SPARD

Spatial Analysis of Rural Development Measures
Contract No. 244944

Work Package No. 5	
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D5.2 Estimated models in case study areas	

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COOPERATION

1 Content

2 Summary and Main Findings

2.1 General

– Observation of partly **low general participation** and rather **skewed value distribution** (especially for expenditures)

– **Spatial econometric analysis not significant** and meaningful for spatial distribution due to low spatial lag (rho) and spatial error (lambda) values for all measures with minor exceptions for measure 311 and 322 indicate only limited neighbourhood effects (between municipalities)

– **Methodological issues**: unequally sized and shaped municipalities; low number of farm holding per municipality; large farm sizes and data confidentiality issues

– **Regional framework conditions** to explain value distribution: **13 factors** have been identified, including urbanisation, tourism, working, forest & LFA, large scale agriculture, grazing, horticulture and co-operative farming

– **Other forces are in place**, which determine the success, the effectiveness of certain RDP measures (e.g. regional framework conditions, personal attitudes, initiatives, local community)

– **Question of the spatial level of decision-making**: large co-operative farm holdings dominating the primary sector

2.2 Measure 121

– Found mostly in peripheral, rural communities and in areas of good soil quality (57 % of all municipalities)

– Uneven distribution with strong concentrations pattern in some municipalities

– Determining factors for participation "co-operative farming" (0.87), "large-scale agriculture" (0.46) and "tourism" (0.62)

2.3 Measure 214 (Organic farming)

– Frequent participation in high nature value areas (under nature conservation measures) → Image/place-making eco-region?

– Determining factors for participation "Co-operative farming" (0.58), "Forest & LFA" (0.58) and "Horticulture" (-0.44)

2.4 Measures 311

– Rather seldom uptake (participation in only 12.6 % of all municipalities)

– Expenditure concentration in the proximity of Berlin → consumption countryside?

– Determining factors for participation "Grassland Management" (0.60) and "Working" (0.37), whereas the latter strong influence on expenditure rate

2.5 Measure 313

– Implementation in areas of touristic interest, but also close to urban centres (40.3 %)

– Determining factors for participation "Tourism" (1.35) and "Arable Production" (-0.55) as well as "Urban & Economic Development" for expenditure rate

2.6 Measure 322

– Strong expenditure concentration in the rural North-west and North-east

– Exclusive phenomenon of the rural periphery with clear political targeting (44.4 % of all municipalities)

– Determining factors for participation "Urban & Economic Development" (-0.53) and "Peri-urbanisation" (-0.44) as well as "Water & FFH" for expenditure rate

3   Introduction

- The case study region of Brandenburg is characterised by its specific situation of (i) average large farm holdings of 237.05 ha UAA per holding (2010), (ii) a strong urban centre – rural periphery slope from Berlin into the remote rural areas of the Federal state of Brandenburg as well as (iii) a relatively homogeneous distribution of bio-physical and landscape conditions (low soil fertility, northern German lowlands). With 75% a large share of the agricultural area is designated a less-favoured area (LFA).

3.1   Data Base

3.1.1   Farm Structure Survey 2007 and Agricultural Census 2010

- Source: Farm Structure Survey 2007 / Agricultural Census 2010
- Aggregated at municipality level by German Federal Statistical Office
- Information on 410 of 419 municipalities in Brandenburg (the missing cases are due to administrative reforms)
- Large share of data confidentiality / privacy cases (less than 3 cases (holdings) in municipality) → to use also this data to prevent large data gaps, cases with less than 3 holdings have been used as value 1.5 (the medium value of the possible values 1 and 2)

3.1.2   Statistical Census Data

- Source: Federal Statistical Office
- Years 2006 – 2009 (earlier data available)
- Information on population, demographic structure, migration, employment, tourism and touristic infrastructure, secondary sector (firms, employees, wages), municipal tax revenues (income and business tax), housing development (incl. permits and construction)
- Information on land use (artificial surface, agriculture, moor and heath, forest, water)

4   RDP 2007-2010 – Descriptive Statistics and Spatial Distribution

4.1   Data Base

- Source: Beneficiary database Ministry of Agriculture Brandenburg, aggregated at municipality level
- Years: Measures 121, 311,312, 322: 2007-2010; measure 214: 2007, 2010
- Information on projects (number and type), expenditures, EU, German Federal and Brandenburg state contribution
- Participation in a particular RDP measure is calculated by number of projects related to the number of holdings, as only figures aggregated for entire municipalities (NUTS4) are available and no information for individual farm holdings (therefore the participation rate can exceed 100%).
- Expenditure intensity is calculated in
    - (i) € per ha UAA for measure 121, 311 and 313;
    - (ii) € per capita for measure 322 as well as
    - (iii) the share of UAA under organic farming schemes (for 214)
- Figures on RDP spending usually refer to the location of main office the farm holding. In some cases farm holdings encompass agricultural area in different municipalities, but the total sum of spending is dedicated to the main office. Therefore partly extreme values for expenditures per ha UAA occurs.
- Due to data confidentiality issues, no information is available for municipalities with less than 3 farm holdings (in 39 cases). Generally, due to the large farm sizes, the number of holdings per municipality is low.

Table 1. Descriptive Statistics RDP 2007-2010, CSA Brandenburg, NUTS4.

	N	Min.	Max.	Medium	Standard Deviation
Participation Rate per holding, Measure 121, 2007-2010, in %	419	.00	600.00	20.72	42.75
Expenditures spend per UAA, Measure 121, 2007-2010, in €/ha	387	.00	158,664.43	654.17	8,215.02
Participation Rate per holding, Measure 311, 2007-2010, in %	419	.00	33.33	.91	3.32
Expenditures spend per UAA, Measure 311, 2007-2010, in €/ha	415	.00	629.59	5.98	36.09
Participation Rate per holding, Measure 313, 2007-2010, in %	416	.00	1,300.00	13.3393	68.42
Expenditures spend per UAA, Measure 313, 2007-2010, in €/ha	382	.00	34,300.67	162.87	1,796.47
Participation Rate per 1,000 inhabitants, Measure 322, 2007-2010, in %	419	.00	8.04	.48	.99
Expenditures spend per capita, Measure 322, 2007-2010, in €/capita	419	.00	1,001.49	32.45	86.29
Share Holdings with organic farming (EF750) in %, 2007	410	.00	100	17.83	29.19
Share Holdings with Organic Farming 2010, in %	260	.00	100.00	8.81	16.04

– Dichotomisation of NUTS4 aggregated participation data: dichotomy yes/no decision, whether participation in a measure has taken place in the particular municipality or not (see Table 2)

Table 2. Municipalities with farm holdings participating in RDP 2007-2010.

	N	in %
Participation Rate per holding, Measure 121, 2007-2010	237	57%
Participation Rate per holding, Measure 311, 2007-2010	53	13%
Participation Rate per holding, Measure 313, 2007-2010	169	41%
Participation Rate per 1,000 inhabitants, Measure 322, 2007-2010	186	44%
Share Holdings with organic farming (EF750) 2007	240	59%

4.2 Spatial Distribution

– **Measure 121 (Farm modernisation)** is implemented in the majority of municipalities (57%). Concentration processes can be found in more peripheral, rural areas outside as well as in areas of good soil quality in the Uckermark (North-east), Oderbruch (East) and Fläming (south-West) (see Figure 1). Payments have been rather unevenly distributed with strong concentrations in some municipalities (see Figure 2).

– In 240 municipalities (57.3%) farm holdings participate in **organic farming schemes (part of measure 214)**. Particularly in municipalities with nature protection areas (Schorfheide-Chorin, Spreewald) the participation is particularly high. Prime farming areas seem to be rather excluded (see Figure 3).

– In only a minority of municipalities (N=53, 12.6%) farmers participate in **measure 311 (Diversification)**. The distribution pattern of participation and spending is rather spread out without any spatial concentration (with a little exception in the proximity of the city of Berlin) (see Figures 4 & 5).

– **Measure 313 (Touristic infrastructure)** is implemented in 40.3% of all municipalities (N=169). Concentrations are found particularly close to urban centres as well as touristically important areas (see Figures 6 & 7).

– Politically steered, **measure 322 (Village renewal)**, is basically an exclusive phenomenon of the peripheral rural areas with concentrations in the North-west (Prignitz) and North-west (Uckermark). 44.4% of the municipalities participate in that measure (see Figures 8 & 9).

Figure 1. Share of farm holdings in municipality participating in measure 121 RDP II 2007-2010.
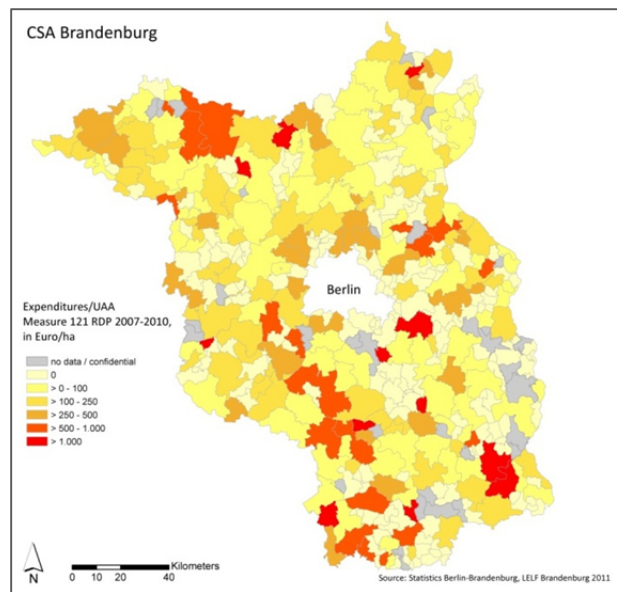
Figure 2. Expenditures (EU funding plus national/ regional public and private co-financing) per hectare UAA on measure 121 per municipality in RDP II 2007-2010.
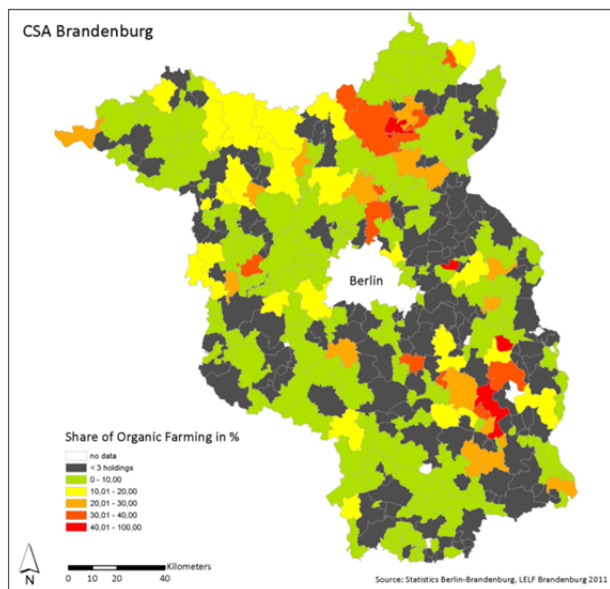
Figure 3. Share of UAA under organic farming schemes per municipality in 2007.

