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INDUSTRIAL SYMBIOSIS - AN ENVIRONMENTAL PERSPECTIVE ON
REGIONAL DEVELOPMENT

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INDUSTRIAL SYMBIOSIS - AN ENVIRONMENTAL PERSPECTIVE ON REGIONAL DEVELOPMENT

With environmental considerations an increasing imperative for regional development, industrial symbiosis’ focus on the environmental benefits spatial proximity for industry merits serious attention. Industrial symbiosis, a burgeoning body of academic work, investigates the environmental and economic benefits from real or hypothesised networks of companies engaged in the exchange of material and energy by-products. The mutual relevance of these literatures has been under-appreciated, which has helped to fuel unrealistic expectations for the regional economic development potential of industrial symbiosis initiatives. The three papers in this collection address areas of common interest to the regional development and industrial symbiosis literatures. In this short paper, we will first introduce Regional Studies readers to industrial symbiosis and the field of industrial ecology, to which it belongs. We then summarise each of the papers contributing to the special issue, before presenting some conclusions about the potential overlap between industrial symbiosis and regional development. Finally, we offer some suggestions for future research.

Industrial Ecology (IE) is a collective term for a number of business-centered systems-oriented approaches to improve the eco-efficiency of industry (FROSCH and GALLOPOULOS, 1989; GRAEDEL and ALLENBY, 1995). Employing ecological metaphors, IE asks questions about the sustainability of the current industrial paradigm. In essence, it argues that the traditional model of industrial activity where individual manufacturing processes take in raw materials and generate products to be sold plus waste for disposal, needs to be transformed into a more integrated “closed-loop” model: an industrial ecosystem. Here raw material extraction and

waste generation are minimized since waste serves as the raw material for other production processes (FROSCH and GALLOPOULOS, 1989).

One sub-field of industrial ecology, industrial symbiosis (IS), is of particular significance to the regional development (RD) community. IS draws its conceptual foundation from the ecological metaphor of biological symbiosis, where unrelated organisms can find mutual benefit through the exchange of by-products. That is, one organism's waste can be another's resource. IS grounds industrial ecology in specific places by emphasizing the synergistic advantages of networks of traditionally separate but geographically proximate companies exchanging by-products and energy cascades or through the joint provision of utilities and services that improve both their overall environmental and economic performance (CHERTOW, 2000).

Industrial Symbiosis' focus on the synergistic advantages of industrial agglomerations coupled with regional science/economic geography's nascent concern with the relationship between the environment and development, presents a number of overlapping themes of interest (GIBBS, 2003; HUDSON, 2007). Until recently, environmental issues have received little attention from industrial geographers, despite the industrial origins of so many current environmental problems. However, practitioners of regional development are under increasing pressure to address environmental issues (HAUGHTON and COUNSELL, 2004). Similarly, whilst industrial ecologists' envisage industrial ecosystems as networks of proximate firms they have paid little attention to either the theoretical or policy debates on the dynamics and efficacy of industrial clusters as reported in the regional development literature (GIBBS, 2003).

Industrial ecology, and especially IS, progressed rapidly from a novel idea to a policy option in the early 1990s, inspired by the discovery of the complex web of by-product material and energy exchanges among a cluster of companies and the community of Kalundborg, Denmark

(CHERTOW, 2007). For example, the local power station pipes steam to a local biotechnology company which provides surplus yeast to local farmers as pig food, and excess calcium sulfate (industrial gypsum) from the sulfur dioxide scrubbers to a local wallboard company (GERTLER, 1995). These linkages evolved gradually and bilaterally, without an overall design plan or recognition of the environmental implications, as the firms sought to make economic use of their by-products and to minimize the cost of compliance with new environmental regulations. The identification of other IS networks in Styria, Austria (SCHWARZ and STEINIGER, 1997), Jyväskylä, Finland (KORHONEN *et al.*, 1999), and subsequently Puerto Rico (DESCHENES and CHERTOW, 2004), promoted interest in the development of additional bounded IS networks.

Significantly, IS became seen as an economic development tool, as well as an environmental, initiative (e.g., COHEN-ROSENTHAL, 2003). IS networks were hailed as an environmental-business-community win-win-win offering with jobs, profit, and environmental improvement (SCHLARB 2001; LOWE, 2002). Eco-industrial parks (EIPs) were conceived as a means of demonstrating IS by implementing it on a local scale (CHERTOW, 2000). EIPs were initially defined as “a community of manufacturing and service businesses seeking enhanced environmental and economic performance through collaboration in managing environmental and resource issues including energy, water and materials” (LOWE and WARREN, 1996, p 78) within the geographic boundaries of an industrial park. However, in spite of initial enthusiasm and high-level policy support for EIPs empirical evidence of successful IS exchanges has been scant (CHIU and YONG, 2004; GIBBS *et al.*, 2005; OH *et al.*, 2005).

