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Proposing an agricultural belt to protect a city's semi-rural characteristics: The example of Bartın, Turkey

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Proposing an agricultural belt to protect a city's semi-rural characteristics: The example of Bartın, Turkey

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ABSTRACT
Urban sprawl, a type of urban expansion, is perceived as a global problem due to changes in land conversions and landscape patterns. Farms, forests and shores have been converted into urban areas; this transformation affects energy flow, biochemical cycles and climatic conditions. To follow and evaluate the physical, social and ecological results of urban sprawl, we identified and measured temporal changes in land use and land cover. This is especially important for urban planning policies. In this study, temporal change is identified in the city of Bartın using remote sensing and landscape metrics. An analysis of land cover and land transformation was done with LANDSAT5 TM/ETM satellite images from 1985 and 2015. These images were used to identify agricultural areas as land that has most commonly undergone drastic changes. Bartın is a small semi-rural city that has undergone significant changes. Among the most important reasons for these changes were uncontrolled urban sprawl due to political and administrative decisions that lacked long-term planning and a comprehensive city plan. This study examined the risk factors for loss of semi-rural characteristics using the example of Bartın city. To protect semi-rural city characteristics and control urban sprawl, we propose an agricultural belt based on spatial suitability and an evaluation of landscape metrics.

KEYWORDS
Urban sprawl; landscape change; agricultural belt; Bartın, Turkey

1. Introduction

Basing the origin of cities on agriculture and soil and describing them as eco-communities, Bookchin (2005) emphasised that urbanisation destroys natural landscapes and the cities themselves. Evaluating urban sprawl as a negative phenomenon, which will endanger cities and the countryside, land transformation due to urban sprawl changes cities into synthetic environments. Thus, according to Teayybi and Pijanowski (2014), it is necessary to observe land transformation as it occurs in parallel with urban sprawl in temporal and spatial scales.

Urban sprawl is perceived as a global problem due to considerable land transformations and a regional problem because of its effects on landscapes (Makse, Andrade, Batty, Havlin, & Eugene Stanley, 1998). In addition to damaging quality of life, urban sprawl has a significant influence on the environment, social structures and economies. The Brundtland Report, written in 1980 when urban sprawl was already accepted as a serious problem, defined it as the 'uncontrollable physical expansion of cities'. The same report stated that urban sprawl created 'serious problems in urban environments

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and economies', it was foreseen that 'if cities are developed unguidedly on more productive agricultural lands, additional agricultural area losses will arise' (Wakode, Baier, Jha, & Azzam, 2014; World Comission on Environment & Development, 1987).

As stated in Shkaruba et al. (2017), 'protected green zones' have been introduced in most European countries to control sprawl on the periphery of cities and in order for the city residents to have recreational areas; how the land is restricted and configured spatially may vary considerably. The Copenhagen finger plan, British green belts and Dutch buffer zones may be considered as popular examples. No matter how such attempts are implemented, the need for suburban land still bears a serious risk for the ecosystems of green open areas, and may result in various problems such as illegal dumping, ecosystem fragmentation and forest loss.

A green belt is seen as a universal solution in planning land use in order to protect rural characteristics in cities and to control urban sprawl (Gant, Robinson, & Fazal, 2011; Tang, Wong, & Lee, 2007). According to Tang et al. (2007), its origin is often linked to the ideas of Ebenezer Howard in the early twentieth century and addressed the development of 'Garden Cities' around London to contain its sprawl (Amati & Yokohari, 2006; Schuyler, 2002). The green belt concept can still be found in many European cities such as Frankfurt (Lassus, 1998), Berlin, Vienna, Barcelona and Budapest (Kühn, 2003), American cities such as Washington DC, Cincinnati, Milwaukee and Chicago (Randall, 2000), Asian cities such as Tokyo, Bangkok, Seoul (Hwang, 2001; Yokohari, Takeuchi, Watanabe, & Yokota, 2000) Guangzhou (Lo, 1994), and Sydney (Golledge, 1960) and Melbourne (Buxton & Goodman, 2003) in Australia.

Green belts are a 'synonym for good planning'; however, some argue that it is an old concept of land use, unable to achieve the aim of controlling urban sprawl. This challenge is discussed under the concept of 'green belt flexibility' (Amati & Yokohari, 2006). The planners confirm that the flexibility of a green belt cannot meet predicted requirements and its performance falls short of optimal goals in land use planning (Royal Town Planning Institute, 2002). Amati and Yokohari (2006) define a green belt as 'a zone of land around the city where building development is severely restricted' and suggested that a separation between town and countryside through green belts was one of the central tenets of post-war British planning. However, contrary to typical green belt use, an agricultural belt can also integrate. The challenge of many situations is how best to conceptualise the urban-rural conflict reproduced between the city and countryside. Land use planning may also consider the relationship between having secure food sources and an urban-ecology, which has become important in many cities.

The green belt strategy, developed to control the pressure of urban expansion and meet the need for recreational areas near cities, with the disappearance of semi-natural landscapes, is reported to be impractical (Barker, 2006). However, the green belts in the cities where this strategy was implemented were not used even for recreational purposes (Bakhtiari, Jacobsen, & Jensen, 2014; Žlender & Thompson, 2017). Academic studies show that this type of application not only caused an increase in land rent, but also made the lands unusable and made no contributions to the protection of rural characteristics and the efficient urban–rural interactive. The studies evaluating urban–rural interactions show that the urban periphery is about to lose its identity and, therefore, has an eclectic character (Nilsson, Pauleit, Bell, Aalbers, & Nielsen, 2013). For such reasons, the protection of the urban periphery and rural character has become a serious matter. Based on the integration of urban and rural areas that underlies much of spatial planning, strategic approaches for the planning of interaction of urban and rural areas are now in development via EU projects (e.g. The PURPLE network) (www.purple-eu.org, 2017; Žlender & Thompson, 2017).

As an alternative to a green belt to control urban sprawl, this study investigated the agricultural belt approach that is being debated for the semi-rural, small-scale city, Bartın. Weber (2012) defines cities that have agriculture-based economies as 'semi-rural' by classifying them according to their economic production structures. He describes 'semi-rural' cities as functioning as typical urban trade centres where there is market traffic and townspeople who have settled throughout a large area and whose livelihoods largely depend on agriculture, including producing food for sale. He also describes semi-rural cities as being clearly different from average cities.