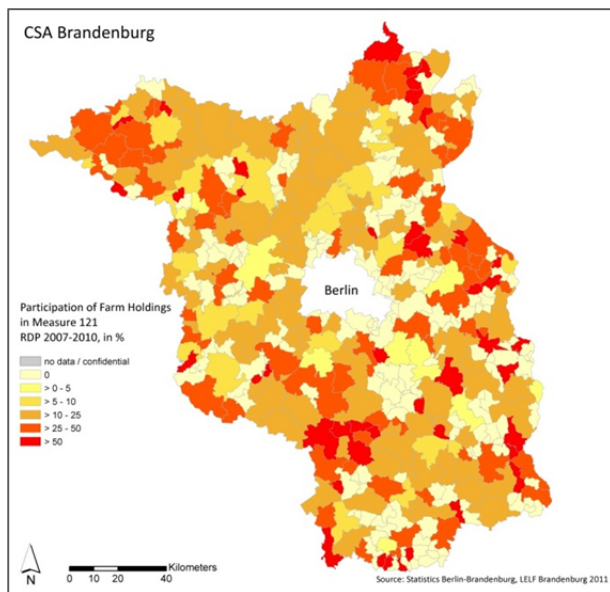Figure 4. Share of farm holdings in municipality participating in measure 311 RDP II 2007-2010.
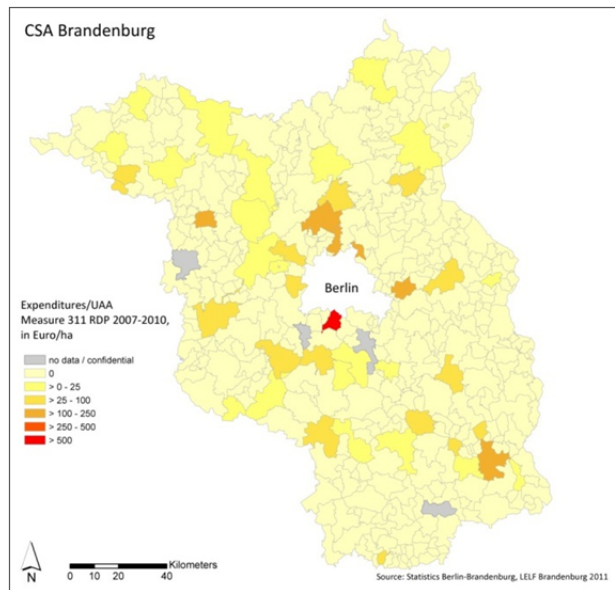
Figure 5. Expenditures in Euro per hectare UAA on measure 311 per municipality in RDP II 2007-2010.

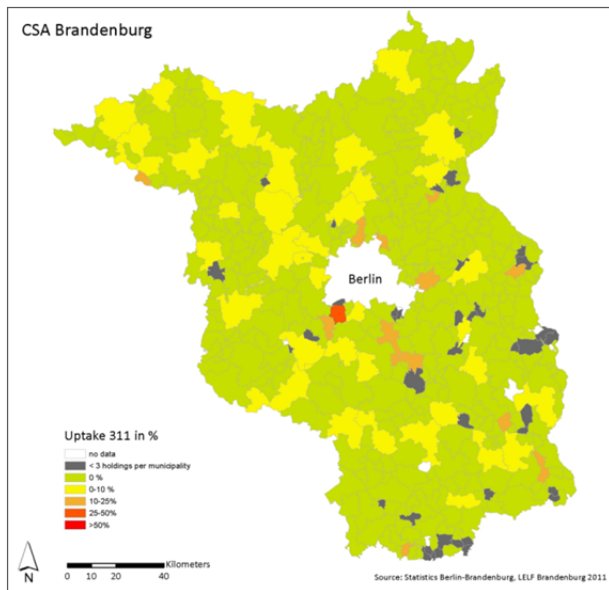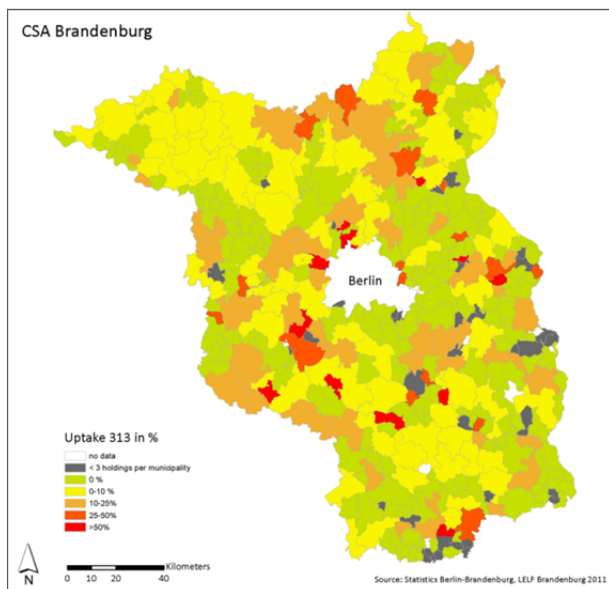Figure 6. Share of farm holdings in municipality participate in measure 313 RDP II 2007-2010.
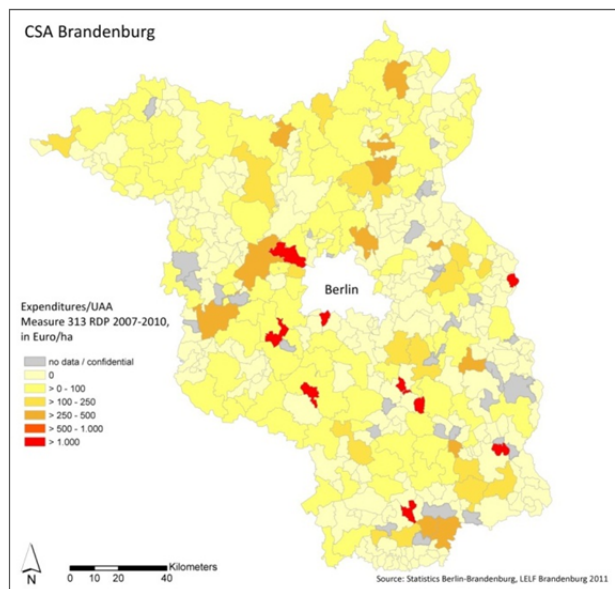
Figure 7. Expenditures in Euro per hectare UAA on measure 313 per municipality in RDP II 2007-2010.
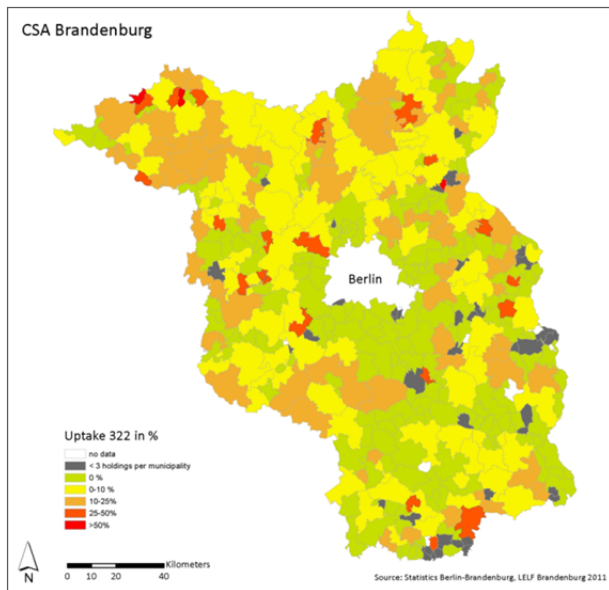
Figure 8. Number of projects in measure 322 per 1,000 inhabitants per municipality in RDP II 2007-2010.
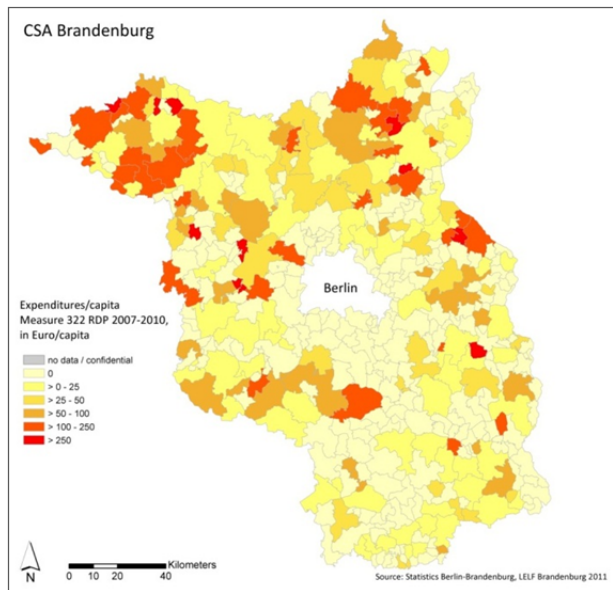
Figure 9. Expenditure in Euro per hectare municipal area on measure 322 per municipality in RDP II 2007-2010.

5 Spatial Context Determinants – Independent Explanatory Variables

5.1 Background

- Along **farm business-related factors**, such as farm structure, farm size and type as well as farm household-related factors, like age, education, existence of a successor with its intrinsic motivations and aspiration, it is the spatial context, which influences strategic decision-making of farm holders.

- Figure 18 gives an overview of the **main elements of the spatial context**: (i) landscape and bio-physical conditions, (ii) the socio-economic characteristics of the local rural community, (iii) the characteristics of the local farming community[1] as well as (iv) site designations and zoning. To some extent (basically as far as it concerns the farming community) this information can be obtained from the context indicators of the CMEF, which includes such things as average farm size, development of non-agricultural sector, ratio full-time / part-time, tourism, availability of labour, stocking densities or dominant agricultural activity.

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[1] "the term community integrates socio-economic characteristics of the local farming sector, e.g. farm structure and land use patterns."
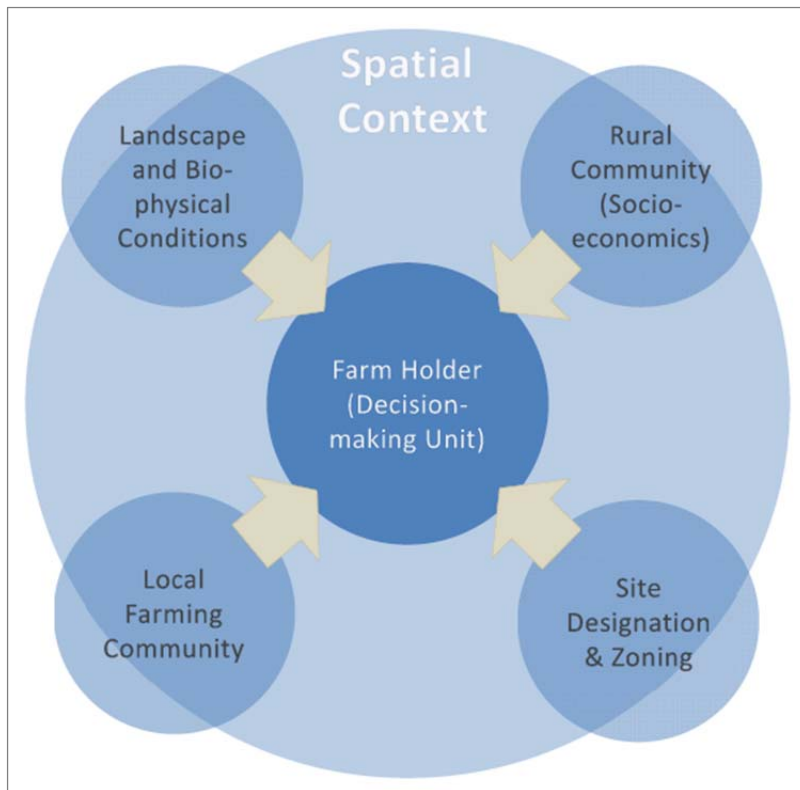
Figure 10. Determinants of the spatial context influencing farm decision-making.

