



How do centrality, population growth and urban sprawl impact farmland conversion in Norway?



Kristine Lien Skog^{a,*}, Margrete Steinnes^b

^a Norwegian University of Life Sciences, Department of Landscape Architecture and Spatial Planning, Postboks 5003, 1432 Ås, Norway

^b Statistics Norway, Department of Economics, Energy and the Environment, Postboks 1400 Rasta, 2225 Kongsvinger, Norway

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ABSTRACT

A strong link has been observed between urbanization processes and conversions of farmland to built-up land. Most previous research has addressed such conversion of farmland in relation to the expansion of larger cities. However, broader analysis of both rural and central areas is needed to increase the empirical basis for these claims. Based on GIS analysis of farmland conversions, this paper aims to expand our understanding of how urban sprawl affects conversion of farmland. We find that most farmland in Norway is converted to built-up areas in relation to existing urban settlement areas. In line with population growth, urban areas in the most central municipalities experience the most significant urban sprawl and loss of farmland. Moreover, the remaining farmland is located in the same areas that already have converted the most. These areas also experience significant pressure for continued land take. Assuming current trends continue, future urban sprawl will pose great challenges for the preservation of farmland in land-use planning. New research and policies are required to handle these challenges more effectively.

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1. Introduction

Global food production needs to double by 2050 to meet the projected demands from a rising population. Increasing crop yields is considered to be the solution to meet these demands. However, yields are no longer improving in many regions in the world. Ray et al. (2013) state that the rise of crop yields is insufficient to meet the need for increased food production. Accompanied by climate change, erosion and salinization, the world may come to face a growing agricultural crisis. Thus, we cannot take the availability of food for granted, and food supply policies to protect farmland are increasingly important. This is recognised on the international policy agenda (FAO and ITPS, 2015).

The conversion of farmland to built-up land is considered to be an irreversible process (Amundson et al., 2015; Haygarth and Ritz, 2009; Jones et al., 2012; Seto et al., 2011). For historical reasons, large areas of farmland are close to urban areas, and urban sprawl is cited as the main driver of farmland conversion. However, limited empirical evidence exists to support this assumption. The aim of this paper is to increase the understanding of how urbanization processes affect the conversion of farmland to built-up land.

The methodology used to analyse spatial land use changes and the empirical results from this study can provide input for future research and land use planning policies.

1.1. Urbanization and farmland conversion

People move from the countryside to the city. This continuous migration increases the proportion of people living in towns and cities. Urbanization historically has been considered a process of population concentration (Tisdale, 1942). According to FAO and ITPS (2015), more than half of the world's population was living in urban areas in 2014. The future is increasingly urban, with approximately 66% of the world's population likely to live in urban areas by 2050. In Norway, eighty percent of the population live in urban settlement areas (Statistics Norway), the same level as in most other European countries (Antrop, 2004), America and Oceania (FAO and ITPS, 2015). The share of the population living in urban settlement areas increases yearly, as a result of immigration and internal migration. Urbanization processes are expected to continue in all regions in the world (FAO and ITPS, 2015).

Urban sprawl, which is closely connected to urbanization, can be defined as the excessive spatial growth of cities (Patel, 2014). A meta-analysis of case studies estimates that an area larger than Denmark was urbanized between 1970 and 2000 globally, and it is estimated that 1.5 million km² is likely to be urbanized in the next

* Corresponding author.

E-mail address: Kristine.lien.skog@nmbu.no (K.L. Skog).

twenty years (Seto et al., 2011). At least 275 ha of land was converted to built-up land in Europe per day between 1990 and 2000; the built-up area increased by 6% (EC, 2011). The rate of natural land converted to built-up land is also high outside Europe, especially in countries with rapidly growing economies (Gardi et al., 2015).

It has been argued that urban sprawl often occurs on the most productive farmland because cities are historically built on fertile soil (Ferrara et al., 2014a; Salvati, 2013; Satterthwaite et al., 2010; Scalenghe and Marsan, 2009). In the U.S., 28% of the land that was developed for urban uses between 1982 and 2010 was classified as farmland. In the Alberta district in Canada, as much as 60% of the urban and peri-urban growth between 1988 and 2010 was located on farmland (Martellozzo et al., 2014). Urban areas are expected to experience more land use pressures (Gardi et al., 2015), which may explain the high proportion of built-up farmland in these studies.

Farmland is considered to be a limited resource, and urbanization is experienced on a global scale (Amundson et al., 2015; Haygarth and Ritz, 2009; Jones et al., 2012; Seto et al., 2011). Because the global population is rising yearly, the rate of farmland conversion will probably increase rapidly. Continued urbanization is expected to have major implications for the conversion of farmland to built-up land and the future of the food supply (FAO and ITPS, 2015).

