



## **Democracy and environment as references for quadruple and quintuple helix innovation systems**

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The perspective of democracy and the ecological context define key references for knowledge production and innovation in innovation systems. Particularly under conditions of environmental change where enhancing the potential for adaptation is critical, this requires a closer look at ecological responsibility and sensitivity in the different innovation models and governance regimes. The “Quintuple Helix” innovation model is an approach that stresses the necessary socio-ecological transition of society and economy by adding an environment helix to an innovation system already made up of three (university-industry-government) or four (civil society relations) helices in a way that supports adaptation by incorporating global warming as both a challenge to and a driver of innovation.

There is the proposition that knowledge production and innovation co-evolve with democracy (Carayannis and Campbell, 2014). In the Triple Helix model (Etzkowitz and Leydesdorff, 2000) the existence of a democracy does not appear to be necessary for knowledge production and innovation. However, the Quadruple Helix (Carayannis and Campbell, 2009, 2010 and 2014) is defined and represented by additional key attributes and components: “media-based and culture-based public”, “civil society” and “arts, artistic research and arts-based innovation” (Bast, Carayannis and Campbell, 2015). Implications of this are that the fourth helix in the Quadruple Helix innovation systems brings in and represents the perspective of “dimension of democracy” or the “context of democracy” for knowledge in general and knowledge production and innovation in more particular.

Within theories of democracy there is a competition between narrow and broader concepts of democracy (Campbell, 2013). This is particularly true when democracy is to be understood to transcend more substantially the narrow understanding of being primarily based on or being primarily rooted in government institutions (within a Triple Helix arrangement). Civil society, culture-based public, quality of democracy and sustainable development, however, demonstrate convincingly, what the rationales and requirements are for conceptualizing democracy broader. This appears to be necessary for a sustainable advancement of sustainable development. In a democracy, political pluralism is necessary. Political pluralism in a democracy co-evolves with pluralism, diversity and heterogeneity of knowledge, knowledge production and innovation (“Democracy of Knowledge”) (Carayannis and Campbell, 2009). This encourages and drives creativity that furthermore drives innovation (Carayannis and Campbell, 2010).

The Quintuple Helix extends the Quadruple Helix by aspects of “natural environments of society and economy”, “social ecology” and the “socio-ecological transition” (Carayannis, Barth and Campbell, 2012). The Quintuple Helix re-defines the ecology to a frontier for knowledge production and innovation. The proposition to-be-tested is that this environmental context of society can also be better addressed in a democracy than in non-democracies. If this is the case, then democracy and ecological progress are tied to each other, laying the groundwork for an approach to innovations systems that can increase resilience and enhance the potential for adaptation to environmental change.