5.1.1   *Landscape and Biophysical Conditions*

– The **farm location** represents an important driver for nature conservation and diversification (Jongeneel et al., 2008). Organic farming as an example of extensive agricultural production, particularly in livestock farming, tends to prevail in locations with less productive and low fertile conditions (Hart et al., 2011), such as mountainous areas (Tobias et al., 2005) or areas with low soil fertility (Piorr et al., 2006).

– Also for diversification, the landscape properties, such as the **proximity to national parks** represent a driver (Pfeifer et al., 2009). (Lange et al., 2013) found, that rural attractiveness correlates with diversification activities; farms tend to make use of the landscape potential and diversify into touristic activities.

– Jongeneel et al. (2008) found that among other factors, the **location in the densely urbanised** part of the Netherlands has a significant influence on participation in activities related to tourism. However, farm-based tourism is rather is limited to more rural areas. It is more geographically biased, since it requires the availability of natural amenities, i.e. mountains, forests or water areas.

5.1.2   *Socio-economic context of the rural community*

– The socio-economic context refers to the characteristics of the farm location in terms of **general economic performance** (especially outside of agriculture) or population and urban density. The economic development of the non-agricultural sector might have spill-over effects, for example, Gross Value Added (GVA) in the secondary and tertiary sectors could also be explanatory variables, or perhaps: labour productivity in the secondary and tertiary sectors (to correct for the size of the region) (see SPARD D3.1).

- Empirical findings by (Roberts et al., 2012) however, point to concern that standard economic indicators (such as GDP and employment) may under-represent the importance of farm households to the wider **regional economy**, as the degree of farm and local economy integration differs depending on farm types and farm sizes.

- Especially existing **urban-rural-relationships**, the proximity to potential (urban) consumers, their purchasing power and their demand for landscape goods and services represent important drivers for the appraisal of the landscape. Population and urban density positively influences the spatial distribution of landscape management measures (afforestation) as (Broch et al., in press) found.

- Demand for **direct marketing and short food supply** differs among different consumer groups (Van Huylenbroeck et al., 2005). Distance to urban areas influences the demand for regionally produced food: peri-urban residents (59%) purchase more often than inner city dwellers (14%) (Boulanger et al., 2004).

- Also farmers and farm households have **direct economic (and social) relations** with a range of different actors in the economy. Based on a results from survey of more than 1,000 farm households in Europe and applying a mixed method approach for analysis, including simulations, Roberts et al. (2013) assess the spatial distribution of income and employment effects, which were generally observed rather unaffected by the CAP, at approximately 70% of the impacts contained within the rural part of the region, while only 30% were spilling over to urban areas.

5.1.3 Farming Community

- It has been found that the structure of agricultural holdings influence the degree of participation in RDP measures. There is a **tendency of larger farm holdings to participate in RDP**. (Agra CEAS 2005, example Czech Republic) (see SPARD D3.1). The dominant agricultural activity of the region can also influence the performance of the measure (121): e.g. share of extensive agricultural area (see SPARD D3.1): measures (121) generally more effective in intensive agricultural area (maintenance effects).

- The **ratio full-time/ part-time farming** (full-time positive for implementation) influences the participation in measure 214 (see SPARD D3.1). Also knowledge spill-over effects, facilitating innovation and adaption processes, such as the introduction of new activities and strategies within the farming community (Beauchesne & Bryant, 1999; Wilson, 1996).

1.1.1 Site Designation and Zoning

- Site designations and zoning measures represent **requirements, restrictions, incentives or disincentives** for farm holders to adopt a desired land use management or activity. They are logically related to the bio-physical or socio-economic site conditions or at least to objectives of natural resource protection and conservation or socio-economic development and encompassing a range of instruments from legally binding to voluntary.

- Particular **Rural Development measures** explicitly refer to them (e.g. 213), others relate implicitly by synergistic potentials. Typical examples for site designations are NATURA2000 sites of the Flora-Fauna-Habitat network, Less-Favoured Areas (LFA), the sensitive areas defined by the Water Framework Directive (WFD), or nature conservation areas such as biosphere reserves, nature and national parks or Environmental Sensitive Area (ESA) in the UK which refer to landscape and bio-physical conditions.

- **Zoning strategies** within Rural Development Programmes, like in the case of Emilia-Romania based on rural development status and urbanisation (Rural areas with developing problems, Intermediate rural areas, Specialised agricultural areas, urban areas) or Brandenburg (e.g. for measure 322 only villages are eligible, respectively a population size threshold of max. 10,000

inhabitants to be eligible for RDP funding) relate more to local socio-economic and farming community characteristics.

– Also more **informal and soft site designations** exist, such as Protection of Geographical Indications and Designations of Origin or other regional trademarks, which can account as incentive for farm holders to participate in RDP measures.

5.2 Selection of independent explanatory variables: Factor Analysis

– **Objective:** Identification of factor representatives within the different dimensions of regional framework (socio-economic, bio-physical and farm structure); Coverage of potential context variables (e.g. such as included in Deliverable 5.1: "average farm size", "development of non-agricultural sector", "ratio full-time / part-time", "tourism", "availability of labour", "stocking densities" or "dominant agricultural activity"); (b) Reduction of semantic redundancies among the potential predictor variables; Prevention of collinearity (in the later stage of the modelling process)

– **Starting point:** Availability of a total of 40 possible variables from four dimensions of the spatial context (landscape and bio-physical conditions, socio-economic characteristics of the local rural community, characteristics of the local farming community and site designations and zoning.

– **Principal Component Analysis (PCA)** was applied with Varimax Rotation and Kaiser Normalisation. Factors included with an Eigenvalue > 1: 13 Factors for the variable groups "socio-economic characteristics of the local rural community" (5 factors), "landscape and bio-physical conditions", "site designations and zoning" (3 factors) and "characteristics of the local farming community" (5 factors)

5.3 Results Factor Analysis

5.3.1 Factors of socio-economic characteristics of the local rural community

– **Five factors** have been extracted with a cumulative variance explanation of 79.43%. Table 1 gives an overview of the factor composition.

– The **first factor** represents the **urban and economic development** aspect. These two are closely linked to each other in the Brandenburg case as there is a distinct separation of the more remote and lagging behind municipalities at the periphery of the CSA as well as those economic well-off municipalities in the adjacency of the Berlin metropolitan area, which are also more densely populated.

– **Factor two** combines variables referring to **tourism and touristic infrastructure**. The **third factor** determines the **place of work**, including the density of working places, the in-commuting as well as the business tax level. The **retirement of the local population** is represented by **factor four**. The **fifth factor** can be described as **peri-urbanisation** and out-commuting aspect.

Table 3. Socio-economic characteristics of the local rural community.

Variable	Factors				
	Urban/ Econ. Dev.	Tourism	Working	Retirement	Peri-urban
Variance explained	*29.57%*	*23.02%*	*12.81%*	*8.07%*	*5.95%*
Eigenvalue	*5.91*	*4.61*	*2.56*	*1.62*	*1.20*
Population Density, 2006, in inhabitants/km²	.739	-.219	.174	.465	.067

Net migration rate (rel. to total population) 2006 , in %	.575	.169	.057	-.047	-.048
Share Population < 15 years 2006, in %	.469	-.163	.002	-.352	-.517
Share Population 15-65 years 2006, in %	.124	-.161	.022	-.770	.343
Share Population > 65 years 2006, in %	-.364	.223	-.019	.832	.005
No. Employees at place of work (rel. to total active population) 2006	.159	.136	.925	.070	.065
No. Employees at place of residence (rel. to total active population) 2006	.111	-.062	-.196	-.247	.742
Commuter Saldo/captia, 2006	.118	.145	.921	.153	-.130
Unemployment rate 2006, in %	-.656	-.176	.087	.235	-.532
No. Residential buildings permits (rel. to total number of buildings 2006, in %	.876	.170	.085	-.188	-.042
No. Flats permits (rel. to total number of flats) 2006, in %	.864	.201	-.052	-.267	-.035
Living Area permits (rel. to total living area) 2006, in %	.887	.161	-.012	-.237	-.052
Municipal income tax/capita 2006, in €	.818	-.046	.228	-.133	.246
Municipal business tax/capita 2006, in €	.025	-.043	.671	-.166	-.133
No. Guesthouses/capita, 2006	-.039	.852	.022	.059	.080
No. Bedplaces/capita, 2006	.082	.955	.022	.057	-.031
No. Arrivals/capita, 2006	.117	.935	.081	.051	.019
No. Overnight stays/capita, 2006	.113	.949	.061	.069	-.024
Tourist-Resident-Quotient, 2006	.113	.949	.061	.069	-.024
Share Area Settlement and Infrastructure in %, 2006	.757	-.219	.226	.391	.090

5.3.2 *Factors of landscape, bio-physical conditions as well as site designations and zoning*

– **Three factors** have been extracted with as cumulative variance explanation of 77.41%. (see table 2). The **first factor** is characterised by a dominance of **forest as well as less-favoured areas** under absence of agriculture area. It can also be seen as a negative to the arable cropping locations.
– **Factor two** summarises the first element of ecological valuable locations – **FFH areas and inland waters**, which occur often simultaneously in the CSA. The presence of **moor and heath** area is the main contributing variable to the **third factor**, as they represent a different type of ecological area.

Table 4. Factors of landscape, bio-physical conditions as well as site designations and zoning.

Variable	Factors		
	Forest + LFA	Water + FFH	Moor & Heath
Variance explained	*37.36%*	*22.63%*	*17.42%*
Eigenvalue	*2.24*	*1.36*	*1.05*
Share Area Agriculture, in %, 2006	-.887	-.241	.069

Share Area Forest, in %, 2006	.911	.102	-.034
Share Area Inland water, in %, 2006	.009	.853	-.188
Share of Municipality Area under FFH designation, in %	.088	.770	.307
Share of Municipality Area under Less Favoured Area (LFA) designation, in %	.733	-.172	.096
Share Area Moor and Heath, in %, 2006	-.007	.036	.958

5.3.3 Factors of characteristics of the local farming community

- The local farming community is represented by **five different factors** with as cumulative variance explanation of 62.02% (see table 3). The **first factor** refers to **large-scale agriculture** as the variables of average farm size as well as juristic person ownership are combined.
- **Factor two** defines the **grassland production** and cattle holding. The **third factor** refers predominantly to **horticultural production**. The presence of **co-operative ownership** characterises **factor four**, **arable and pork production factor five**.

