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Risks in urban rooftop agriculture: Assessing stakeholders' perceptions to ensure efficient policymaking

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ABSTRACT

Rooftop agriculture (RA) is an innovative form of urban agriculture that takes advantage of unused urban spaces while promoting local food production. However, the implementation of RA projects is limited due to stakeholders' perceived risks. Such risks should be addressed and minimized in policymaking processes to ensure the sustainable deployment of RA initiatives. This paper evaluates the risks that stakeholders perceive in RA and compares these perceptions with the currently available knowledge, including scientific literature, practices and market trends. Qualitative interviews with 56 stakeholders from Berlin and Barcelona were analyzed for this purpose. The results show that perceived risks can be grouped into five main categories: i) risks associated with urban integration (e.g., conflicts with images of "agriculture"), ii) risks associated with the production system (e.g., gentrification potential), iii) risks associated with food products (e.g., soil-less growing techniques are "unnatural"), iv) environmental risks (e.g., limited organic certification) and v) economic risks (e.g., competition with other rooftop uses). These risks are primarily related to a lack of (scientific) knowledge, insufficient communication and non-integrative policymaking. We offer recommendations for efficient project design and policymaking processes. In particular, demonstration and dissemination activities as well as participatory policy-making can narrow the communication gap between RA developers and citizens.

1. Introduction

Both the increase in the urban population and growing food demand are stimulating the worldwide expansion of urban agriculture (UA) (Mok et al., 2014; UN-Habitat, 2013). UA seeks a sustainable way to increase local production and thereby reduce the urban "foodprint" (Goldstein et al., 2014) while contributing to the socio-economic development of communities (Mok et al., 2014). UA initiatives include a wide range of stakeholders and project types, from traditional sites (e.g., community gardens) to high-tech building-integrated solutions (Cohen et al., 2012; Specht et al., 2014; Thomaier et al., 2015).

Building-related agriculture is growing in European and North American cities in particular. It embraces concepts such as vertical farming (Despommier, 2010), zero-acreage farming (Specht et al., 2014), building-integrated agriculture (Caplow, 2009) and sky-farming (Germer et al., 2011). As the most common type, rooftop agriculture (RA) encompasses open-air RA and rooftop greenhouses (RTGs) (Thomaier et al., 2015). Open-air RA is cultivated on available roofs ranging from non-commercial rooftop gardens to entrepreneurial rooftop farms (e.g., Brooklyn Grange in NYC, USA, http://brooklyngrangefarm.com/). RTGs are greenhouses that commonly employ soil-less techniques (e.g., substrate) (Cerón-Palma et al., 2012). Because of the necessary investments in infrastructure, RTGs are typically commercial businesses. Gotham Greens, for example, runs a 1400 m^2 RTG atop a former warehouse in NYC since 2011 (http://gothamgreens.com/).

1.1. Research on rooftop agriculture

The existing literature on RA has addressed its theoretical background, agronomic and food security aspects, and the quantification of its environmental and economic balance. Some authors have reflected on definitions, current practices and potential

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business models (Despommier, 2010; Goldstein et al., 2014; Thomaier et al., 2015). The associated benefits and limitations have been identified for different European contexts. Cerón-Palma et al. (2012) determined the barriers and benefits that technical focus groups (e.g., architects, engineers) associated with the implementation of RTGs in the Mediterranean region. Specht et al. (2014) summarized opportunities and limitations of building-related agriculture based on the existing literature. Both studies highlighted potential benefits and problems in all three dimensions of sustainability (societal, economic and environmental).

The potential contribution of RA to domestic vegetable production has been assessed for various cases (Astee and Kishnani, 2010; Orsini et al., 2014; Sanyé-Mengual et al., 2015a; Whittinghill et al., 2013). The environmental savings associated with shortening the supply chain through RTGs were quantified as the substitution of imported products by local RTG vegetables (Sanyé-Mengual et al., 2013). The environmental and economic burdens of different types of RA have been quantified for RTGs in Barcelona (Spain) (Sanyé-Mengual et al., 2015b) and for community rooftop gardens in Bologna (Italy) (Sanyé-Mengual et al., 2015c).

Previous studies of policymaking surrounding UA have largely focused on developing countries. These studies have addressed the question of how policy can contribute to improvements in urban land use policy, urban food security and health, and environmental policy (Bakker et al., 2001; Bryld, 2003). Research objectives related to RA policy have also recently emerged for Canada and the US (e.g., Cohen and Reynolds, 2015). For cities in Europe, however, research on RA policy implementation has largely been absent.