In this study, Bartın is regarded as a 'semi-rural' city because it has an agriculture-based economy. However, studies about the city have revealed that it faces the risk of losing its agricultural features. Cengiz (2014) identifies that the most suitable areas for agriculture cover 81.403 km^2 and that settlements are spread across these agricultural lands. Gökyer (2009) states that as urban development areas spread across agriculturally suitable lands and floods affect agricultural areas in Bartın's central district, landscape fragility has increased in these areas. Çelik and Murat (2009) mention that it is possible to produce alternative agricultural products, but that this opportunity has not been exploited. According to Yılmaz and Atik (2006), although Bartın's climatic conditions are suitable for agricultural activities, these conditions have been mostly ignored and arable lands have been misused. Based upon these studies, it is concluded that the arable lands in Bartın have been misused. The economy can be recovered by transforming these areas into cultivated lands, and it is necessary to expand agriculture in ways that connect fragmented agricultural areas and encourage cooperation.

Thus, it is necessary to observe land transformation, especially in rapidly sprawling, expanding and developing cities. Techniques such as remote sensing, geographic information systems and landscape metrics have been used to observe the vertical and horizontal relationships of land transformation in cities and to produce planning policies. The effects of land transformation on cities' production characteristics can be determined by associating demographic and economic parameters with spatial data values acquired through these techniques.

The purpose of this study is to provide a model for an 'agricultural belt' aimed at achieving sustainability for the semi-rural identity of Bartın. Thus, the study (i) depicts the agricultural potential of Bartın's city centre; (ii) determines the temporal (1985 and 2015) and spatial values of land transformation (especially in agricultural areas) caused by urbanisation pressure; (iii) presents a study on landscape pattern changes; and (iv) evaluates optimal approaches for an agricultural belt. As a result of these evaluations, the concept of an 'agricultural belt' is suggested as a planning principle to protect 'semi-rural' city characteristics and to control urban sprawl. The study has three parts: periodic determination of land change, assessment of existing land use plans and development of a model to build an agricultural belt.

2. Materials and methods

2.1. Study area

Bartın, a small-scale city in Turkey, is located on hills 12 km from the coast and bordered on three sides by the flora of the Kocaçay and Kocanaz water courses, which comprise small streams that create the Bartın River. The average height is 25 m. This study includes Bartın city centre's municipal boundaries and its surroundings (the adjacent area). The total municipal boundary is 35.6 km^2, and the adjacent area is 132 km^2 (Figure 1).

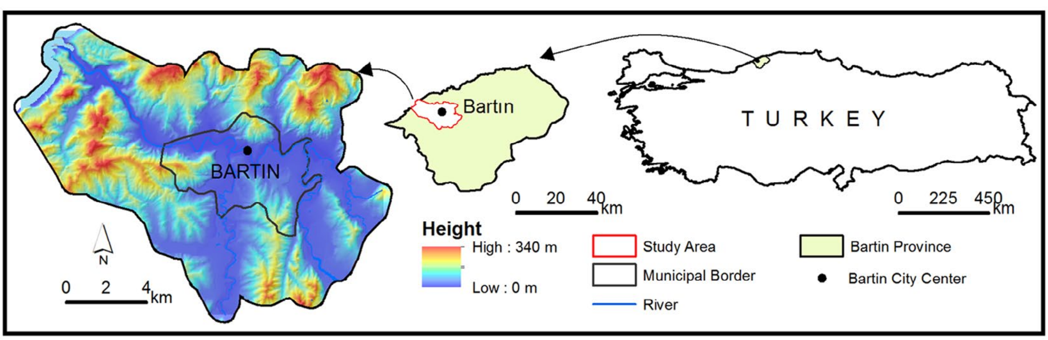

Figure 1. Location of study area. Source: The Authors.

According to the 2014 census, the total provincial population was 189 139 and the population of the city centre was 61 289 (Türkiye İstatistik Kurumu/TUİK, 2014a). Comparisons of the population census from different times show that provincial populations have tended to decrease and that the city centre population appears to have increased. There are 32 villages in the Bartın adjacent area and 10 districts within its municipal boundaries. Area field studies and regional studies observed that agricultural potential is high around the city, but that agricultural areas are threatened by urban sprawl.

2.2. Land use/land cover analysis

Land use/land cover analysis utilised Landsat 5 TM and Landsat 8 OLI satellite images dated 07/1985 and 07/2015, obtained from the U.S. Geological Survey with an image track number of P178 R31. Both images have a 0% cloudiness rate. After Landsat satellite images of the study area were accessed from 1985 and 2015, atmospheric correction was used to remove system errors and minimise effects from atmospheric particles in the images (Balçık et al., 2011).

Classification pre-treatments in the study were conducted using ENVI. After the region of interest (ROI), including descriptions of the land use and land cover (LULC) in the area were identified, spectral attribute files were created for each LULC category. Using the image data from these attribute files, the images were classified using a maximum likelihood algorithm in a controlled manner. The overall accuracy and kappa coefficients for the classification results by year are: 1985 overall accuracy 88.56% and kappa coefficient 0.844; and 2015 overall accuracy 89.23% and kappa coefficient 0.8539

As a result of the classification, six LULC classes were generated: arable land, permanent cropland, woodland, construction land, water surfaces, sea and beaches. While arable lands represent cultivated areas such as greenhouses, fields and gardens, permanent cropland signifies land cultivated with crops that occupy the land for long periods, such as for hazelnut or poplar vegetation. Construction lands are roads, industrial areas, infrastructure and super structure and constructed areas such as cities. Analysis in this study was focused on the change in direction of arable land, cropland and woodland. Therefore, changes in these LULC patterns between 1985 and 2015 were emphasised. In particular, any LULC changes around the city of Bartın were highlighted