Table 5. Factors of characteristics of the local farming community.

Variable	Factors				
	Large Scale Agriculture	**Grazing**	**Horti-culture**	**Co-operatives**	**Arable Production**
Variance explained	*18.04*	*13.61*	*11.62*	*9.58*	*9.17*
Eigenvalue	*2.17*	*1.63*	*1.39*	*1.15*	*1.10*
Average Agricultural Area (UAA) per holding (EF258) in ha, 2007	**.757**	.181	-.117	.284	.103
Share Holdings with arable land (EF245) in %, 2007	.048	-.187	-.357	.420	**.532**
Share Holdings with permanent grassland (EF245) in %, 2007	-.169	**.838**	.057	-.058	-.139
Share Holdings owned by private persons (EF13) in %, 2007	**-.624**	.174	-.083	-.088	.008
Share Holdings owned by co-operations (EF13) in %, 2007	.044	.047	.075	**.826**	-.057
Share Holdings owned by juristic persons (EF13) in %, 2007	**.841**	-.052	-.036	-.230	.104
Share Holdings with cattle (EF107-118) in %, 2007	.052	**.724**	-.154	.073	.282
Share Holdings with sheep (EF120-123) in %, 2007	.036	.289	**.627**	-.050	.068
Share Holdings with pigs (EF125-134) in %, 2007	.145	.136	.151	-.129	**.797**
Share Holdings with poultry (EF136-138), 2007	-.436	.050	.221	**-.461**	.430
Share Holdings with vegetable in the change with other agricultural produce outdoors (EF223) in %, 2007	-.059	-.208	**.661**	-.038	-.050
Share Holdings with vegetable in the change with other horticultural produce outdoors (EF224) in %, 2007	-.025	-.286	**.519**	.325	.178

6 Explanatory Spatial Data Analysis (ESDA) of RDP Measure Participation

6.1 Methodology

- **Objective:** Analysis of the spatial distribution pattern of RDP participation and expenditures (neighbourhood relationships, spatial spill-overs)

- **Approach:** Exploratory Spatial Data Analysis (ESDA) based on spatial maps of RDP participation and expenditures with GeoDA (GIS software); Identification of neighbours: chequerboard, Queen's Continuity, 3 steps distance

- **Result:** Moran's I spatial lag variable value (indicating the degree of similarity to neighbouring municipalities) and a global Moran's I (indicating the global degree of spatial neighbourhood similarities)

6.2 Results Measure 121
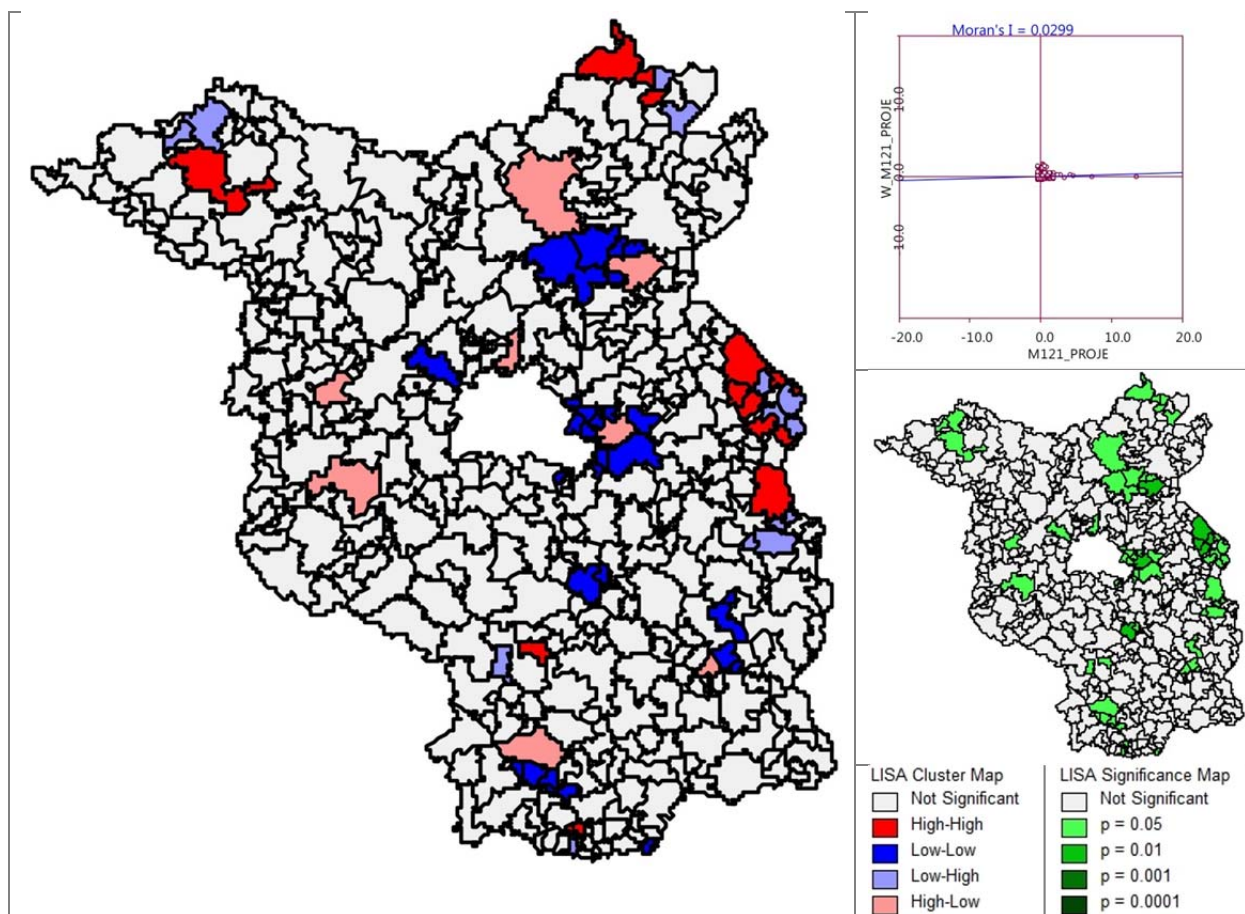
Figure 11. LISA Map Measure 121: Projects per Holding in %.

- Global Moran's I = 0.0299

- Hardly any neighbourhood relationships, except high-high relationships in areas of fertile soils (Uckermark, Oderbruch), which are suitable for intensive agriculture

- Low-low spillovers particularly in nature conservation areas (Schorfheide-Chorin, Spreewald) and near Berlin
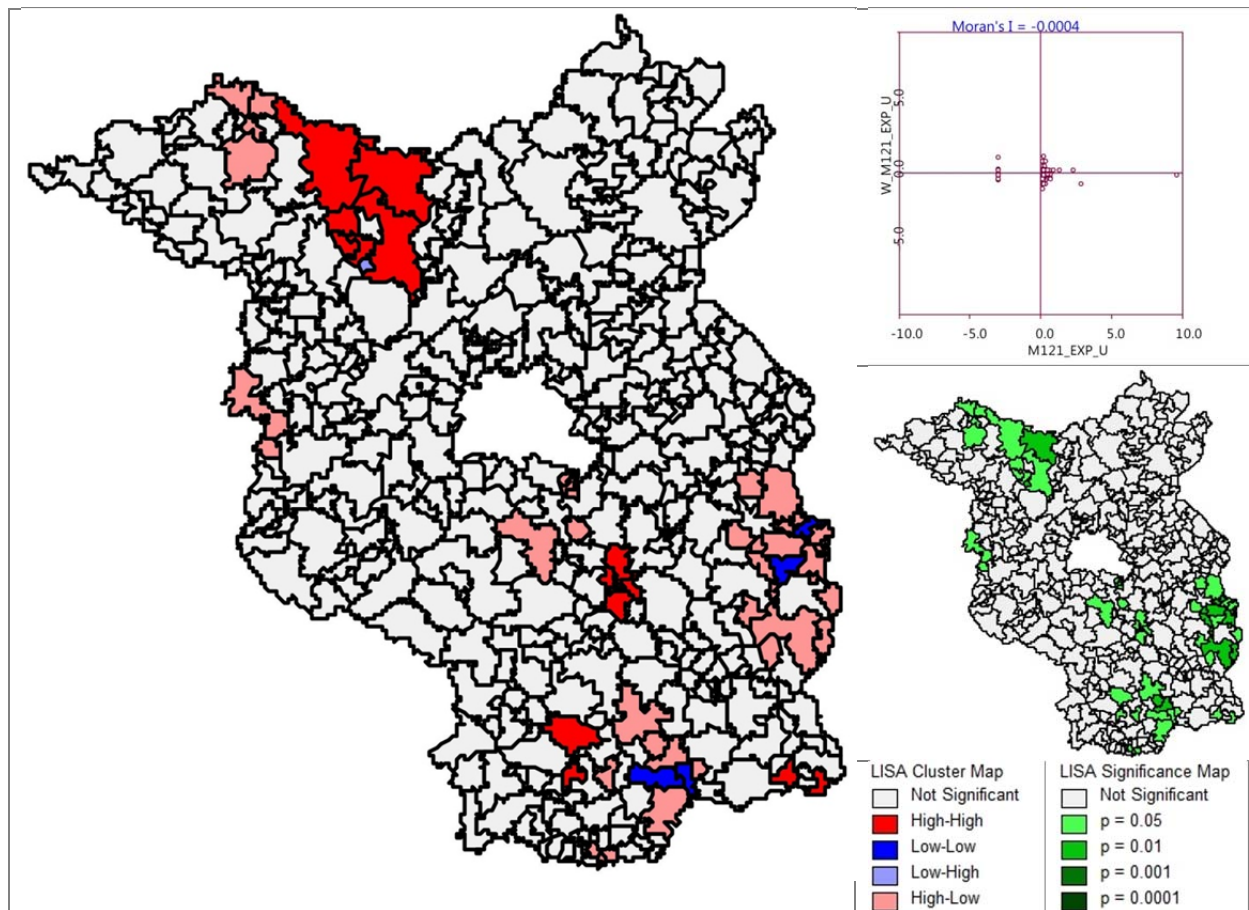
Figure 12. LISA Map Measure 121: Expenditures per hectare UAA.