While 40% of total land surface is used as cropland and/or for grazing globally (Foley et al., 2005), only 3% of the total land area in Norway is farmland. The rate of food supplied by national resources is less than 50%, and decreases yearly. Available farmland per capita in Norway is only 0.2 ha, lower than the average in the OECD countries (0.3 ha per capita). Urban settlement areas constituted only 0.7% of total land area in 2015. However, these areas increased by almost 2.300 ha yearly between 2008 and 2011, and 1.500 ha yearly between 2013 and 2015.

The Norwegian Parliament has acknowledged conversion of farmland as one of the major threats to the future food supply and established a specific national target to limit farmland conversion. The Government has recommended that municipalities establish urban settlement growth borders to strengthen the prevention of farmland around urban settlements. However, we are nevertheless experiencing significant urban settlement expansion. How do these trends affect the conversion of farmland to built-up land?

1.2. Status of research

There is limited empirical evidence documenting that urbanization is the principal cause of conversion of farmland to built-up land. Most previous research has only focused on case studies in areas that have experienced large-scale urbanization without also analysing non-urbanized areas for comparison (Curran-Cournane et al., 2014; Debolini et al., 2015; Martellozzo et al., 2014; Pribadi and Pauleit, 2015; Salvati, 2013; Song et al., 2015; Su et al., 2012). However, Hennig et al. (2015) also point to significant land take in rural areas, although they did not separate agricultural land take from other land take in this study. A national study in Norway from 2006 points to scattered building in the rural areas as the major cause of farmland conversions (Saglie et al., 2006). Thus, urbanization has both rural and central dimensions that need to be included (Antrop, 2004; FAO and ITPS, 2015; Hasse and Lathrop, 2003; Malik and Ali, 2015). Deng et al. (2015) also point to the need for more systematic studies in this field. To improve our understanding of how urban sprawl affects farmland, these two dimensions should be included in the GIS analysis.

In addition to the rural-central dimension, the location of the conversions inside, close to or far from the urban settlement zones is relevant to mapping their contribution to urban sprawl. Burchell et al. (2005) describe urban sprawl as an unlimited outward and leapfrog expansion of low-density new development,

outside established urban settlement borders. However, few broad studies have analysed the location of farmland conversions in relation to existing urban settlement borders. We need both systematic digital mapping of urban settlement zones and large-scale analysis of farmland conversions and their proximity to these borders to increase this knowledge.

Rural/central typology should be able to deal with rural issues at regional or local levels. Van Eupen et al. (2012) point to the need to adapt thresholds and variables to define rurality according to different contexts; one single threshold is not valid across Europe. Muilu and Rusanen (2004) also highlight the need to adapt the definitions of rurality to the needs of regional and local planning. They argue that detailed, fine-grained georeferenced data analysis is needed to identify rural diversity in sparsely populated regions. Van Eupen et al. (2012) argue that the explanatory capacity increases as scale narrows. Detailed mapping and adapted thresholds for rurality and centrality in Norway provide possibilities for efficient GIS analyses at the national level.

Population development is also vital to the concept of urban sprawl; urban sprawl can be defined as an increase of scattered settlements with low population density (Prokop et al., 2011). Population density is often included when describing urban sprawl trends in research, see for instance EC (2011) and Hennig et al. (2015), but seldom analysed in relation to conversion of farmland to built-up areas.

Research has most often dealt with conversion of farmland for residential purposes (see for instance Levia and Page, 2000; Polimeni, 2005). Little attention has been given to other building purposes, such as leisure building or industry. One study in Norway actually questioned the notions of residential settlement as the major cause of farmland conversions; Saglie et al. (2006) found a surprisingly high percentage of farmland converted for agriculture-related building purposes. In order to increase the empirical knowledge on how farmland conversion and urban sprawl are related, both population density and the purpose of the farmland conversions need to be established.

It has been argued that the most productive farmland is situated in regions where people live, near cities or towns (Alterman, 1997; Martellozzo et al., 2014; Satterthwaite et al., 2010; Scalenghe and Marsan, 2009). However, the evidence for this assumption is limited. Few studies address the extent to which existing farmland is located in relation to urban settlement areas. Thus, further analysis of the spatial distribution of remaining farmland is required to strengthen our understanding of how future urbanization processes might impact future farmland conversion.

1.3. Objectives

In order to prevent farmland conversion and manage urbanization, it is of vital importance to understand how urban sprawl impacts agricultural land take. Urban settlement areas express the development of urban expansion and provide information useful to determining urban sprawl. This paper aims to increase the empirical knowledge concerning how urban sprawl affects conversion of farmland by including urban settlement borders in both central and rural municipalities. The paper can also provide input for new methodology in GIS analyses of urban sprawl. We address the amount and location of farmland conversions and remaining farmland in relation to (1) urban settlement areas; (2) centrality of the municipality; (3) type of farmland soil; (4) purpose of farmland conversions; and (5) population development and land-use density.

We define farmland conversions as agricultural land take and changes in land use from farmland to built-up land (as used by Prokop et al. (2011), Malik and Ali (2015) and FAO and ITPS (2015)). The built-up land includes sealed land, the permanent coverage

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