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Röstlund, I., Björling, N. (2020). Holistic sustainable material process - Potential in local resources. IOP Conference Series: Earth and Environmental Science, 588(4).
http://dx.doi.org/10.1088/1755-1315/588/4/042069

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To cite this article: I Röstlund and N Björling 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **588** 042069

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Holistic sustainable material process – potential in local resources

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Abstract. The construction and transformation of the built environment is a key factor in the transition to a sustainable future. The interest in material's role in this transition increased in the last few years, especially in regard to embodied energy in the construction phase. This is however only a small part of the societal and environmental impact caused by the material chain. Because the material practice in todays globalised world is increasingly complex and materials should be considered cultural artefacts that are part of ecological, social and economic systems. In this article the concept of a holistic sustainable material practice is discussed from the perspective of a relocalised material process. The concept of landscapes and social-ecological systems is used to frame this process and allows discussion of opportunities and challenges within such a process. This has been achieved through literature studies and by using Regenerative Sustainability and Circular Economy as theoretical framework. The article has explored the relocalisation of the material process from the perspective of Sweden, though many of the aspects discussed can be applied in other contexts.

1. Introduction - the dynamics between the local and the holistic

The UN Sustainable Development Goals (SDGs) can be seen as a roadmap for transition to a sustainable future, setting goals in relation to challenges such as unequal distribution of resources and power, environmental degradation and climate change. The seventeen goals are interconnected and just as it is important to understand them individually, a holistic perspective is also essential to identify synergy points which can transform current systems into more sustainable alternatives [3].

Material practice is a very intricate and complex process but in discussions regarding sustainable construction this tends to be reduced to a focus on optimization of emissions and embodied energy. There is a need for a discussion which considers the ethical dimension of material practice in regard to the wider societal and environmental impacts, since material flows both create and at the same time embody cultural, political and economic structures [4].

In this conference paper we aim to discuss the potential of the material practice in creating sustainable societies when addressed from a holistic perspective. By using the notion of locality and considering the material processes in a long-term perspective as well as scarcity of resources, we reframe the process to go beyond todays rationalities. Because we see that the different steps in the material chain, from extraction and production to construction and use as well as the end life, have a wide impact on ecological, social and economic systems, both direct and indirect. The relationship

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between the different steps of the material chain and the SDGs is evident and can as the report *Mapping the Role of Raw Materials in Sustainable Development Goals* from the European commission suggests, be stated as both positive and adverse [5].

One way to understand this increasing disconnection to resources is to look at the changes that have accelerated in the last hundred fifty years. Through industrialisation, a high level of technical development has occurred, especially in regard to building materials e.g. steel and concrete. The technical development in combination with growing transport infrastructure and trade opportunities, has meant that materials no longer are bound by availability on a local scale or regional traditions. This has led to many innovations and raised standards of living conditions in many places around the world, but as side effect it also tends to create an illusion of endless resources [6]. The economist E. F. Schumacher writes in his book *Small is Beautiful* how this illusion of the misconception of the quantity of resources contributed to materials further losing their value [7]. The rationalised and centralised production process has continued since – leading to further decoupling between resources, communities and landscapes. The fact is though that we have only one planet with both finite and renewable resources that we are overconsuming. In 2019 Sweden reached the overshoot day on the 3rd of April, which means that for three quarters of the year we have lived on borrowed resources to consume and take care of the waste created.

In order to ensure long-term resource security this wastefulness of the earth resources needs to end. This also means changing our socio-economic and socio-ecologic systems since many of them depend on consumption and production, which create economic lock-ins. We then see that it is essential to change the linear logic of resources to circular flows, that make use of resources and prevent the need for extraction of raw materials and the creation of waste. The Ellen MacArthur foundation is a global platform that has investigated the concept of circular economy within many sectors, including architecture and planning. Their definition of circular economy is based on three pillars: 1) design out waste and pollutants; 2) keep products, components and materials at their highest value and; 3) regenerate natural systems [8]. This should be done with consideration to minimise energy use and value loss to avoid downcycling. An essential part of the model is the consideration of the future life of products and goods in the design stage in order to ensure circulation as many times as possible.