- – Global Moran's I = 0.0004
- – Only small-scale neighbourhood spill-overs, due to concentrations of intensive expenditures/ investments

6.3   Results Measure 214
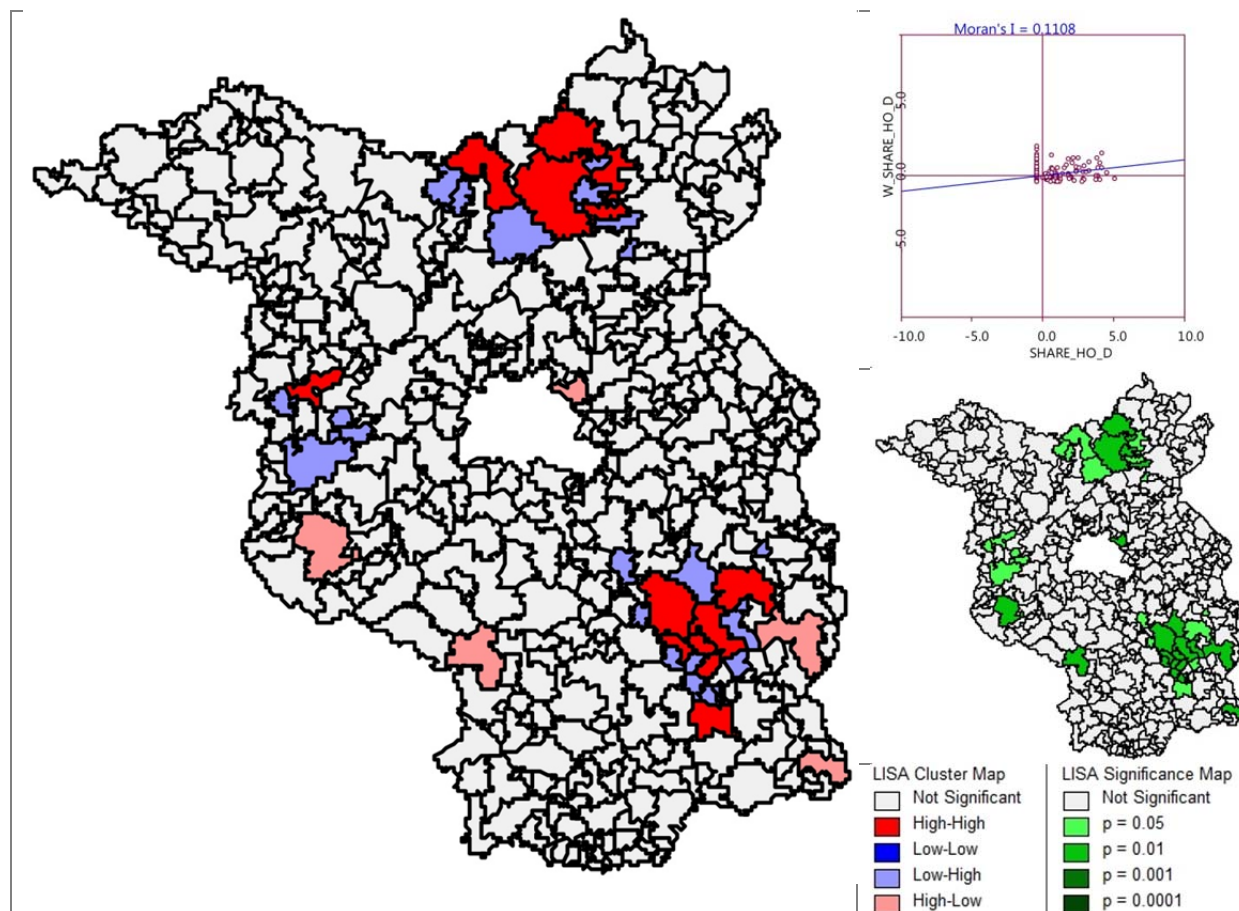
Figure 13. LISA Map Holding under Organic Farming Schemes in %.

- Global Moran's I = 0.1108
- Neighbourhood effects in Biosphere reserves and intensive horticultural production areas

6.4   Results Measure 311
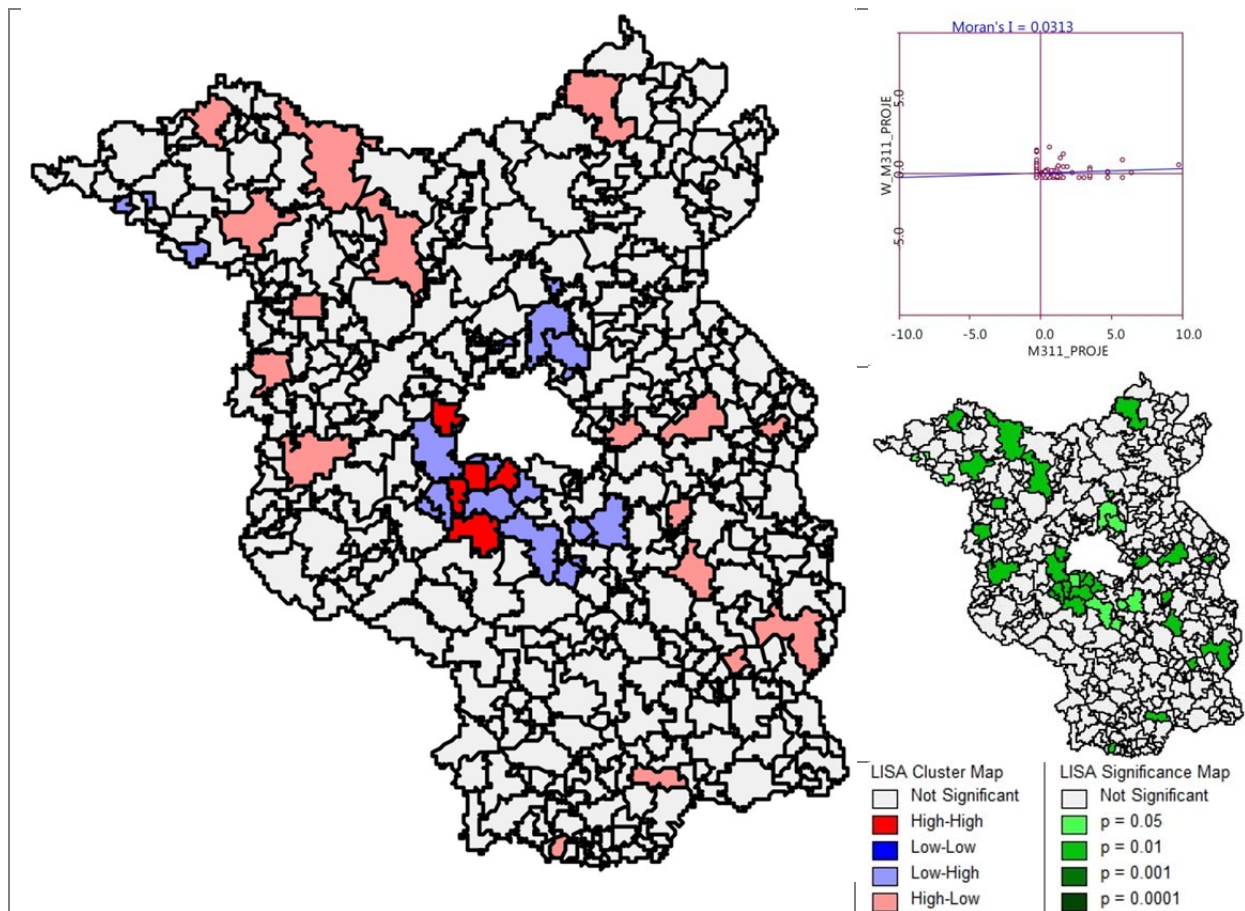
Figure 14. LISA Map Measure 311: Projects per Holding in %.

- – Global Moran's I = 0.0313
- – Heterogeneous pattern in the vicinity of Berlin
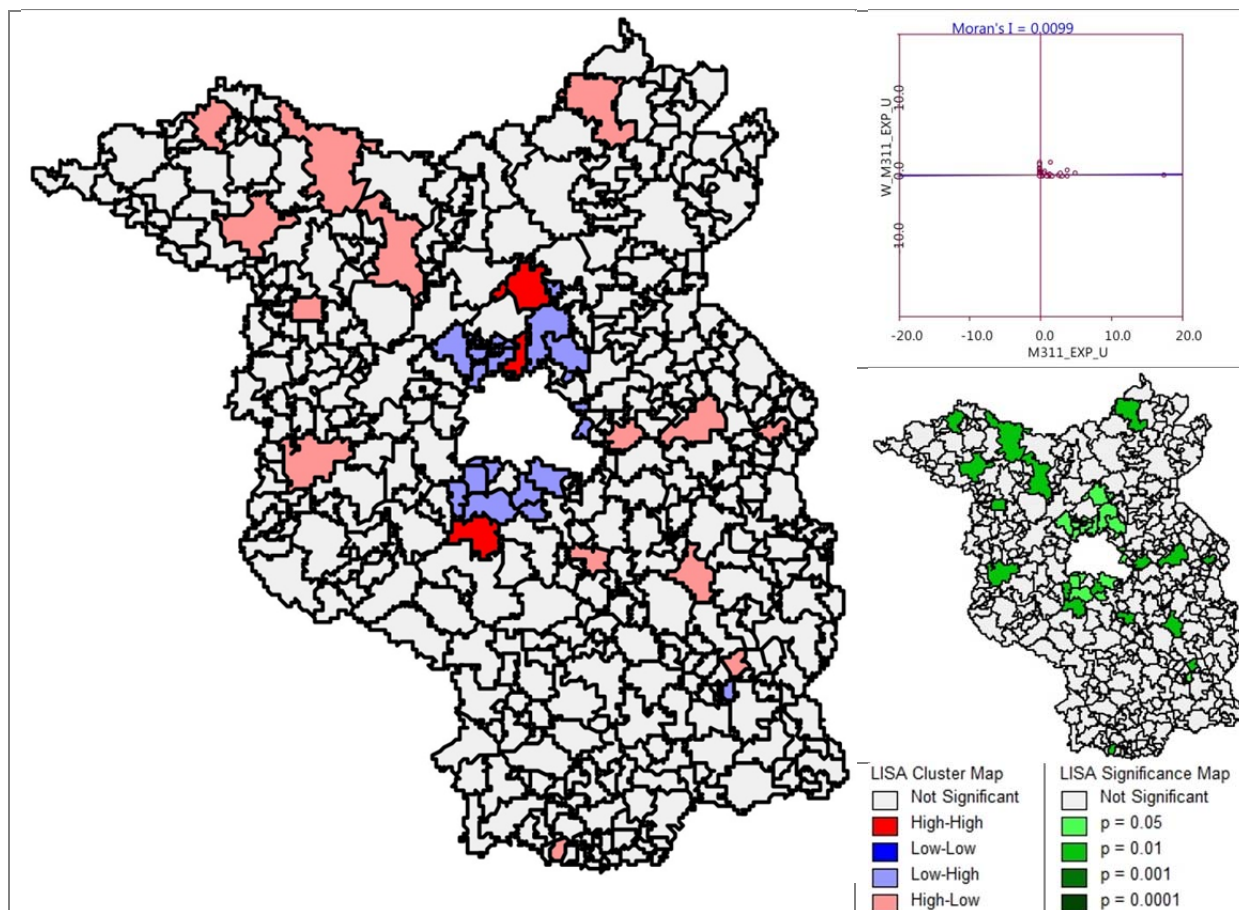
Figure 15. LISA Map Measure 311: Expenditures per hectare UAA.

