Chapter 3.8
Triple Helix, Quadruple Helix and Quintuple Helix and How Do Knowledge, Innovation and the Environment Relate To Each Other?
A Proposed Framework for a Trans-disciplinary Analysis of Sustainable Development and Social Ecology

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ABSTRACT

This article develops an inter-disciplinary and trans-disciplinary framework of analysis that relates knowledge, innovation and the environment (natural environments) to each other. For that purpose the five-helix structure model of the Quintuple Helix is being introduced. The Triple Helix model, designed by Etzkowitz and Leydesdorff (2000), focuses on the relations of universities, industry and governments. The Quadruple Helix (Carayannis & Campbell, 2009) blends in the perspective of a media-based and culture-based public. The Quintuple Helix finally frames knowledge and innovation in the context of the environment (natural environments). Therefore, the Quintuple Helix can be interpreted as an approach in line with sustainable development and social ecology. "Eco-innovation" and "eco-entrepreneurship" should be processed in such a broader understanding of knowledge and innovation.

1. INTRODUCTION: THE DRAFTING OF A PROPOSED FRAMEWORK FOR A TRANSDISCIPLINARY ANALYSIS OF SUSTAINABLE DEVELOPMENT AND SOCIAL ECOLOGY

This article is being guided by the following key research question: *How do knowledge, innovation and the environment (natural environment) relate to each other?* Advanced or advancing knowledge and innovation systems (across a multi-level architecture of sub-national, national and trans-national levels) could be characterized by a pluralism of knowledge and innovation modes. In fact, a certain co-evolution or congruence between advanced knowledge (innovation) systems and advanced (high-quality) democracy may be stated, postulating that advanced knowledge and innovation take over some of the structural elements of a democracy, such as pluralism and diversity.

Referring to the research question as conceptual point of departure, our final objective is to design and to propose for discussion an interdisciplinary and transdisciplinary framework of analysis for sustainable development and social ecology that exactly ties together knowledge, innovation and the environment. This model we will call the Quintuple Helix, a five-helix model that embeds the Triple Helix and the Quadruple Helix. Triple Helix focuses on knowledge production and use in context of "university-industry-government relations" (Etzkowitz & Leydesdorff, 2000). Quadruple Helix extends the Triple Helix by adding the helix of a "media-based and culture-based public" (Carayannis & Campbell, 2009). The Quintuple Helix contextualizes the Triple Helix and Quadruple Helix by further adding on the helix of the "environment" ("natural environments"). The Quintuple Helix thus offers an analytical frame or framework where knowledge and innovation, on the one hand, are being connected with the environment, on the other. By this the Quintuple Helix addresses and incorporates features of "social ecology". Furthermore, the

Quintuple Helix also can be seen as a framework for interdisciplinary analysis and transdisciplinary problem-solving in relation to sustainable development, because a comprehensive understanding of the Quintuple Helix clearly implies that knowledge production and use as well as innovation must be set in context or must be contextualized by the natural environment of society.

The analytical program of work of this article will be as follows. In Chapter 2 we present an overview of key concepts on knowledge and innovation, also attempting to trace their conceptual evolution. Pivotal are innovation and the national or multi-level innovation systems. Innovation overlaps or even coincides with the application, diffusion and use of knowledge. Chapter 3 summarizes the knowledge and innovation concepts of Mode 1 and Mode 2 (Gibbons et al., 1994), Triple Helix, and reviews in detail Mode 3 and Quadruple Helix (Carayannis & Campbell, 2009). More particularly, we focus in this article section also on phenomena or trends of a continuously broader contextualization of knowledge and on the broadening of some concepts of democracy. The proposition would be to state a co-evolution (or certain congruence) between knowledge and (high-quality) democracy. In the conclusion, Chapter 4, we finally introduce the Quintuple Helix in reflection of our principal research question.

2. WHAT ARE KNOWLEDGE AND INNOVATION? OVERVIEW OF CONCEPTS AND THE EVOLUTION OF CONCEPTS

The Wikipedia definition of knowledge, also cross-referencing to the Oxford English dictionary, lists as a crucial element of knowledge "the theoretical or practical understanding of a subject". The Wikipedia definition furthermore associates knowledge to "expertise, and skills" that a person may have gained either by experience or through education.[1] Currently, there exists a general belief

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