In order for circular economy to reshape economic processes and encompass a wider social-ecological impact, consideration needs to be made to industrial logics to avoid falling into the current lock-ins. To further understand these wider impacts we find the theoretical model of *Regenerative Sustainability* to be useful [9]. The model is based on a whole system thinking and emphasizes the need to consider of both the biophysical levels of reality and the internal or human context that entails ex. values, culture, legislation and economic system, and that these together form a wholeness [10]. This wholeness also relates to the dimension of time, a constant flux of change that the world has to relate to and adapt with. By acknowledging the need for adaptiveness, the ability of resilience is then essential in a system in order to transform and meet new challenges [9].

If we then consider a circular and regenerative material process from a holistic perspective we find that a *landscape approach* is central in order to address a number of specific SDGs. We can then connect their individual potential to comprehensive strategies for a sustainable development:

- Materials should be produced with low/clean energy, minimal greenhouse gas emissions and without toxic pollutants. *Sustainable Development Goals: 5. Clean water, 9. industry, innovation and infrastructure* and *12. responsible consumption and production*.
- People's wellbeing should be essential throughout the process, from extraction to production, construction, use and demolition. This is related both to health, economical equity and equality. *Sustainable Development Goals: 1. No poverty, 3. Good health and wellbeing, 4. Quality of education, 8. Decent work and economic growth, 12. responsible consumption and production* and *13 climate action*.
- Land and sea degradation should be avoided, and biodiversity loss should be minimised. *Sustainable Development Goals: 5. Clean water, 9. industry, innovation and infrastructure, 12. responsible consumption and production* and *15. Life on land*.

By using the (local) landscape, we can frame and visualise the relationship between resources and environmental degradation. We use the term of landscape as an interplay between spatial form and social-economic and social-ecological processes rather than topography [11]. Transformation of landscapes is shaped by both local and global influences. They encompass the holistic perspective and can be used to accentuate the immediate relationship between resource use and the impact on local and global contexts.

We see that the landscape perspective and relocalisation of the material practice is of benefit in regard to a holistic perspective. For example the discussion of locality regarding food production has grown over the last years, relating to food security, short supply chains and mental connections between produce and consumer [12]. The topic however is less explored in regard to building materials, in practice the focus has been placed on geographical distances and emissions related to transportation where the local scale relates to administrative borders such as municipalities or regions [5]. In several case studies [13] the locality is used in combination with traditional building techniques, again due to short transportation, but also since these techniques use low processed natural materials which are considered beneficial in regard to health and energy [13]. The first view is quite pragmatic while the second risks being romanticised if not connected to scale of production.

The paper uses the Swedish context as a testbed to understand challenges and opportunities related to a localised process. We see that a holistic material practice relates to many of the SDGs, especially in regard to culture, economy, knowledge and awareness, which are explored in the paper.

2. Method

The conference paper is based on literature studies which are used to frame a holistic sustainable material practice through relocalisation of the material process. The research considers how the concept of locality is discussed in practice and academia in relation to building materials. The findings have been related to Swedish conditions for a relocalisation process of the holistic material practice. Directives from the national government and construction industry have been used to lift opportunities and challenges within this context. The outcome of the paper is then discussed in relation to the UN Sustainable Development Goals.

3. Localised Material Practice

"Like the building they make, materials themselves are cultural artifacts, constructed in social and political context and subjected to the same critical analysis." *Katie Lloyd Thomas* [14]

A local material process is not in itself sustainable, it needs to be considered in relation to time and ecological, economic and social-cultural contexts. The relocalisation process is therefore explored from the relationship to local resilient landscapes, economic conditions in relation to actors as well materials as carriers of cultural values.

3.1. Resilient Landscapes

The contemporary use of materials and logic of the building industry is to a large extent the result of a modernistic approach to buildings, landscapes and professions. According to architectural theorist Susannah Hagan the pre-industrialised society was foremost a stage where *new* things were repeated over and over. To create and handcraft new objects was labour intensive so things that decayed were repaired or the components were reused. This tradition was however challenged during the 19th and early 20th century by the totalising effect of industrialisation, standardisation and commodification. The notion of the *new-and-renewed* was swept away by the assembly line to be replaced by the conceptual understanding of *new-as-novelty* [15].