– Global Moran's I = 0.0099

6.5   Results Measure 313
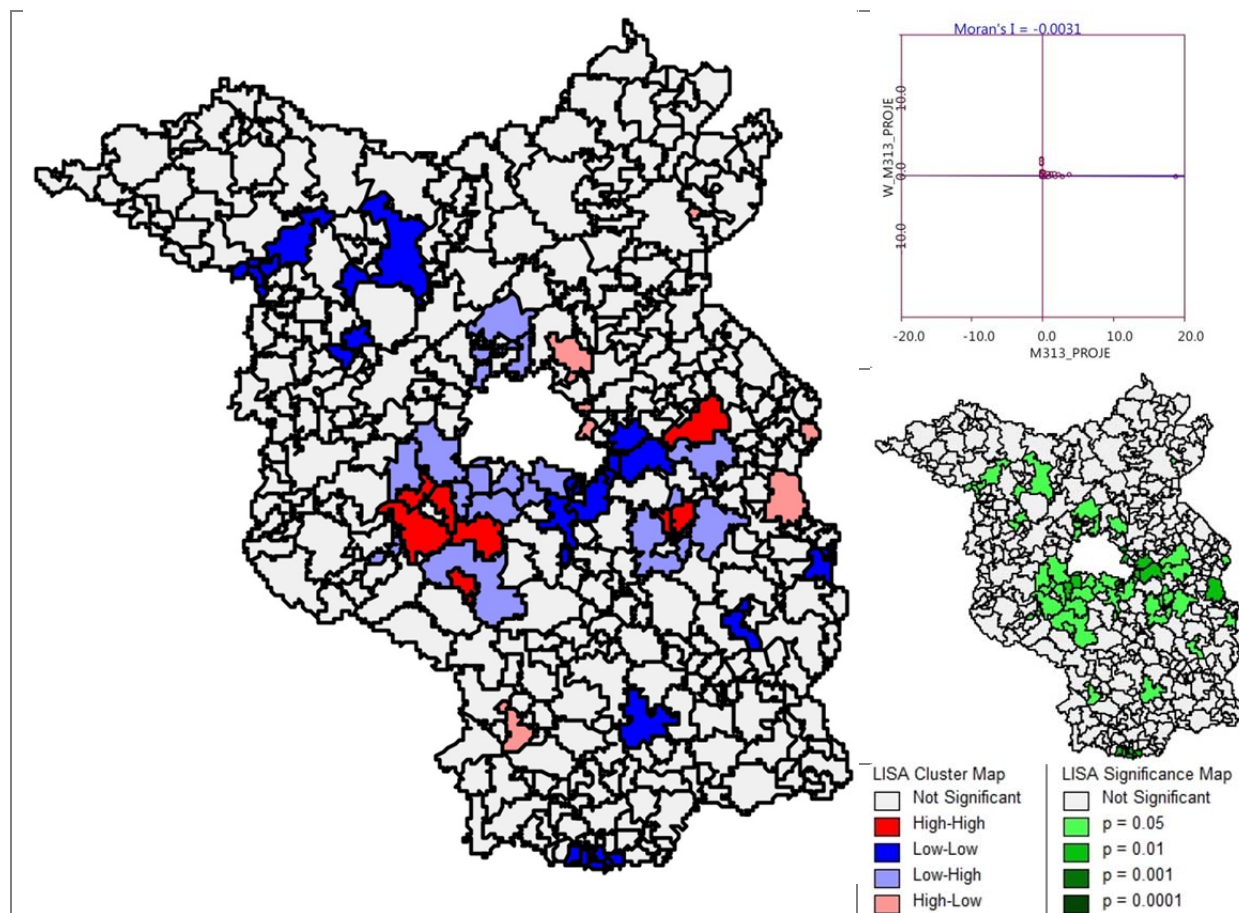
Figure 16. LISA Map Measure 313: Projects per Holding in %.

- Global Moran's I = 0.0031
- Spatial pattern show only little neighbourhood effects
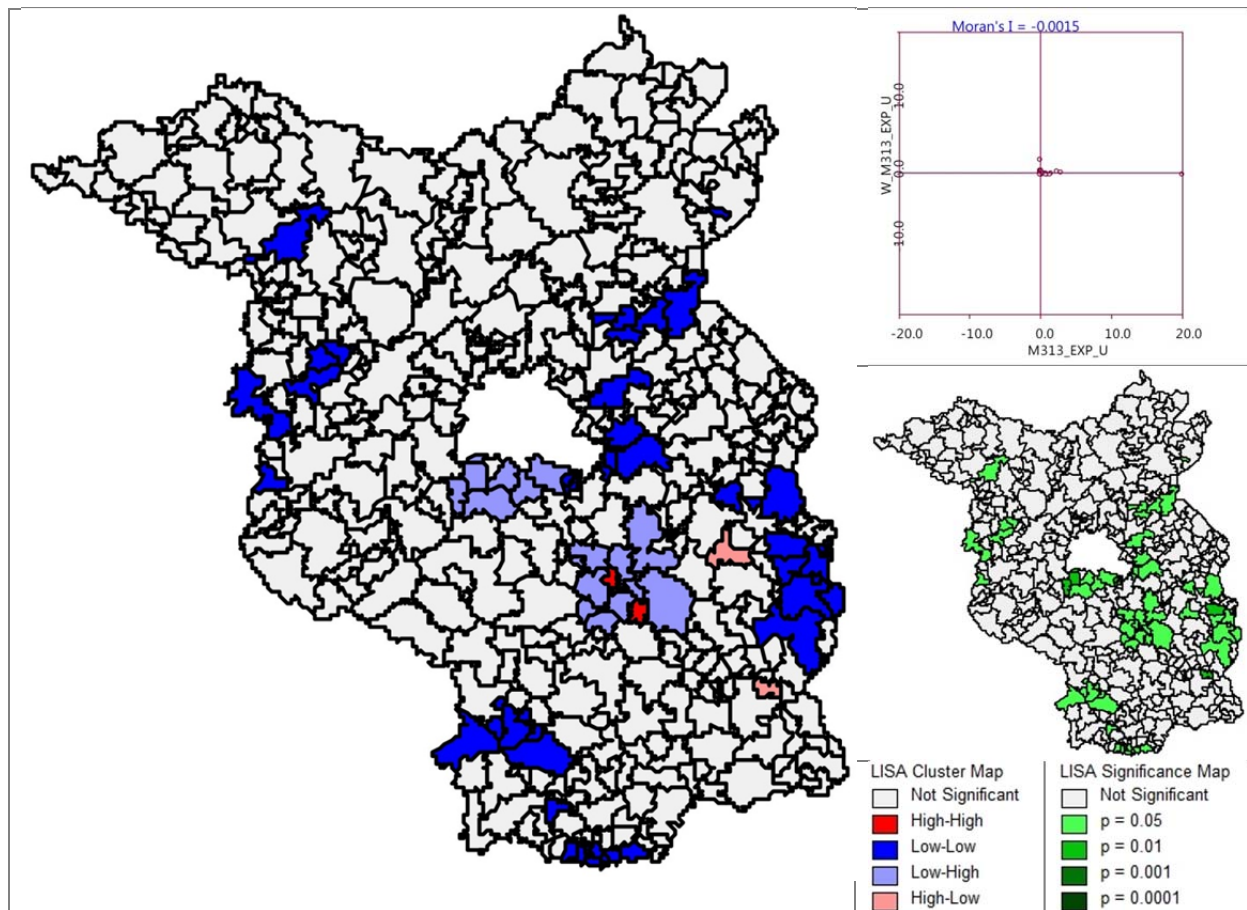
Figure 17. LISA Map Measure 313: Expenditures per hectare UAA.

- Global Moran's I = 0.0015
- Clustering of low values
- Low neighbourhood effects found.

6.6   Results Measure 322
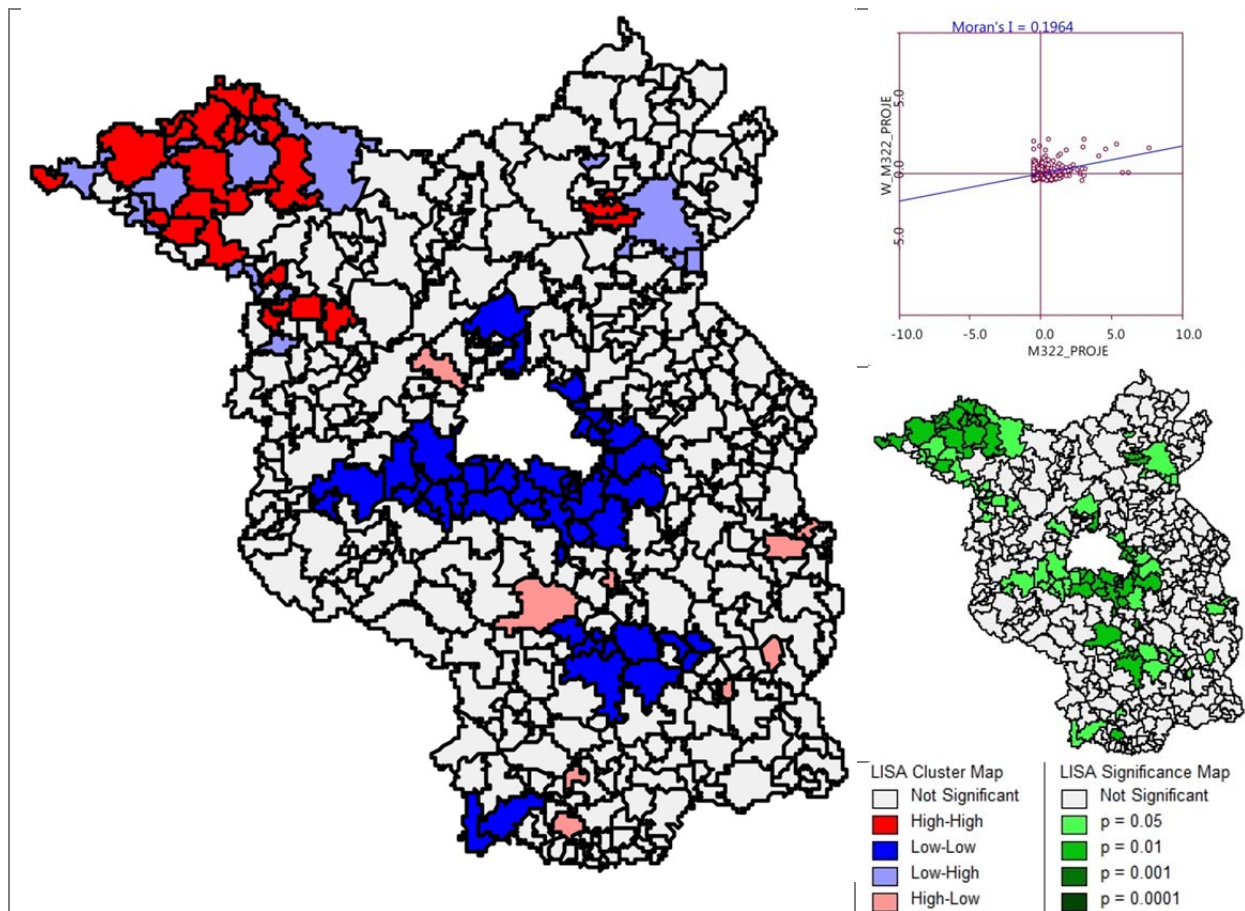
Figure 18. LISA Map Measure 322: Projects per 1,000 inhabitants.