2.3. Landscape metrics

With the aim of displaying the change in the habitats and to define landscape characteristics around Bartın, landscape pattern metrics were calculated. From past to present, change in habitat health is of importance as an indicator of a future change. Therefore, UNIX based FRAGSTATS v4.2 (MCGarigal & Marks, 1994) was utilised. The metrics used to measure landscape composition and the structure of land use and land cover in 1985 and 2015 were selected at both a class and landscape level: number of patches (NP), patch density (PD, n/100 ha), largest patch index (LPI, %), edge density (ED, m/ha), landscape shape index (LSI), mean patch area (AREA_MN, ha), mean shape index (SHAPE_MN), mean euclidean nearest-neighbour distance (ENN_MN), total edge contrast index (TECI, %), mean edge contrast index (ECON-MN, %), interspersion and juxtaposition index (IJI, %), effective mesh size (MESH -ha), splitting index (SPLIT), aggregation index (AI, %), Shannon's diversity index (SHDI) and Simpson's evenness index (SHEI). Further information about the metrics is available from (Botequilha Leitao & Ahern, 2002; McGarigal, 2002; McGarigal & Marks, 1994; Botequilha Leitao, Miller, Ahern, & McGarigal, 2006).

2.4. Construction of agricultural belt model

Agricultural land evaluation classification was undertaken according to the FAO (1976 and 2007) system to assess the suitability of the studied area soils for arable land and development. The methodology flow chart for both agricultural suitability and most aggregated agricultural areas are shown in Figure 2.

Figure 2 shows the agricultural belt is approached in three steps: the first developed an 'Agriculture Suitability Model' that shows the most suitable lands for agriculture. The second step used the 'Most

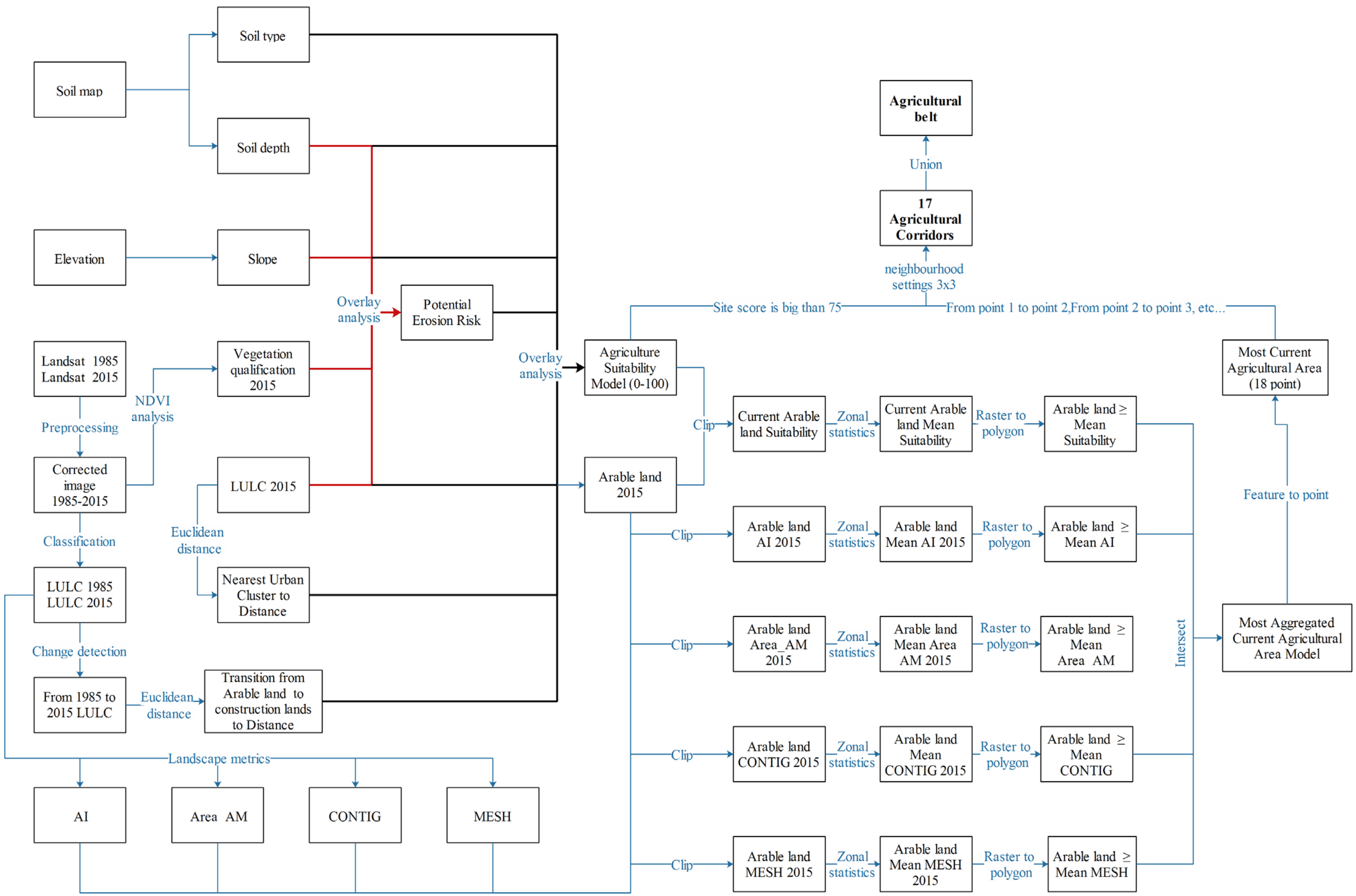

Figure 2. Flowchart for generating an agricultural belt.

Aggregated Current Agricultural Area Model' to reveal the least fragmented parts of current agricultural lands. The third step determined an appropriate 'Agricultural Belt'.

2.4.1. Step 1: Agricultural suitability model

The following layers were used in this model: distance to nearest urban cluster, distance to transition from agriculture (arable land and permanent cropland) to construction land, potential erosion risk, slope, soil depth, soil type and LULC in 2015. The layer of 'Potential Erosion Risk' used in this step was a result of weighted patching of the layers of slope, soil depth, NDVI and 2015 LULC layers obtained from Landsat 2015 satellite image (Table 1).

The Agricultural Suitability Model was obtained through the weighted patch of layers mentioned above and re-scaling of the maps between 0 and 100, which received a value 1–9.