With new technological solutions a similar disconnection took place in architecture. Kenneth Frampton writes in his text 'Towards a critical regionalism' about how the tabula rasa approach of the modernist movements which strived towards an universal civilisation, a kind of 'one size fits all' methodology, has contributed to a global phenomenon of placelessness, especially in the western

world [16]. His concept is aiming to break the notion of the universal civilisation. The solution is not to revert back to traditional techniques but rather use the historical perspective as a way to problematise the current system that is easily understood as the only way to value things. It emphasises the opportunity to work with the local conditions such as site topography, local climate and available materials instead of leveling a site completely and raising a standardised structure. The use of local materials could potentially make people feel more connected to their local environment and create more resilient communities by increasing control and benefits of local resources.

Professor of Environmental Policy and Planning Terry Marsden emphasizes the risk that a localised process based on a bio-economy can further the disconnection between global economic development and technological development from local, societal and environmental impacts. According to Marsden an eco-based economy instead develops the local landscape based on its ecological conditions [17].

Urban theorist Kim Dovey addresses the need for diversity together with redundancy to gain capacity to perform in many different ways and adapt to changed conditions. These characteristics are however often in conflict with the 'goal of formal planning' that 'strives for optimum efficiency of the current system'[18].

This is a long-term process and the aspect of time has to be taken into consideration. Local situations may change, and landscapes have to adapt to these instabilities. In the book *Resilient Sustainable Cities* the authors write about qualities that make a society more resilient. This is a way to estimate how vulnerable a society is to negative impacts, also called shock or disturbance, these could be environmental ones e.g. flooding events [19]. The Transitions network advocates that this could also be applied to social or economic crises like the great recession in 2008 or the influx of refugees in Europe in 2015. The concept can also be applied on different scales from countries to small societies [20]. From the perspective of a localised material production in relation to resilience, societies would be less vulnerable if they were relying on many small connections rather than a few large-scale systems.

3.2. Economic Systems and Actors

Affordability is an aspect that is mentioned in relation to local resources in some of the in the studies *Local Building Materials: Affordable Strategy for Housing the Urban Poor in Nigeria* and *Vernacular Heritage and Earthen Architecture: Contributions for Sustainable Development*. The studies where this is discussed are however set in developing countries where the use of local natural resources such as straw or clay are a cheaper option compared to industrialised materials. An important aspect of this is the low salaries within these contexts [21]. In a Swedish context some of the traditional building techniques for example straw bales or rammed earth are used in projects by self-builders where labour is conducted by owners themselves or volunteers. The democratic nature of the process allows beginners to work while being supervised. This democratic process is man-centred and allows a good opportunity for resourcefulness and durability [22].

In the Green Certification system LEED v.4 there is a MR credit 5: Regional Materials, this has been transformed into a Location Valuation Factor compared to V.3. In this version materials first have to meet at least one of the other sustainable criteria's ex. FSC certified, recycled content. If the materials are then extracted/harvested, manufactured and bought within 160 km (100 miles) of the site, the materials are valued at 200% of their cost (i.e., the valuation factor is 2). The intent of this credit is to support the local economy [23]. There is no explanation for the set distance. When discussing local food production an important aspect is the closeness in regard to the supply chains.

Except for LEED v.4, none of the reviewed material defines what local is, some of the reports [5] described the scales as international, national, regional and local. This implies that the scale of local relates to the municipal level or smaller. The state public report '*Agenda 2030 och Sverige: Världens utmaning – världens möjlighet*' regarding agenda 2030 describes the importance of county councils and municipalities as important actors in relation to sustainable development [24]. The county administrative boards are also pointed out as important actors who bridge the gap between national goals and local implementations to avoid goal conflicts [25]. Public procurement is considered

essential in the transition to sustainable practice and was highlighted by both the agenda 2030 report as well as directives from the Swedish building and construction sector [24]. In 2017 the public procurement laws were changed in order to encourage the consideration of sustainable aspects such as LCA values rather than lowest price [25]. Municipal allocation plans were also noted by the industry as a potential tool to set demands for sustainable values [26].