- Global Moran's I = 0.1964
- Low value clustering in the vicinity of Berlin
- Distinct positive neighbourhood spill-overs in the North-east of Brandenburg
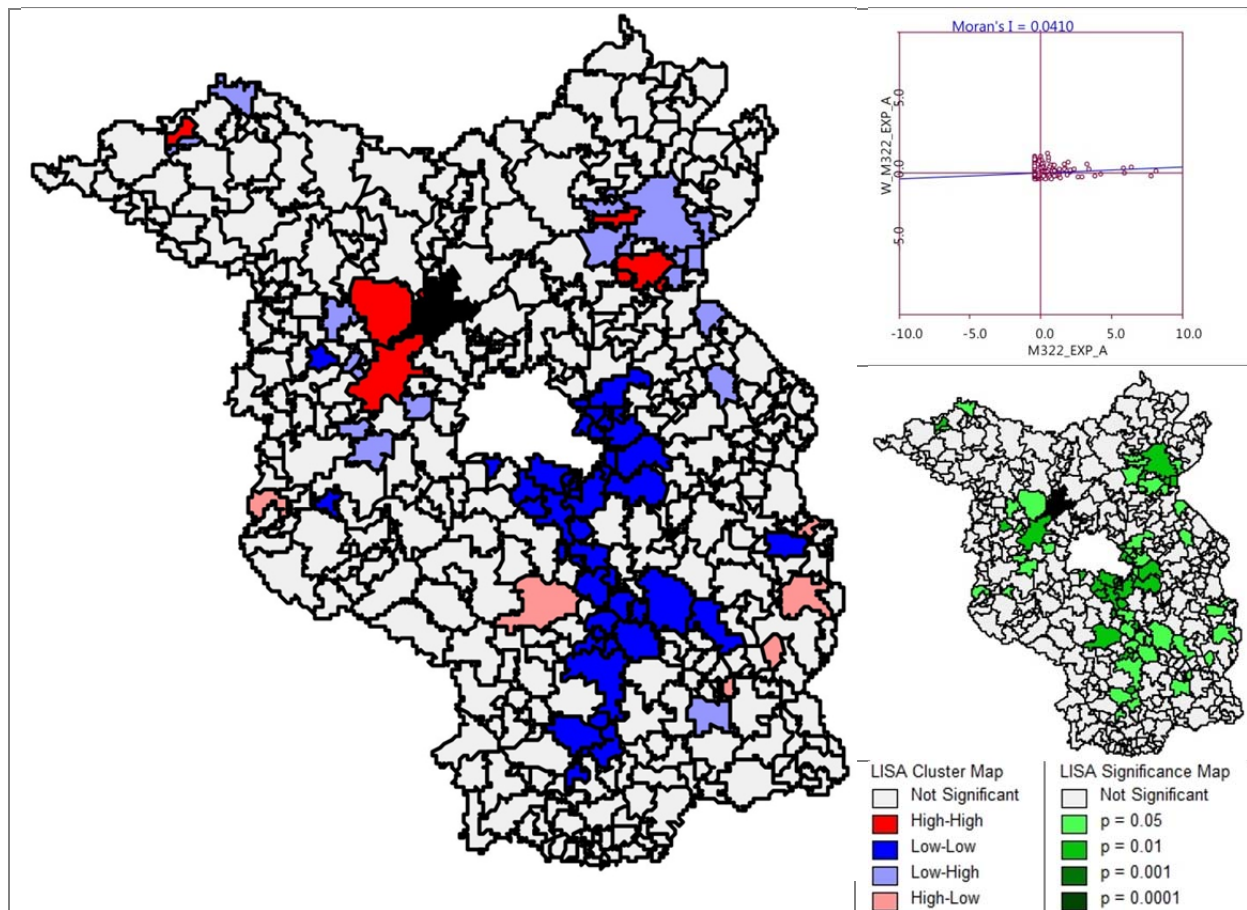
Figure 19. LISA Map Measure 322: Expenditures per hectare municipality area.

- Global Moran's I = 0.041
- Low value clustering in the vicinity (particularly south) of Berlin

7 OLS Regression, Spatial Lag and Error Model (Model A, B & C)

7.1 Methodology, Model Specification

- Software used: GeoDA
- Neighbourhood Weight matrix: Queen continuity, 2nd order (other neighbourhood relationships with QC, 1st, 4th, 8th, 16th order, as well as 5, 10, 15 nearest neighbours have been applied with no model improvement)
- Regression models: OLS, spatial lag & spatial error.

7.2 Results

Table 6. Model A (Participation) – Ordinary Least Square (OLS) Regression (aspatial).

		Participation Rate, M121[1]	Participation Rate, M311[1]	Participation Rate, M313[1]	Participation Rate, M322[1]
Socio-Economics	Factor Urban / Economic Development	n.s.	n.s.	n.s.	**-0.160****
	Factor Tourism	n.s.	n.s.	n.s.	n.s.
	Factor Working Place	n.s.	n.s.	n.s.	**-0.160*****
	Factor Retirement	n.s.	n.s.	n.s.	n.s.
	Factor Peri-urbanisation	n.s.	n.s.	n.s.	**-0.236*****
Landscape	Factor Forest/LFA	**-7.685*****	n.s.	n.s.	**-0.184*****
	Factor Water/FFH	n.s.	n.s.	n.s.	n.s.
	Factor HNV Area	n.s.	n.s.	n.s.	n.s.
Farming Structure	Factor Large-scale Agriculture	**7.085*****	n.s.	n.s.	n.s.
	Factor Grassland Management	n.s.	**0.378****	n.s.	**0.153*****
	Factor Horticulture	n.s.	n.s.	n.s.	n.s.
	Factor Co-operatives	n.s.	**-0.405****	n.s.	n.s.
	Factor Arable Production	n.s.	n.s.	n.s.	**-0.122****
Intercept		**20.91*****	**0.915*****	n.s.	**0.477*****
R²		*0.08*	*0.04*	*0.01*	*0.13*
Corrected R²		*0.05*	*0.01*	*-0.02*	*0.10*

*Significant at the 10% level, **significant at the 5% level, ***significant at the 1% level.

Table 7. Model A (Expenditures) – Ordinary Least Square (OLS) Regression (aspatial).

		Expenditures per ha UAA in €, M121	Expenditures per ha UAA in €, M311	Expenditures per ha UAA in €, M313	Expenditure Measure 322 per 1,000 inhabitants, in €
Socio-Economics	Factor Urban / Economic Development	n.s.	7.12***	552.34***	n.s.
	Factor Tourism	n.s.	n.s.	n.s.	n.s.
	Factor Working Place	n.s.	7.10***	n.s.	n.s.
	Factor Retirement	n.s.	-8.57***	n.s.	n.s.
	Factor Peri-urbanisation	n.s.	n.s.	n.s.	-19.27***
Landscape	Factor Forest/LFA	n.s.	n.s.	n.s.	-12.10**
	Factor Water/FFH	917.41**	n.s.	n.s.	n.s.
	Factor HNV Area	n.s.	n.s.	n.s.	n.s.
Farming Structure	Factor Large-scale Agriculture	814.89*	n.s.	-225.86*	n.s.
	Factor Grassland Management	-1,223.21***	n.s.	n.s.	13.24**
	Factor Horticulture	883.18**	n.s.	n.s.	n.s.
	Factor Co-operatives	-1,218.44***	n.s.	n.s.	n.s.
	Factor Arable Production	n.s.	n.s.	285.74***	n.s.
Intercept		n.s.	5.86***	146.46*	32.64***
R^2		0.06	0.09	0.11	0.08
Corrected R^2		0.03	0.06	0.09	0.05

*Significant at the 10% level, **significant at the 5% level, ***significant at the 1% level.

Table 8. Model B (Participation) – Spatial Lag Model.

		Participation Rate, M121[1]	Participation Rate, M311[1]	Participation Rate, M313[1]	Participation Rate, M322[1]
Socio-Economics	Factor Urban / Economic Development	n.s.	n.s.	n.s.	**-0.131****
	Factor Tourism	n.s.	n.s.	n.s.	n.s.
	Factor Working Place	n.s.	n.s.	n.s.	**-0.148****
	Factor Retirement	n.s.	n.s.	n.s.	n.s.
	Factor Peri-urbanisation	n.s.	n.s.	n.s.	**-0.214*****
Landscape	Factor Forest/LFA	**-7.470*****	n.s.	n.s.	**-0.142*****
	Factor Water/FFH	n.s.	n.s.	n.s.	n.s.
	Factor HNV Area	n.s.	n.s.	n.s.	n.s.
Farming Structure	Factor Large-scale Agriculture	**7.022*****	n.s.	n.s.	n.s.
	Factor Grassland Management	n.s.	**0.378****	n.s.	**0.121****
	Factor Horticulture	n.s.	n.s.	n.s.	n.s.
	Factor Co-operatives	n.s.	**-0.404****	n.s.	n.s.
	Factor Arable Production	n.s.	n.s.	n.s.	**-0.103****
Intercept		**19.045*****	**0.902*****	n.s.	**0.333*****
Lag coefficient (Rho)		*0.090*	*0.013*	*-0.048*	*0.308****
R²		*0.081*	*0.040*	*0.015*	*0.155*

*Significant at the 10% level, **significant at the 5% level, ***significant at the 1% level.

Table 9. Model B (Expenditures) – Spatial Lag Model.

		Participation Rate, M121[1]	Participation Rate, M311[1]	Participation Rate, M313[1]	Participation Rate, M322[1]
Socio-Economics	Factor Urban / Economic Development	n.s.	**7.52*****	**555.09*****	n.s.
	Factor Tourism	n.s.	n.s.	n.s.	**6.59*****
	Factor Working Place	n.s.	**7.30*****	n.s.	n.s.
	Factor Retirement	n.s.	**-8.62*****	n.s.	n.s.
	Factor Peri-urbanisation	n.s.	n.s.	n.s.	**-3.16***
Landscape	Factor Forest/LFA	n.s.	n.s.	n.s.	**-5.14*****
	Factor Water/FFH	**942.01****	n.s.	n.s.	n.s.
	Factor HNV Area	n.s.	n.s.	n.s.	n.s.
Farming Structure	Factor Large-scale Agriculture	**811.13***	n.s.	**-225.84****	n.s.
	Factor Grassland Management	**-1,239.79****	**3.40***	n.s.	**3.96****
	Factor Horticulture	**877.61****	n.s.	n.s.	n.s.
	Factor Co-operatives	**-1,232.28****	n.s.	n.s.	n.s.
	Factor Arable Production	n.s.	n.s.	**286.58*****	n.s.
Intercept		**639.69***	**6.44*****	**151.88***	**10.39*****
Lag coefficient (Rho)		*-0.077*	*-0.089*	*-0.058*	*0.10*
R²		*0.065*	*0.095*	*0.115*	*0.078*

*Significant at the 10% level, **significant at the 5% level, ***significant at the 1% level.