2.4.2. Step 2: Most aggregated current agricultural area model

The agricultural lands of 2015 were used to create 'the most aggregated current agricultural area model'. Depending on this, the areas where intensive clustering existed in the current agricultural lands, namely the less fragmented areas, were determined by using landscape metrics such as aggregation index (AL, %), area weighted patch area (AREA-AM), contiguity index (CONTIG) and effective mesh size (MESH, ha) taking into account both arable land and permanent cropland. An Agricultural Suitability map was also included in the analysis to cover the most suitable agricultural lands obtained from Step 1 while determining the most aggregated current agricultural area. The moving window analysis of the FRAGSTATS programme was used to achieve spatial metric values. Four of our landscape-level metrics—the same as those for the global landscape—were used by employing a 500 m radius (window size). In this step, the average slopes of the current agricultural lands according to AI, Area AM, Contig Mesh and Agriculture Suitability Model were determined by using a zonal statistics tool.

After determination of an average trend for current agricultural lands, they were reclassified according to whether they are equal to or above the average trend, using a map algebra tool. The most suitable areas were determined through overlap of data of AL, AREA-AM, CONTIG, MESH and Agricultural Suitability belonging to a reclassified agricultural area. These areas were converted into polygons. Eighteen agricultural nodes were determined by designating points in the centres of areas

Table 1. Evaluation scale of the parameters.

Layers	Classes	Code	Leyers	Sınıf	Puan	Leyers	Sınıf	Puan
Nearest Urban Cluster to Distance	0–150	1	Transition from agriculture to build up to Distance	0–150	1	LULC 2015	Arable land	5
	150–600	3		150–600	3		Beach	1
	600–1200	5		600–1200	5		Construction Land	1
	1200–2400	7		1200–2400	7		River	1
	2400<	9		2400<	9		Sea	1
Potential Erosion Risk	No risk	9	Soil depth	Low	1		Permanent Cropland	9
	Medium risk	5		Modarate	5		Woodland	9
	High risk	1		High	9			
Slope	0–2%	9	Soil type	Alluvial soil	9			
	2–6%	8		Grey brown podzolic soil	2			
	6–12%	7		Red yellow podzolic soil	4			
	12–20%	5		Brown forest soil	7			
	20–30%	3		Non-calcareous brown forest soil	5			
	30<	1		Non soil disturbed soil	1			

that were turned into polygons. These 18 nodes represent the most suitable areas in terms of agricultural production and are areas where the least fragmentation is seen in terms of current agricultural activities (Figure 3).

2.4.3. Step 3: Agricultural belt

The agricultural corridors were formed by using these 18 nodes that show the centres of the most suitable areas obtained in the Agricultural Suitability Model (ASM) in Step 1 and in the current agricultural lands in Step 2 (Figure 3). Accordingly, among the 18 agricultural nodes, 19 corridors were formed that take into consideration areas whose values are 75 and above in the ASM. In this analysis, a moving window was used according to a 3 × 3 neighbourhood relationship. A single agricultural belt was acquired after combining the obtained corridors (Figure 3). 'Land Facet Corridor Tools', a free ArcGIS extension available from Jenness Enterprises (Jenness, Brost, & Beier, 2013), was used to create a corridor that was obtained from 17 agricultural nodes.

3. Findings and discussion

3.1. Agricultural potential

The types and rates of agricultural production within the districts and villages of the Bartın adjacent area and its municipal border, as of 2012, were obtained from the Ministry of Food, Agriculture and Livestock Village Information System (Türkiye İstatistik Kurumu/TUİK, 2014b). Because the greenhouse cultivation data came from the year 2006, they were evaluated independently from the 2012 data. In the above mentioned system, some farmers had formally applied for a farmer's certificate, while others had not enrolled in the system, with the number of the latter unknown. These data report that in the study area, the rate of cereal crops was 36.99%, feed crops 19.26%, fruit production 40.31% and vegetable production 3.42%. There were 2,890 greenhouses in the adjacent area, and the agricultural crops grown in the area contributed to both local and home economies. Among the women who came to the Bartın Women's Bazaar (where women sell agricultural products; open on Tuesdays and Fridays in Bartın's city centre) from the districts and villages in Bartın's adjacent area and municipal boundaries, 40% came from within the municipal boundary to sell their agricultural products in 2004, 6.6% came from the municipality including the adjacent area and 53.3% came from the adjacent area. In 2007,

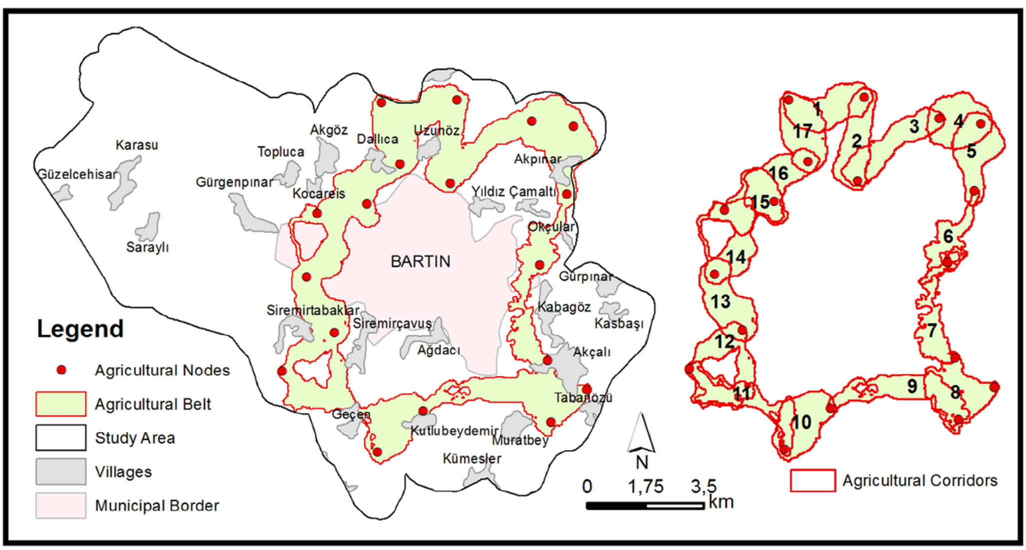

Figure 3. Distribution of 2015 agricultural nodes around Bartın city. Source: The Authors.