The lack of success in the implementation of IS within EIPs has generated reflection within the IS community (CHERTOW, 1999; DESROCHERS, 2002; VAN LEEUWEN *et al.*,

2003; HEERES et al., 2004) with cautionary notes being sounded as to the rate of progress that could reasonably be expected at establishing symbiosis. However, the initial aims of IS were clouded by expectations of economic benefits. This and the subsequent disappointment at the concrete economic and environmental results, was fostered by the isolation of the IS literature from mainstream economic development debates and the conditions under which industrial clusters may generate new economic growth.

The papers in this issue situate IS firmly within an RD context. This enables consideration of the lessons of the RD literature for IS, and of both the lessons and limitations of IS as a potential component of sustainable regional development policy.

IS represents an emerging form of economic activity, focused in particular on material and energy flows, in an attempt to recover industrial by-products in a profitable way. Given increasing interest in sustainable regional economic development, it is important to consider how these activities interrelate both spatially and sectorally with other forms of economic activity.

Agglomeration economies are a key area of interest in regional development (e.g., PELEGRÍN and BOLANCÉ, 2008). CHERTOW et al. (this volume) examine whether IS practices can produce environmental benefits of co-location distinct from the dimensions traditionally considered in terms of agglomeration economies. The paper examines how the agglomeration economies theorised in the RD literature are expressed in industrial clusters in Puerto Rico. They also examine potential and actual sharing and cycling of resources such as energy, water, and materials amongst the co-located firms. In the terms of CHERTOW (2007), the authors “uncovered” significant existing networks of “kernels” of IS. What makes the observed exchanges a unique form of agglomeration economy is the simultaneous reduction in negative environmental impact and lowering of production costs from the replacement of virgin

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inputs, coupled with local environmental improvement from less waste disposal. These non-trivial benefits were all generated from exchanges between firms in separate economic sectors. The authors extend the theorisation of agglomeration economies to encompass the positive environmental externalities that can accrue in industrial clusters by means of IS.

Another area of overlap between IS and RD relates to clusters and networking (GIBBS, 2003). Given the numerous perspectives on clusters within RD (e.g., BENNEWORTH and HENRY, 2004), DEUTZ and GIBBS (this volume) investigate whether eco-industrial parks (EIPs) are an environmentally explicitly version of an existing approach to RD, or comprise a distinct perspective. The empirical focus of this study is EIPs being developed de novo, in contrast to the pre-existing regional clusters of industries studied in the CHERTOW et al. paper. Using the three meta-themes of external economies of scale, networking and policy, the authors argue on both theoretical and empirical grounds that EIPs should be seen as a distinct cluster perspective. They then investigate the policy implications for IE and RD of recontextualising IE as a cluster perspective. They caution that EIPs are a challenging form of economic development, given that success requires specific types of transactions (physical exchange of by-product waste and energy). Whereas proximity can reduce transaction costs in other forms of clusters, IS transactions (e.g., finding someone to purchase or simply take a by-product) can be complex than the alternatives (e.g., direct disposal of waste).

The difficulty in overcoming issues of trust and confidentiality in the establishment of synergistic networks or clusters of firms are well known to both the IE and regional development community. However, notwithstanding elaborate theoretical descriptions of the importance of trust to inter-firm transactions, there is little in-depth work on the processes or mechanisms through which trust (or distrust) emerges in particular social or economic contexts (e.g.,

MURPHY, 2006). The final paper, by HEWES and LYONS takes up this topic and presents an ethnographic analysis of the strategies employed by two IS/EIP “champions” to establish the conditions necessary for IS oriented transactions to emerge. The paper asks three questions in relation to their strategies: how the champions developed trust-based social relationships; the importance of the champion being personally located in the community and the longer term viability of EIPs once the champion departs. Whilst the particularities of the two champions’ approaches differed, in both cases their key strategy was to build out from individual relationships that were purposely constructed and to leverage those relationships to get broader buy-in from the community.

In conclusion, the evidence presented here suggests that IS does have the potential to generate regional environmental and economic benefits. However, it is more commonly associated with pre-existing clusters of industries than planned *de novo* regional developments. Thus, IS should be deployed only with reservations as a weapon in the armoury of regional economic development. Nevertheless, increasing imperatives for regional sustainable economic development may dictate that IS’ system-scale approach to resource efficiency receive serious exploration. Further research is needed therefore to examine the lessons from successful IS kernels that are transferable nationally and/or internationally. Important questions for further research include: Given the potential public good from IS, what should be the role of the state in its promotion? What form of policies would be effectively engage business in IS practices, and how would they vary according to geographic context? What is the role of the region in the development of IS? What are the implications of international commodity flows for closed-loop production? How can the scope of IS be broadened to incorporate consumer as well as industrial waste? What would be the role for the existing materials recycling and recovery industries within

an economy where by-product exchange were increasingly the norm? Whilst there are presently more questions than answers, applying insights from industrial ecology and regional development literatures opens a dialogue between researchers in both fields that should help both move forward toward a better understanding of the complex relationship between development and the environment.

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