond the sustainable yield of the environment. In addition, programs of education for those who harvest sustainable materials would help improve the learning curve for using new technologies as well as to ensure that harvesters are aware of the most current and least damaging techniques and tools for harvesting’.

3. Bio-systems and SMEs

3.1. Bio-integrated systems

In addition to the use of products from a plant such as the date palm it is possible, of course, to combine the materials that emerge from date palm processing with materials of other plant resources (El-Mously, 1997). In order to add value and to benefit from the creation of added-value this should preferably be considered and realised at the front-end, or the design phase of the use cycle of date palm products, rather then at the back end, were various types of date palm product waste will be generated. Such wastes, however, can still produce value and in turn may also be combined with other types of agro-processing wastes and agricultural residues. Yet even other sources of natural organic waste can be integrated in the systems of material, by-product, residues, and waste production. This is the broader view that is promoted by Doelle. He refers to bio-integrated systems for rural prosperity as follows (Doelle, 2002) : ‘Given the current accessibility and knowledge levels of agricultural biotechnology, there is no reason for rural farming communities to struggle on low per capita incomes. A complete utilization of all renewable resources, such as plant biomass, crops, human and animal [livestock] wastes, can give self-efficiency and sustainability to the rural communities and the environment.

But farming has to change from the old industrial-economic into a socio-economic structure using bio-integrated systems and current bio-refinery concepts for energy, food, fertilizer and commodity product formations. Such a system will help in eradicating poor health and living standards, poverty and starvation, which in turn will automatically influence population growth'.

Anaerobic digestion of waste and effluent is an integral part of what he calls 'environmental biotechnology'. He concludes that: 'The biotechnology issues for developing countries in future requires a change from the presently commercially driven to a more human development, combining 'old' and 'modern' biotechnological techniques for the improvements in the health and living conditions of 80% of our world population'. (Doelle, 2001).

3.2. SMEs and sustainable regional development

In a case study on the role of small manufacturing enterprises in sustainable regional development in Ismailia governate, Egypt, the subject of a ph.d.-study, Hefnawy (2006) found that the production processes incorporated within SMEs have serious environmental impacts. He reports that this is attributed to the lack of environmental awareness as evidenced by the overuse of available raw materials and energy, without regard to the potential needs of future generations, as well as the absence of production control mechanisms. The percentage of SMEs in his study area that depend on local natural and renewable raw materials did not exceed 10% in spite of the fact, he comments, that needed raw materials are already available locally. More than 70% of SMEs within the target area in de wood industry sector import raw materials for product manufacturing. Hesnawy's research reveals that the dependence of SMEs on alternate, local raw materials will minimise the environmental impacts resulting from the transport process which he says therefore will lead to new job creation opportunities that did not previously exist within the region. His advice is to adopt the use of cluster and network policies for SMEs to maximise their role in achieving sustainable regional development.

Endogenous knowledge will be basic to endogenous development. Müller, in this respect, stresses that endogenous knowledge is often confused with and conceived as synonymous with traditional knowledge.

He is of opinion that most traditional knowledge is contained within the endogenous knowledge confines, and that endogenous knowledge systems in addition include all such exogenous knowledge elements that gradually has been assimilated or 'endogenised' (Müller, 2003). In an article about the uptake of environmentally sensitive innovation to transform production systems in Sub-Saharan Africa, Muchie states that the best way forward to African economies is to learn quickly to reveal new comparative advantages on the basis of sustainable development. Which, he thinks, translates in the African context as the creation of new industries by drawing from the natural resource base of the countries. Therefore, more empirical studies must be done on the creation of value-added manufacture of the agrarian sector through eco-technology capability and competence building and learning (Muchie, 2003).

3.3. Local community and local resources

The local community serves as a meeting area for local resources, production and consumption. Here the spheres of local resources, production based on local resources and consumption activities encounter. However, as has been discussed above, there is much more to it. The local community can be illustrated as being at the heart of a three dimensional crystal, having a square level with the corners 'companies', 'consumption', 'culture' and 'context', and beneath and above this plane are the points of 'components' and 'concepts'.

Within the community or the region, clusters of bio-SME companies transform concepts into products for the fulfilment of elementary needs. As has been elaborated above, the character and intensity of a local community's use of resources, very much depends on the resource use concepts that locally have been developed or have become known.

From the above argumentation concerning the resource potential of renewable material resources can be derived that several of the principles involved are of a universal character and that the application of these principles and the value attached to potential of resources, is very much of a contextual character. A hierarchy of principles of renewable material resource use here suggested is:

- Respect the ecosystem functioning; - Apply multi-purpose use; - Apply multi-use of plant parts; - Combine products from trees, shrubs and plants; - Cluster SMEs; - Revaluate agro-production and agro-processing wastes; - Realise bio-integrated systems.

Waste-derived biogas and sugar or starch-based ethanol that result from local renewable resource production and consumption could be used for on-site electricity generation. That would - among other things - facilitate the realisations of 'Bionetic SMEs', a new type of SME working in a bioregion, its networking, and its involvement with advanced information and communication systems: 'Bio-' SME concern for natural life and supportive ecological systems; 'Net-' as the SMEs will participate in many networked activities and shared resources; and 'IC-' Information and Communication technologies will play a significant role in the success of the SMEs, locally, regionally and internationally (Benjamin, 2000, p. 46).

According to Wimmer, rural electrification is a rapidly developing field. She observes that rural electrification is in transition, stimulated by a variety of innovations which interact and reinforce each other: ‘Hybrid systems, for instance, can use solar, hydro, wind, biomass and diesel energy in clever combination both off and on-grid. Already they supply power day and night, summer and winter in even widely dispersed villages because they can be installed where needed, allowing for a distributed and decentralised infrastructure of power supply’, to which she adds: ‘Greater things lie ahead because innovation is about much more than technology and products. It is about applications, business models and entirely new markets - far different from those in the industrialised urban world. The combined force of these innovations can speed-up rural 'evolution' and help meet the untapped energy needs of two billion rural custodes’. (Wimmer, 2007).

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