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Long-term impact of socio-economic changes on agricultural land use in the Polish Carpathians

Anna Bucała-Hrabia

Institute of Geography and Spatial Organization, Polish Academy of Sciences, Department of Geoenvironmental Research, Św. Jana 22, 31-018 Krakow, Poland

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ABSTRACT

The impact of socio-economic changes on land use on the period 1846–2009 are studied in village of Ochotnica (105 km^2) and the Jaszcze and Jamne catchments in the Polish Carpathians. The analysis of maps, aerial photos, historical and census reports indicates that during the investigated period the forest area in Ochotnica increased by 77% and in the Jaszcze and Jamne catchments by 29% and 43%, respectively and cultivated land decreased by 94% in both catchments. The population density increased from 33 to more than 50 people/km^2, while employment in agriculture decreased from 98% to below 30%. The analysed period shows diverging trends of land use, referring to the three stages of socio-economic development in the Polish Carpathians. Until World War II, agricultural land contribution was the highest throughout the history of human activity. After World War II, a communist maintenance system of the land use structure was inherited from the past. A free market economy, introduced after 1989, forced the largest increase in forest area since the first colonisation of the Gorce Mountains. In contrast to the mid-mountains of Western Europe, a decrease in population density did not accompany forest expansion, nor did a dominance of small farms in the ownership system.

1. Introduction

The mountain areas in the world have a long history of land use and land cover (LULC) change that links natural and human systems together (Black et al., 1998; Bičik et al., 2001; Bender et al., 2005; Rudel et al., 2005). The literature recognises many proximate causes such as agricultural expansion, timber extraction and infrastructure development (Vanacker et al., 2003; Viglizzo et al., 2011) and underlying driving forces (Ales, 1991; Mather and Needle, 2000; Briner et al., 2012) of LULC change acting in various combinations (Turner, 2002; Geist and Lambin, 2002; Muller and Zeller, 2002; Lambin and Meyfroidt, 2010).

Different mountain regions may experience LULC changes at different points in time, mostly by technological development, changed political and economic situations, and also by natural conditions (Bender et al., 2005; Rudel et al., 2005; Meyfroidt and Lambin, 2011). Despite political borders and differences in altitude it is possible to find some common driving forces of LULC change in the West European mountains mainly related to socio-economic development.

The progressive abandonments of pastures and croplands in the mountains occurred as population moved out – following the Industrial Revolution in the United Kingdom and France at the end of the 18th century and beginning of the 19th century (Devine, 1979; Koerner et al., 1997; Collantes, 2006). The process of further economic development accompanied with intensive urbanisation spread to other Western European countries in the second half of the 19th century and early decades of the 20th century (Arnaez et al., 2011; García-Ruiz and Lana-Renault, 2011; Lasanta et al., 2017). It led to massive migration from mountain rural areas to towns and cities (Debussche et al., 1999; Macdonald et al., 2000; Gellrich et al., 2007; Poyatos et al., 2003), cessation of traditional farming (Astrade et al., 2011) and shifting from agriculture to other activities, leaving land abandoned and subject to afforestation (Didier, 2001; Krausmann et al., 2003; Garfi et al., 2007; Bracchetti et al., 2012).

Changes in LULC under the influence of relatively gradual socio-economic development sometimes interferes with rapid political changes such as the introduction of new economic systems, at times accompanied with shifting international borders and population displacement. As a consequence of World War II, the eastern part of the Polish Carpathians (Beskid Niski and Bieszczady Mountains) experienced a severe population displacement of its Ukrainian inhabitants in 1947 (Wolski, 2016; Affek, 2016). There was a pop-

E-mail address: abucala@zg.pan.krakow.pl

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ulation decrease of 54% from 1931 to 1950 (Soja, 2008) in Beskid Niski, accompanied by a collapse in agricultural activity. In effect, forest cover increased from 30% in 1938 to 67% in 1995, as a result of rural depopulation and farmland abandonment during the 1940s (Lach and Wyżga, 2002). Resettlement actions of German inhabitants that likewise led to depopulation and then forest expansion was also noted in the Sudety Mountains in Poland (Latocha, 2009). The same consequence of political decisions occurred in the Sudety Mountains in Czechoslovakia, where approximately three million ethnic Germans were transferred out between 1945 and 1947, causing a decrease especially of arable land and the increase of forests and grasslands (Bičik et al., 2001; Lipský, 2001; Kopecký and Vojta, 2009).

Simultaneously, after World War II Central and Eastern Europe stayed fully-oriented towards a centrally controlled economy, nationalisation and collectivisation (Van Dijk, 2003; Kozak, 2010; Baumann et al., 2011). Mechanization and inputs (e.g., fertilizer) mostly increased, and some forests were converted to croplands and pastures (Elbakidze and Angelstam, 2007). Agriculture was heavily subsidised and production was mainly targeted toward internal or other socialistic countries' markets (Kozak, 2010). According to socialist ideology, the establishment of large production units in which every member contributed his share, and society as a whole would benefit from its yield, was the most important issue (Van Dijk, 2003).