There are many examples of municipalities and urban areas that on a local level are working according to circular economy principles such as taking care of local resource flows. In the 2018 EIT Climate Kic report different examples describe how municipalities around the world (including Sweden) are working according to these principles. In regard to building materials the case studies in the report deal with mapping and conservation of local buildings and materials, support with deconstruction instead of demolitions [27]. The main aim seems to be to identify local resources that usually would be perceived as waste and encourage use of these locally or beyond.

The use of local resources within their own context can also help to strengthen local economies both in urban [28] and more ruralized [20] areas. Rob Hopkins, co-founder of the *Transition Town Movement*, uses the *New Economics Leaky Bucket* model to discuss how a local material practice could strengthen local economies by encouraging capital to circulate within the community [20].

3.3. Cultural Perception

"*Materials, like forms, carry with them cultural associations. One material may signal or support certain societal aspirations, whereas another might disrupt them" Elizabeth Golden* [13]

It is important to not forget that materials are also carriers of cultural associations [13]. The decoupling of resources and landscape have contributed to increased consumerism and to what Hagan describes as the notion of '*new-as-novelty'*. This stands for everlasting, resurrection, never decaying to be the ideal and a symbol of wealth and success. It has set the foundation for the ideology of modernist architecture, to be complete and permanently new. The same applied to the built fabric, where renewal was replaced by the modern movement's concept of *tabula rasa* [15].

The aspect of cultural perception is not limited to users but also affects professional groups working in the construction industry. With industrialisation there were also a shift in attitude towards materials, an engineering perspective where construction materials suitable for calculation verification replaced a process that had a strong connection to experience and material knowledge. This meant for example the replacement of timber joints with steel [22]. Certification and safety are of course essential but there is a risk that the industrial perspective becomes the norm and that its underlying logic taken for truth. This can lead to misinformation regarding alternative systems that are verified in other ways. The question of maintenance is one example that historically has been considered an opportunity to re-new and prolong material life while from today's perspective is considered an inconvenience. Due to the scale of the industry in relation to the market in Sweden it is also hard for new producers with alternative products to enter the market compared to for example Germany.

This means there is a risk of stigma both in regard to the materials aesthetic qualities as well as the functional, both from users and professional groups. The increased environmental awareness in Sweden in combination with the current movements against modernistic form could however contribute to a shift towards alternative values.

4. Discussion

By using the landscape to frame a localised material process the impacts of the material chain can be considered from a social-ecological and socio-economic perspective. The landscape captures the holistic impact of the process and shows opportunities and challenges of the relocalisation in transition to sustainable societies. To ease the discussion, we propose that a separation should be made between the process of identification and refinement or reuse of local materials and the use and construction of materials produced with local resources. The first aspect is already taking place, where urban areas

have started to explore this based on circular economy. The latter can either relate to an internal use within the same landscape that the material was produced or within another, external, context.

The local landscape in itself is rarely defined explicitly, in some of the reports the regional and local scale are defined as important, which means that the local scale could be interpreted as municipal or communal. The administrative borders of these areas are quite abstract geographical boundaries in regard to material flows but when considered as stakeholders and facilitators of social and political systems, they become relevant. Especially since the government considers the public sector have a duty to support long-term sustainable investments and consider sustainable values in the public procurement process. The local landscape however is not limited to the administrative scales or geographical distances but is multidimensional and can vary depending on the perspective, stakeholder or material from which it is considered.

Is it then important that the identified resources are used within the landscapes from where they were produced? In part yes, the relocalisation of the use of materials reconnects to the landscape and brings awareness to resource use which contributes to narrow the gap between product and user, a process we believe is an important step in achieving goal *12. responsible consumption and production*. An internal use can also spark local innovation and encourage resourcefulness in regard to smaller resource flows that would struggle to compete on a global market contributing to *Goal 8. Decent work and economic growth* and *9. industry, innovation and infrastructure*.

The internal use also has potential to strengthen the local economy through the local circulation of capital. This can make it easier for smaller municipalities with an already strained budget to justify the priority of sustainable values over the lowest price, since in the long-term it would contribute to local sustainable jobs – this is key in achieving goal *8. Decent work and economic growth* also in smaller and decentralised contexts. The reinforcement of local economies in this way is however not a straightforward development. This type of process can also lead to increased competition between regions and cause protectionism - therefore it is important that the process is not developed from a sole internal focus. National and international directives in connection to local initiatives are then crucial in order to set up cohesive goals that together make a large impact. These directives are also needed to set common goals and avoid unhealthy competition and isolationism between regions[29].