34.58% of the participating women came from within the municipal boundary, 22.93% came from the municipality including the adjacent area and 42.95% came from the adjacent area. In 2011, 30.92% of women came from within the municipal boundary, 26.11% came from the municipality and the adjacent area and 42.95% again came from the adjacent area.

Agricultural potential is relatively high in the study area. The production figures are as follows: in settlements within the municipal boundaries, 9.73% of what is produced are crops; 11.66% are feed crops; 3.08% are fruits; and 6.69% are vegetables. In the settlements both within the municipal boundaries and in the adjacent areas, 2.89% of land is devoted to crops, feed crops comprise 3.35%, fruits 1.81% and vegetables 3.27%. Meanwhile, in adjacent villages the percentages are 83.37% crops, feed crops 84.98%, fruits 95% and vegetables 90.02%. Greenhouse production is 5.09% within municipal boundaries, 32.36% within the municipal boundary plus the adjacent area and 62.53% in the adjacent area (Table 2). Distance from the city does not affect the types of agricultural production, and distance from the bazaar also does not affect which women come to the bazaar.

3.2. Risks in agricultural areas

Many reasons for not using agricultural potential and for the pressures on agricultural areas have been emphasised in studies related to Bartın. In the first Five Year Development Plan, a complicated industrial project was planned in the Zonguldak Zone (Görmüş & Artar, 2010). The project was based on the mining and iron-steel industries, with agricultural areas considered to be of secondary importance. Because industrial areas are located around agricultural lands, agricultural areas were affected spatially in relation to choices for optimum industrial sites. As a result of industrial development, migration from rural to urban areas transformed agricultural areas into non-functional areas and forests. Moreover, housing needs in urban areas also further transformed agricultural lands into construction sites.

The 'Western Black Sea Coastal Corridor', which is defined as an ecotourism region in the 'Tourism Strategy Action Plan of Turkey', describes a structure that aims to serve metropolises such as Istanbul and Ankara (Kültür ve Turizm Bakanlığı, 2007). This strategy is considered to be the cause of the increased construction in Bartın. Although the 'Zonguldak-Bartın-Karabük Regional Development Project' is mentioned in Turkey's National Rural Development Strategy, there has been no considerable development related to the project.

Unplanned urbanisation, uncontrolled housing and lack of improvement in agricultural potential have been cited as significant problems with the project (Görmüş & Artar, 2010). The area's expansion rates, selection of optimum sites and the types of urban growth are important elements in Bartın's urbanisation (Turoğlu & Özdemir, 2005). The city often suffers from flooding because of geomorphological factors that were ignored when it was being selected as an optimum site. These are arable lands. Microbial mass, which indicates soil fertility and microbial diversity, is low in the planted areas, a situation that can result from agricultural techniques and pesticides. Unless adequate measures are taken, the soil is likely to lose more of its fertility in the future (Kara & Bolat, 2008). As a result of the negative effects of the current uses of Bartın's construction lands and the settlement areas around it, sensitive areas have expanded. Ecological and biological recovery needs to be studied in the mentioned areas as prominent issues in planning processes. It is necessary to evaluate the eligibility of land uses in planning processes (Çelikyay, 2005).

3.3. Urban sprawl caused land transformation

Around the city of Bartın, the rate of construction lands increased from 3.4% to 6.8%; however, agricultural lands and permanent cropland decreased. Woodlands were another important landcover in the area. Woodlands increased because of unused farmlands. Figure 4 and Table 3 indicate that construction lands are distributed along areas that are arable land and permanent cropland. Therefore, green spaces are highly fragmented around the centres of the construction lands. The agricultural cover decreases from the countryside areas it gets closer to the construction lands. This progression shows

Table 2. Agricultural production potential.

	Village/District	% Share of production in village/district boundary (in) Total production × 100/(in) Total village/district area	% Share of cereal production in the village's total production.	% Share of feed crop production in the village's total production.	% Share of fruit production in the village's total production.	% Share of vegetable production in the village's total production.
Districts within the Municipal Boundary	Ağdacı	12.62	53.35	13.44	27.96	5.23
	Aladağ	9.81	100	0	0	0
	Balamba	42.96	53.09	34.25	10.06	2.57
	Gölbucağı	13.09	56.21	31.62	12.15	0
	Karaköy	19.34	21.32	42.55	34.06	2.05
	Kemerköprü	0	0	0	0	0
	Köyortası	0	0	0	0	0
	Orduyeri (mah)	2.62	0	0	100	0
	Şiremirçavuş	19.16	36.21	42.47	19.77	1.52
	Tuna	2.4	0	0	0	100
Villages in Municipal Boundary + Adjacent area	Dallıca	9.96	34.54	20.66	39.03	5.74
	Kocareis	9.27	23.72	2.76	71.17	2.32
	Kutlubeydemirci	7.09	57.46	24.78	12.15	5.60
	Şiremirtabaklar	7.88	36.04	45	16.69	2.25
	Uzunöz	11.31	58.16	7.67	24.14	10.02
	Yıldız	4.71	54.04	8.09	35.79	2.06
Villages in Adjacent Area	Akçalı	19.41	58.81	23.07	17.34	0.76
	Akgöz	23.917	36.32	1.64	50.46	11.56
	Akpınar	9.87	74.06	10.12	10	5.79
	Budakdüzü	7.70	59.66	27.56	7.28	5.47
	Çamaltı	18.39	63.27	26.61	7.34	2.76
	Epçilerkadı	290.60	38.64	56.71	3.39	1.24
	Gecen	16.40	62.06	21.79	14.57	1.56
	Gürgenpınarı	8.05	12.05	0	78.38	9.55
	Güzelcehisar	209.21	12.08	0.004	82.45	5.45
	Kabagöz	24.11	50.37	43.74	4.22	1.65
	Kaman	0.94	62	2.45	33.06	2.48
	Karasu	32.64	4.74	0	87.02	8.22
	Kaşbaşı	29.81	50.2	44.54	4.58	0.66
	Kazpınarı	6.82	6.04	0.44	91.07	2.44
	Kümesler	10.26	61.39	33.01	5.1	0.48

(*Continued*)

Table 2. (*Continued*).