The collapse of communist economies in 1989 caused most Central and Eastern European countries to carry out land reforms to restructure their farming sectors, individualised land use and privatised farmland (Kuemmerle et al., 2008). The lack of agricultural subsidies and corresponding decreased profitability led to the bankruptcy of most agricultural enterprises (Müller et al., 2013). This transition from the communist system to a free-market economy in 1989 brought about substantial land use changes, including forest expansion on abandoned land (Kozak, 2010; Munteanu et al., 2014; Bucała-Hrabia, 2017). Land abandonment is now becoming a serious and growing trend that is accelerated by the retirement of the older generation of farmers and the significant migration of young people to urban areas in Poland and other parts of Western Europe (Griffiths et al., 2013; Pašakarnis et al., 2013; Munteanu et al., 2014).

Regardless of the type and duration of human activity in the natural environment of mountains, the effects of this activity typically first appear in the form of changes in vegetation (Benjamin et al., 2005; Baur et al., 2006; Geist and Lambin, 2006). Progressing deforestation and subsequent transformation of the agricultural land also affects transformation of the natural landscape (Wolski, 2016; Lipský, 2001; Olah et al., 2009; Bucała, 2014; Bucała and Wiejaczka, 2015) including changes in geomorphic and hydrologic processes (Kondolf et al., 2002; Liébault and Piégay, 2002; Łajczak et al., 2014) and soil properties (Adamczyk and Komornicki, 1969; Peco et al., 2006; Bucała et al., 2015).

This paper examines how long-term agricultural activity has affected the LULC changes in the mid-mountain (elevation of 600–1300 m a.s.l. in the Polish Carpathians). It is hypothesised that different socio-economic systems were dominant causes of long-term LULC changes in the mid-mountains. The main characteristics of LULC changes are analysed in the village of Ochotnica and two catchments in the Gorce Mountains from 1846 to 2009. This period covers three stages of socio-economic development: (1) 1846–1954 – a period of agriculture dominance in the national economy, (2) 1954–1997 – a period of the communist system to the beginning of post-communist transformation and (3) 1997–2009 – a period of free market economics and European Union membership.

2. Materials and methods

2.1. Study area

The Polish Carpathians (19,600 km^2) cover, besides the small region of the high Tatra Mountains, areas of mid- and low-mountains (the Beskidy and Bieszczady Mountains), as well as foothills and valley bottoms. The foothills are traditionally the cultivation areas with a small proportion of forest (20–30%) and less than 10% of steep slopes above 15°. The medium high Beskidy Mountain region with cultivation and animal husbandry have a greater contribution of forest (30–70%) and 50–80% steep slopes above 15° (Starkel, 1990; Łajczak et al., 2014). The Polish Carpathians are relatively densely populated (127 persons/km^2) and more than 65% of the population live in rural areas (Długosz and Soja, 1995).

Study area is located in the Gorce mid- mountains in the Beskidy part of the Polish Carpathians. They form a mountain range of about 550 km^2 deeply dissected by river valleys. Detailed studies were carried out in the Ochotnica village with the Jaszcze and Jamne catchments, which are located in the Ochotnica Dolna commune (Fig. 1). The Ochotnica is the largest village in Gorce Mountains, as well as in the Polish Carpathians with an area of 105 km^2, inhabited by 5400 people. It is drained by the Ochotnica river that runs along main valley with a length of 20 km, to which deeply cut valleys of tributary streams, including Jaszcze and Jamne streams contribute.

The Jaszcze and Jamne catchments (area of 11.39 km^2 and 8.95 km^2, respectively), are in the range of the flysch Magura nappe which appear in the form of alternate sandstone and shale layers. High ridges (1000–1250 m a.s.l.) and deep V-shaped valleys dissected up to 300–600 m are thus the main relief forms. Steep slopes above 15° cover more than 70% of the Jaszcze and Jamne catchments. On sandstone, sandy loam Podzols developed with high rock fragments contributing to the grainsize composition. On the outcrops of shale, Luvisols have formed which contain large quantities of silt. The narrow valley bottoms are covered by alluvial sandy clay soils (Adamczyk and Komornicki, 1969; Bucała et al., 2015).

The Jaszcze and Jamne catchments are located in two vertically-differentiated climatic zones: a temperate cold zone (of a mean annual temperature of 4–6 °C) between 600 and 1100 m a.s.l., and a cold zone (2–4 °C), above 1100 m a.s.l. (Hess, 1965). Mean annual precipitation, in the years 1958–2008, was 841 mm. The Jaszcze and Jamne streams have an average discharge of 0.3 m^3/s and 0.2 m^3/s, respectively (Niemirowski, 1974). Both catchments are overgrown with mixed forest (oak, spruce, pine) between 600 and 1100 m a.s.l. and spruce forest which occurs at elevations above 1100 m a.s.l. (Medwecka-Kornaś and Kornaś, 1968).

The Jaszcze and Jamne catchments have environmental features representative of the mid-mountain part of the Polish Carpathians. However, the Jamne valley is wider, with gentler slopes, greater contribution of the area of southern exposure and with a larger contribution of deep and less rocky soils in comparison to the Jaszcze valley. More favourable climatic and soil conditions for agricultural development resulted in the Jamne catchment being more deforested, with a higher proportion of the agricultural land.

2.2. Historical development of study area

The first traces of human activity and culture (mainly ceramic artefacts) in the Gorce Mountains was associated with a Slavanic settlement in the Prague Province (Parczewski, 1988). It is confirmed by palynological analyses and radiocarbon dating of the sediment taken from Iwankowskie Lake, dug out of a landslide in Ochotnica village at an altitude of 772 m (Fig. 2). The methods permit correlation of pollen (vegetation) changes due to anthropogenic impact with determination of absolute age of the sediment. The