A part of the relocalisation process can be seen as a decentralisation of the productions process, something that has become increasingly globalised in the last decades. A localised materials process could benefit from a shift towards networks of small and medium scaled companies. In *The Ecology of Building Materials* the architect Bjorn Berge describes that a decentralised production process have a better opportunity to connect to the local landscape, both in from of social-economical systems as well as resource flows. In this a decentralised process the technological realm needs to move closer to the user and worker, and by increasing the number of centres for decision-making a better awareness can be realised regarding the whole chain [22]. What the best scale for resourcefulness then is, has to be explored further. But based on a landscape perspective this is likely to change depending on the local situation and the material in question. This decentralised production process and increased diversity in scale and resource use can contribute to a more resilient material process, both in relation to ecological and social systems. Over time the local landscapes will be able to adapt and be less vulnerable in relation to environmental or social-economic shocks. This is an important aspect in the creation and transformation of societies and can be connected to both SDGs 8 and 9.

The relocalisation of the material process will affect both the kind of resources that is used as building materials, the way these are used and on the scale in which they are produced. In order to meet these changes, the need for re-skilling is essential. This is a concept formulated by Hopkins in regard to the need for entrepreneurs to develop knowledge in order to work with new materials [20]. We want highlight this and see that there is need for this throughout the construction process for example the decoupling that has taken place between the architectural design process and materials [30]. Within the holistic and localised material process knowledge needs to be transferred between the building scales from detail to layout of building and communities to the whole local landscapes and vice versa. These societal changes connect both the SDG goal *9* and *4 Quality education*.

The aesthetics and form of buildings will most likely be affected by the transition to a holistic sustainable material process and work in line with the SDG 12 *responsible consumption and production*. Initially there is the potential for conflict in users between the current cultural preference and stigma connected to some natural or circular materials. An increased environmental awareness, influenced by the relocalisation, could however contribute to an understanding and acceptance of the changes.

5. Conclusion

The material chain is a complex process with many positive opportunities but also risks for adverse impacts on socio-ecological systems. The article has discussed how the UN Sustainable Development Goals are connected to this both as individual goals and as a comprehensive guide towards a sustainable future. The paper advocates a holistic approach in materials practice to enable the transition to sustainable societies. By relocalising parts of the materials process through decentralized networks, the gap between the resources and producer and user is decreased and resources can be extracted according to circular and regenerative models in sensitive ways. This means that the social-economical aspects regarding circular trends, affordability and stakeholders as well as cultural perception and relations to local landscapes then become relevant to understand before setting geographical distances.

While the paper has considered the localised process from a Swedish perspective, we see that the holistic perspective and localised process can be applied in other contexts. This then needs to be discussed from the conditions of the local landscape in relation to its own situation. It is essential that the localisation process is not driven from a sole perspective of the local. The system needs to be developed in a hybrid between a global and national perspective in relation to local bottom-up initiatives to ensure cohesion and avoid isolation and increased competition.

The process takes inspiration from traditional techniques but underlines that the aim is not to revert back to a logic used before industrialisation however use them to revaluate and challenge the current system that supports an unsustainable use of resources globally. In relation to these changes the paper raises the need for reskilling within the construction and refining industry, design professions and the opportunity this can be for local contexts. New knowledge is needed both to identify and produce material based on local resources as well as the design, planning and construction stages. The localised process also has an opportunity to strengthen weaker contexts through reevaluation of recourses, increased education levels and local circulation of capital.

Humanity is sharing one world with finite resources, and currently we are living on natural capital that we have borrowed from future generations at the expense of global ecosystems. To meet the goals set up by the UN for Agenda 2030 for Sustainable Development a reformulation of our value systems is needed to formulate new questions beyond the consumption logics of today. Transition needs to happen before scarcity of resources forces us to do so. By a holistic reconnection of our social, economic, and cultural systems to ecological landscapes we can build a society with a more robust road map for transition to a sustainable future.

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