Village/District	% Share of production in village/district boundary (in) Total production × 100/(in) Total village/district area	% Share of cereal production in the village's total production.	% Share of feed crop production in the village's total production.	% Share of fruit production in the village's total production.	% Share of vegetable production in the village's total production.
Muratbey	6.61	58.01	3.91	16.13	21.93
Okçular	7.49	53.16	44.94	1.38	0.51
Saraylı	6.11	32.89	0.91	62.49	3.7
Şahne	8.98	21.85	55.27	12.38	10.49
Kutlubeytabaklar	143.03	59.52	32.81	5.69	1.96
Tabanözü	190.33	63.05	31.16	3.73	2.05
Terkehaliller	64.54	69.28	12.51	15.56	2.64
Topluca	1.69	32.4	4.12	60.19	3.26
Tuzcular	12.32	55.02	19.8	14.54	10.61
Uğurlar	59.66	24.51	4.62	68.48	2.37
Yeşilkaya	37.86	45.72	14.19	39.56	0.51

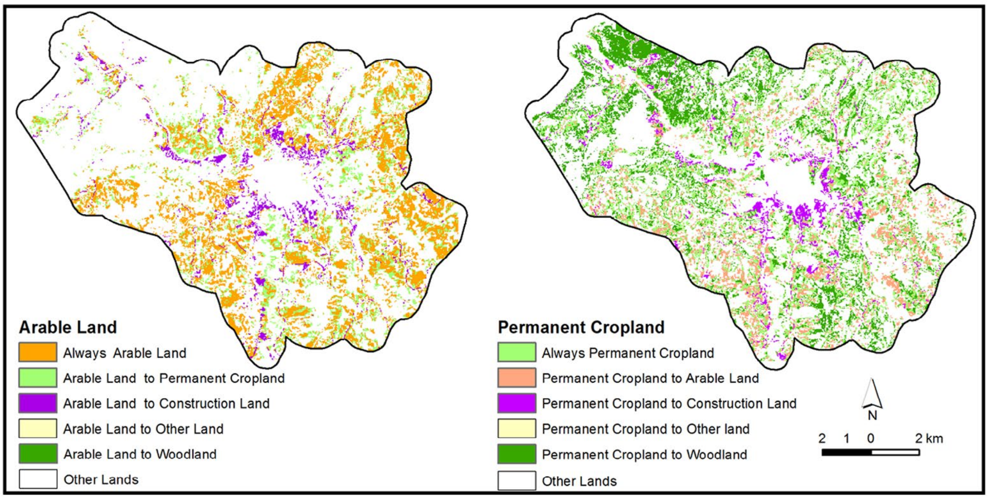

Figure 4. Maps of change detection of arable lands and permanent croplands. Source: The Authors.

Table 3. Change detection ratio (%) derived from the land use/land cover map of 1985–2015.

Land use /land cover	Arable Land	Permanent Croplands	Woodland	Construction land	Others
Arable Land	**53.6**	27.0	8.9	9.8	27.0
Permanent Croplands	21.3	**34.9**	35.6	7.8	0.3
Woodland	2.8	7.7	**87.7**	1.7	0.1

that between 1985 and 2015, agricultural lands decreased by 45.7% and these areas were covered with either permanent croplands or wooded areas, or by construction lands. Additionally, along with the construction lands, although some parts of the permanent croplands were converted to woodlands, others were opened to settlement.

Analyses show that in the 30-year period between 1985 and 2000, permanent croplands decreased by 64.7%. This is a dramatic change. Furthermore, the percentage of permanent croplands that became woodlands was 35.6%. These areas are unused nut farmlands. It is clear that from 1985 to 2015, the direction of change was permanent croplands to woodlands. Although permanent croplands have decreased, woodlands have increased together with construction lands. Previously, permanent cropland areas have been transformed into settlement areas as they approach the city, and those that are distant from the city have been left as woodland (Table 3; Figure 4).

3.4. Characteristics of the landscape pattern change

Landscape characteristics around the city of Bartın were revealed through landscape metrics (Tables 4 and 5). Construction lands reflected a real increase in 2015 and can be said to be more compact compared to that of 1985. Agricultural lands between the unplanned and scattered settlements turned into construction areas and constructed area sketches are adjacent to this road. The sprawl in the last 30 years appeared in all groups based on NP and PD values. Fragmentation and the highest tendency for sprawl were in permanent croplands and the least sprawl tendency was in arable lands. Disorganisation in arable lands in 2015 decreased from 1985. Arable land areas that were disorganised, and not features of corridors, were easily influenced by the pressure of construction due to planning regulations. LSI values indicate that the links between permanent croplands are gradually being disconnected. Fragmentation in permanent croplands also affects the distribution of habitats according to MESH values. This can also

Table 4. Class-level indexes from 1985 to 2015.

	LULC type							
	Arable land		Permanent croplands		Woodland		Construction land	
Metrics	2014	2015	2014	2015	2014	2015	2014	2015
NP	1510	1573	1248	2558	1274	1515	37	195
PD (n/100 ha)	5.46	5.69	4.51	9.25	4.61	5.48	0.13	0.71
LPI (%)	3.30	2.88	3.71	0.75	2.97	4.29	2.69	6.03
ED (m/ha)	65.70	58.15	86.29	84.21	28.58	42.57	11.89	16.48
LSI	63.14	59.68	76.44	92.37	39.22	41.96	26.66	26.42
AREA_MN (ha)	3.51	2.95	4.98	1.57	2.05	3.38	25.71	9.61
SHAPE_MN	1.42	1.36	1.49	1.51	1.25	1.28	2.69	1.32
ENN_MN	77.35	80.59	73.48	70.58	107.61	91.15	202.87	136.77
TECI (%)	98.63	98.66	98.87	99.29	98.46	97.79	99.77	99.46
ECON-MN (%)	98.63	98.99	98.26	98.78	99.25	98.71	99.91	97.54
IJI (%)	39.37	44.36	49.08	52.38	11.94	35.25	66.36	64.85
MESH (Ha)	43.71	44.75	96.61	5.75	27.15	85.87	20.34	100.47
SPLIT	632.40	617.72	286.12	4811.42	1018.23	321.89	1359.09	275.13
AI (%)	74.22	74.02	71.17	56.41	77.39	82.73	74.75	82.24

negatively affect the urban habitat as permanent croplands are adjacent to constructed areas. Thus, it is important to prevent fragmentation in order to improve the quality of city life.