1.2. Social acceptance and perception of risks around innovations

In general, perceptions of innovative products and technologies are critical for their further implementation. An innovation such as RA depends on its social acceptance, particularly in the initial stages (Specht et al., 2016a). "Acceptance" is defined as "the process or fact of something being received as adequate, valid, or suitable" (Oxford Dictionary, 2014). The predominant field of investigation in acceptance research has focused on exploring social acceptance of technological innovations. Therefore, one particular objective of such research is to analyze people's attitudes toward certain new technologies, especially those related to risks. The widespread phenomenon of perceived risks and low social acceptance of innovations has already been described in different societal contexts, such as new fields of agricultural production, energy production, GMOs or carbon capture and storage (Renn, 2005; Wüstenhagen et al., 2007). Well-known examples of agricultural production innovations initially facing low social acceptance include precision farming, organic farming and conservation agriculture (Kutter et al., 2011; Padel, 2001; Sattler and Nagel, 2010).

In the RA field, previous studies analyzed stakeholder and public perceptions of RA in Berlin and Barcelona in terms of perceived benefits, problems, risks and future implementation actions (Sanyé-Mengual et al., 2016; Specht et al., 2015, 2016a, 2016b). Although a lack of social acceptance had already been identified as potential limitation of RA implementation, previous studies had broader objectives and did not thoroughly investigate the question of perceived risks. Moreover, existing results have not yet been linked to policy.

1.3. Aims and research questions

This study aims to close this gap in research and to analyze and debate the risks of RA that stakeholders perceive and link them to policymaking. Thus, the following research questions are investigated:

- What risks of RA do stakeholders perceive?
- What are the main differences between the stories of Berlin and Barcelona?

Table 1
Population, regional food demand, UA and RA development in Berlin (compiled from Specht et al., 2015, 2016b, p. 4) and Barcelona case studies.

	Berlin, Germany	Barcelona, Spain
Population	- 3.5 million inhabitants - Second most populous city proper (within the city limits) in the EU	- 1.5 million inhabitants - Second most populous city in Spain
Regional food demand	- Regional agricultural products are increasingly requested by urban consumers (BMELV, 2013)	- Approximately 16% of food distributed through MercaBarna (food distribution center) is regionally produced (MercaBarna, 2014) - Demand for local and sustainable food has recently increased in the region (Generalitat de Catalunya, 2012)
UA development history	- Long historic tradition: During industrialization (19th century), inner-city gardens were established to improve food security and health of low-income inhabitants - During World War I, World War II and shortages, the gardens (Schrebergärten) helped protect the population	- UA activities in Barcelona began in the 1980s, promoted by the municipal administration through the Barcelona Urban Gardens Network program - Previously, UA was limited to individual gardens in squatted vacant lands in peri-urban areas (Ajuntament de Barcelona, 2014).
Current status of UA	- 3000 ha (3% of the city's area) are covered by family home food gardens and garden plots. - Over 73,000 plots are officially designated urban allotment gardens (Senatsverwaltung Berlin) - Over 100 community gardens have been established - A growing number of UA projects, accompanied by increasing media interest and constantly growing public and political awareness	- 4.8 ha in the city center are devoted to 13 municipal gardens, which were created as a leisure option for elderly people (Giacchè and Tóth, 2013) - 315 school gardens (Agenda 21) to promote sustainable development (Ajuntament de Barcelona, 2002) - Development of squatting community gardens as a form of activism - The Vacant Lands Plan (Pla Buits) awarded some vacant lands to social entities for developing community gardens (La Vanguardia, 2013) - Policy level: "UA in Barcelona: global strategy" (Ajuntament de Barcelona, 2014)
Current development of urban RA	- Development of start-ups and experimental cases - Test stages for research and investigation of new applications or to showcase production in RTG - Examples: "ECF Containerfarm" (urban farm, RA in shipping containers) and "Watergy" (integration of energy and water cycles between urban buildings and greenhouses)	- Pilot projects and planned projects - Some stakeholders have switched their interest to RA - Research entities, architects and restaurant managers have started planning RTGs in Barcelona, though such planning is still in the research and pilot stage (Sanyé-Mengual et al., 2016) - Example: Fertilecity project