When examining forms in the landscape, the increased disorganisation becomes apparent. The shapes of landscape for permanent crops became more disorganised, especially in 2015 compared to 1985. There is a remarkable tendency for organisation in the shape of construction lands. The increase, especially in SPLIT for permanent croplands signifies the severity of fragmentation. While aggregation rises in woodlands and construction lands, it decreases in arable lands and permanent croplands. This shows that there are woodlands where a real growth is seen. Similarly, LPI goes up in construction lands and woodlands, while going down in the others. TECI and ECON showed that the edge contrast of land use groups is rather high.

Changes at the landscape level are shown in Table 4. In the study area the number of patches and patch density area increases. However, considering the LPI in this context, 4% of the landscape was covered with a single patch in 1985, while this percentage was 6% in 2015. This large patch consisted of construction lands in both periods. In Bartın, urban sprawl has continued to expand from the inner city to the city fringe, ignoring natural, rural and agricultural landscapes. Along with this expansion, high-value agricultural areas have destroyed a considerable portion of natural habitats that have biodiversity value. This type of urban sprawl has a significant impact on the occurrence of these negative cases. Because of this sprawl, the largest patches of the construction lands are increasing. According to ENN-MN, the same habitats grew closer in the period 1985–2015. Similarly, MESH decreased during the period 1985–2015. From 1979 to 1985, Patch types are more interspersed. This shows decreasing numbers of neighbours of the same patch type within the specified search radius.

The shape index exhibits an increasing trend, showing that the shape of the overall landscape became more irregular. SHDI exhibited an increasing trend, which shows that spatial heterogeneity was increased because the scattered arable lands and permanent croplands fragmented. The SHEI value showed an improvement, indicating that major landscape types no longer played a dominant role, and the average patch area became similar and the patches tended to have a uniform distribution. The indices report that the maximum evenness of the area's distribution was 70% in 1985 and 75% in 2015. The fact that index values in the landscape are not too high indicates an irregular distribution of different patch types in the area.

According to theories about urban sprawl and the temporal and spatial data for the city of Bartın, urban sprawl occurs both cumulatively and expansively in cities. An accumulation policy has caused 'fragmentation' in inner-city open areas, especially in inner city and city fringe agricultural areas. Inner-city agricultural areas have become settlement areas because of accumulation. City fringe agricultural

Table 5. Landscape-level indexes from 1985 to 2015.

Year	NP	PD	LPI	ED	LSI	AREA-MN	SHAPE-MN	ENN_MN	TECI	ECON-MN	IJI	MESH	SPLIT	AI	SHDI	SHEI
1985	4768	17.2	3.7	102.9	43.8	3.4	1.4	96.6	95.2	98.8	45.7	198.2	139.5	73.8	1.46	0.7
2015	5863	21.2	6.0	103.6	44.0	2.8	1.4	82.1	95.3	98.8	50.3	240.5	114.9	73.6	1.47	0.8

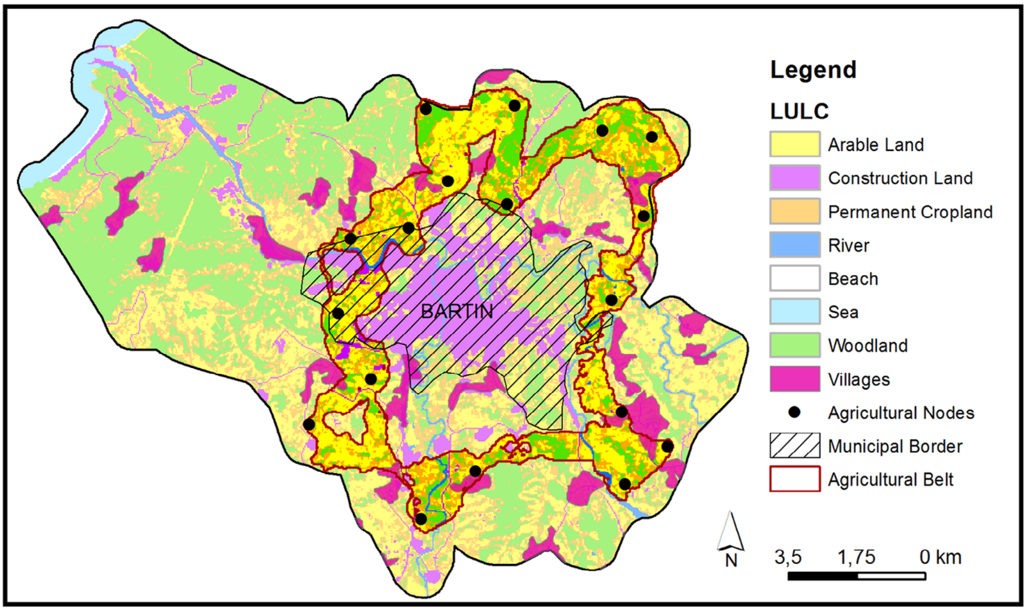

Figure 5. Agricultural belt proposal. Source: The Authors.

areas have been fragmented with 'edge density growth' from the centre to the fringe. The scattering of individual properties, and their small sizes, have also affected the overall fragmentation process.

3.5. Creation of the agricultural belt

In this study, the concept of an agricultural belt is proposed to protect the semi-rural city and agricultural landscape characteristics of Bartın city (Figure 5). This suggested agricultural belt will ensure control over urban sprawl as well as agricultural areas. 'The agricultural belt' approach, based on a 'green belt' approach, must be evaluated together with 'service area restrictions' and 'land consolidation' practices. As is known, green belt and 'service area restrictions' have been enacted in many cities around the world to prevent the pressure of urban sprawl on ecological balance, environmental conservation and recreational areas. Land consolidation refers to agricultural parcelling that aims to increase agricultural production costs, conserve the soil and consolidate small areas in order to ensure ecological balance. Since 2005, Turkey's Soil Conservation and Land Use Law (number 5403) has recommended land consolidation.

The total area of the suggested agricultural belt is 32.4 km^2, with a perimeter of 127.3 km. It is comprised of a total of 19 corridors, with a minimum of 1.7 km^2 and maximum of 2.9 km^2 (Figure 5). 46.5% of this area is arable land; 30.6% (992 ha) are permanent croplands, and 17.9% (582 ha) is woodland. Only 3.1% (100 ha) are construction lands. Inside the belt, 1.9% (62 ha) are rivers. Wetland plants throughout the belt have the function of providing connectivity in the belt. Construction land of 3.1% in the belt is important in terms of the suitability of the belt. These constructed areas are usually the service areas. Another important consideration is that woodland is comprised of agricultural waste lands around Bartın. The belt combining the agricultural nodes where the current fragmentation is low, considering the most suitable agricultural lands, will lead to the efficient use of old agricultural lands. As such, agricultural activities in the belt would improve in the following period.

In the low-density cities where agriculture is an important source of income, the agricultural belt approach concentrates attention on food production, and providing its sustainability with ecological techniques can ensure a positive interaction between the urban and rural areas. It is known that the majority of land-planning decisions are made in favour of construction for the purpose of fast economic growth, especially in developing countries. Therefore, the use of a green belt approach, causing an increase in land rent in these countries, brings about serious risks. An agricultural belt approach will not allow a land rent because it is based on agricultural production. Moreover, an agricultural belt is not only a physical barrier for urban sprawl but also an approach that avoids the pressure of construction in rural areas, protects the rights of residents making their livings from agriculture, ensures the continuity of active rural life and protects the characteristics of urban and urban periphery. An agricultural belt promotes the protection of proprietary rights of people who work in agricultural production. Also, the forest areas in the periphery of cities contribute to the protection of water surfaces and open green areas and help protect the biodiversity of urban and rural landscape.

In this study, the proposed agricultural belt approach supports the approach of 'continuous manufacturing landscapes' in the urban planning scale (Viljoen, Bohn, & Howe, 2005). The integration of both approaches is considered to be an efficient model in urban landscape planning and could make great contributions to the survival of active rural life characteristics and an agriculturally productive society. The incremental loss of rural characteristics, due to the ignored soil-based production as a result of global competition and conventional agricultural knowledge, and the sharp and negative progression in the interaction of rural and urban areas, may trigger the development of preventive and protective alternative spatial planning both in Turkey and similar countries.

4. Conclusion

The effect of urban sprawl on the semi-rural characteristics of the city of Bartın from 1985 to 2015 was studied using RS, GIS and landscape metrics. Moreover, an agricultural belt was proposed based on agricultural suitability, agricultural potential and agricultural aggregation.

A lack of awareness regarding the importance of natural topography on the part of educational institutions, medical establishments, small-scale industrial areas and in planning for the construction of public highways (which can now reach the settlements with high tourism potential) have contributed to the uncontrolled urban sprawl in Bartın. Before planning (before 1978), the city was predominately agricultural (the inner city and city fringe areas were used as middle-sized agricultural parcels and vegetable and fruit gardens). Using microforms that were completed by the Provincial Bank in 1978, service corridors were built along with highway crossings. Service corridors caused urban settlement areas to accumulate in agricultural areas along the city's fringes, and they have been the leading cause of the area's urban sprawl. As a result, housing began to expand into agricultural areas.

The example of Bartın shows how quickly even small-scale, agriculture-based cities that were once considered to be 'semi-rural' ceased agricultural production due to urbanisation. The relationship between agricultural areas and urban sprawl is that one destroys the other while expanding. Conceptualising the relationship between the two is not difficult, but it is still complicated. The difficulty in conceptualising the relationship between agricultural areas and urban sprawl results from the rapid changes to societies and economies and to the many sub-components of the relationship. We believe that after a few years, this agricultural belt will improve the semi-rural characteristics of the city of Bartın.

Urban sprawl theories and the laws in Turkey have the capacity to support this implementation. The 'agricultural belt' approach should definitely be considered for controlling land transformation and urban sprawl and especially for conserving the rural and agricultural characteristics of 'semi-rural' cities. Agricultural belts can be regulated in Turkey based on Construction Law 3194, Soil Conservation and Land Use Law 5403 or the Municipal Law.

The European Commission Green Paper on the Urban Environment, published in 1991, states that urban sprawl causes fragmentation and represents a system of economic, social, cultural and political dynamics within cities and their surroundings (The European Commission, 2015). The European Spatial Development Perspective (European Environment Agency, 2016) explicitly states that the quality of rural areas around urban areas has decreased as a result of uncontrollable sprawl. The European Environment Agency and European Commission, in a joint declaration published in 2006, stated outright that new visions were necessary for the spatial development of European cities and regions, and that these visions were possible with policy developments.

While urban planning practices in European cities and urban planning practices in developing countries are made within the same approach, the applications are very different from each other. In developing countries, the construction sector has become a sector important to the survival of many countries' economies. As such, agricultural areas were placed secondary in the quest for development of industry.

In sum, a green belt and planning approach are not enough to control urban expansion. Areas around these corridors will continue to rise further and encourage urban expansion. Unlike the green belt, with an agricultural belt approach, the land would not create an increase in rent, so it might be necessary to have a new vision of planning to control the urban sprawl. Importantly, reorganisation of the urban rural relationship with an agricultural belt is a step that can ensure that urban planning policy is more democratic and has the potential to overcome the effects of the construction market on the common culture of life. Although strategies like the green belt which aim to promote the ecological comfort of a city are important, it is clear that they are unable to protect ecological production conventions, namely cultural identity. Therefore, it cannot be implemented as a universal urban planning strategy. In countries that are different from European countries in many respects, this strategy will make these areas a centre of attraction for urbanisation and not provide recreational and ecological benefits. It will be more significant to adopt the agricultural belt, which is loyal to cultural and community contexts rather than standard urban planning principles, as an urban planning strategy that controls urban sprawl.

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