Table 10. Model C (Participation) – Spatial Error Model

		Participation Rate, M121[1]	Participation Rate, M311[1]	Participation Rate, M313[1]	Participation Rate, M322[1]
Socio-Economics	Factor Urban / Economic Development	n.s.	**0.349***	n.s.	**-0.145****
	Factor Tourism	n.s.	n.s.	n.s.	n.s.
	Factor Working Place	n.s.	n.s.	n.s.	**-0.156*****
	Factor Retirement	n.s.	n.s.	n.s.	n.s.
	Factor Peri-urbanisation	n.s.	n.s.	n.s.	**-0.223*****
Landscape	Factor Forest/LFA	**-7.693*****	n.s.	n.s.	**-0.162*****
	Factor Water/FFH	n.s.	n.s.	n.s.	n.s.
	Factor HNV Area	n.s.	n.s.	n.s.	n.s.
Farming Structure	Factor Large-scale Agriculture	**7.064*****	n.s.	n.s.	n.s.
	Factor Grassland Management	n.s.	**0.372****	n.s.	**0.114****
	Factor Horticulture	n.s.	n.s.	n.s.	n.s.
	Factor Co-operatives	n.s.	**-0.407****	n.s.	n.s.
	Factor Arable Production	n.s.	n.s.	n.s.	**-0.100***
Intercept		**20.903*****	**0.917*****	n.s.	**0.480*****
Lag coefficient (Lambda)		*0.023*	*-0.044*	*-0.064*	*0.299****
R²		*0.080*	*0.040*	*0.016*	*0.148*

*Significant at the 10% level, **significant at the 5% level, ***significant at the 1% level.

Table 11. Model C (Expenditures) – Spatial Error Model.

		Expenditures per ha UAA in €, M121	Expenditures per ha UAA in €, M311	Expenditures per ha UAA in €, M313	Expenditure Measure 322 per 1,000 inhabitants, in €
Socio-Economics	Factor Urban / Economic Development	n.s.	7.78***	549.13***	n.s.
	Factor Tourism	n.s.	n.s.	n.s.	6.81***
	Factor Working Place	n.s.	8.26***	n.s.	n.s.
	Factor Retirement	n.s.	-8.90***	n.s.	n.s.
	Factor Peri-urbanisation	n.s.	n.s.	n.s.	-3.28*
Landscape	Factor Forest/LFA	n.s.	n.s.	n.s.	-5.32***
	Factor Water/FFH	934.86**	n.s.	n.s.	n.s.
	Factor HNV Area	n.s.	n.s.	n.s.	n.s.
Farming Structure	Factor Large-scale Agriculture	808.15*	n.s.	-225.65**	n.s.
	Factor Grassland Management	-1,208.44**	3.73**	n.s.	4.02**
	Factor Horticulture	878.09**	n.s.	n.s.	n.s.
	Factor Co-operatives	-1,248.88**	n.s.	n.s.	n.s.
	Factor Arable Production	n.s.	n.s.	287.55***	n.s.
Intercept		596.42*	5.88***	145.20*	11.58***
Lag coefficient (Lambda)		-0.089	-0.256**	-0.042	0.142
R²		0.066	0.106	0.115	0.080

*Significant at the 10% level, **significant at the 5% level, ***significant at the 1% level.

7.3 Discussion of Results

- In the CSA Brandenburg, the regression models which are making use of spatial-econometric analysis (spatial lag and error) cannot contribute to any explanation of the spatial distribution of values for the participation rate and expenditures per area for the RDP programmes. Numerous structural errors and shortcomings can be identified for that failure.
- The coefficients for the spatial lag (rho) and spatial error (lambda) hardly contribute significantly to the OLS models.
- Due to the exclusion of cases (municipalities) with "no data" (necessary to conduct the spatial regression analyses) from the analysis, the space of observation is not continuous anymore. Therefore the spatial models are based on biased neighbourhood assumptions. Further, the sample of "no data" cases does not have the same value distribution as the totality of cases, as no "no data" case has the RDP value (participation & expenditure) "0" (in most cases the particular RDP measure has been adopted, whereas the number of farm holdings was <3).
- Due to the high shares of "0" values for some measures (especially M311), the value distribution is skewed, so that conclusions about relationships regarding amounts of RDP (participation & expenditures) are not easily possible.
- The total amount of farm holdings in the CSA is low. Frequently there are less than 3 holdings per municipalities. Further, often farm holdings also encompass several municipalities, although the RDP participation and expenditures are counted only for the municipality home of the main office/headquarter of the holding, which gives a biased picture of the real situation.
- As a result, a varying aspatial regression model (binary logistic) which takes the specific character of the CSA and the data quality into consideration.

8 Aspatial Binary Logistic Regression / OLS Model (Model D)

8.1 Model Specification

8.1.1 Binary Logistic Regression

- **Approach:** Explanation of binary participation pattern (yes/no), whether at least one farm holder has implemented a certain RDP measure (dependent variable) through the 13 factors, describing the regional framework and the Moran's I spatial lag value, indicating the degree of spatial spill-over (see Figure 20).

- As statistical method **Binary Logistic Regression** modelling has been applied to explain the participation.

- From 419 municipalities 190 (45%) have been included in regression model process, 229 excluded due to data gaps of the independent variables
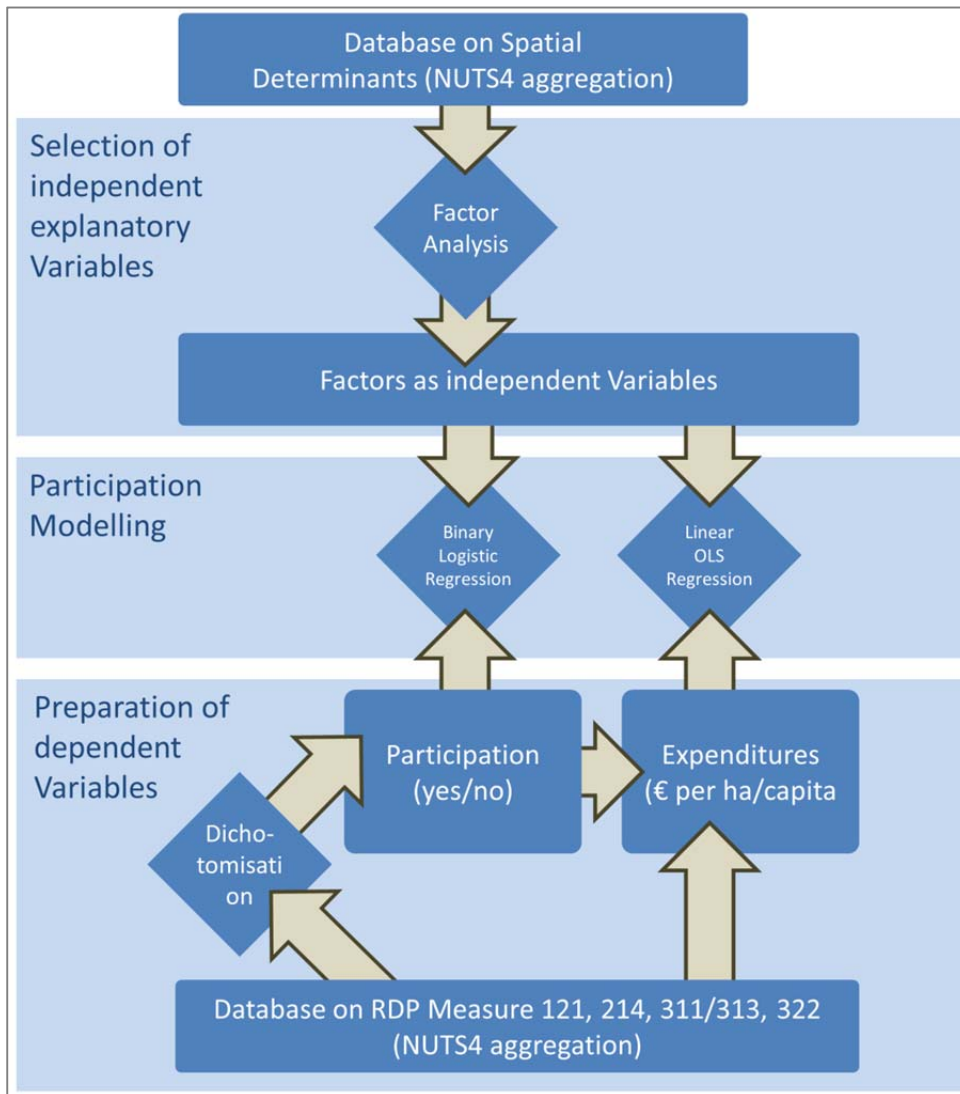

Figure 20. Methodological Approach.

8.1.2 Multivariate Linear Regression (only cases with participation)

- **Linear relationship** between regional determinants and participation in RDP measure expected (as no profound hypothesis for explanation of non-linear behaviour existing, respectively unavailability of historical data do not allow to assess state of development curve) → Linear Ordinary Least Squares (OLS) regression modelling to estimate the influence of regional framework conditions on the spatial distribution of RDP measures (participation per holding / capita[2] and expenditures per hectare UAA / capita[3]) (standardised values).

- Model was selected to **maximise the corrected R²** (included only those predictor variables, which significantly increase the explanatory value of the model). Only those cases (municipalities) have been included where the particular RDP measure has been implemented (in at least one farm holding).

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[2] In the case of measure 322.

[3] In the case of measure 322.

8.2 Results

8.2.1 Model D (Participation) – Binary Logistic Regression Model

Table 12. Binary Logistic Regression model for the participation in RDP measures.

		Participation Rate[2], M121[1]	Participation Rate[2] Organic Farming.	Participation Rate[2], M311[1]	Participation Rate[2], M313[1]	Participation Rate[3], M322[1]
Socio-Economics	Factor Urban / Economic Development	n.s.	n.s.	n.s.	n.s.	**-.532****
	Factor Tourism	**.620****	n.s.	n.s.	**1.348*****	n.s.
	Factor Working Place	**.388***	**.356****	**.365***	**.362****	n.s.
	Factor Retirement	n.s.	**-.363***	n.s.	n.s.	n.s.
	Factor Peri-urbanisation	n.s.	n.s.	n.s.	n.s.	**-.444****
Landscape	Factor Forest/LFA	n.s.	**.575****	n.s.	n.s.	n.s.
	Factor Water/FFH	n.s.	n.s.	n.s.	.381*	n.s.
	Factor HNV Area	n.s.	n.s.	n.s.	n.s.	n.s.
Farming Structure	Factor Large-scale Agriculture	**.456****	**-.364***	n.s.	n.s.	n.s.
	Factor Grassland Management	n.s.	n.s.	**.595****	n.s.	n.s.
	Factor Horticulture	n.s.	**-.442****	n.s.	n.s.	**-.440****
	Factor Co-operatives	**.873*****	**.579****	n.s.	**.626****	n.s.
	Factor Arable Production	n.s.	n.s.	n.s.	**-.549*****	n.s.
Intercept		**.771*****	**.579*****	**-1.695*****	n.s.	n.s.
Chi²		*46.351*	*45.901*	*13.762*	*60.601*	*31.328*
Nagelkerke Pseudo R²		*.297*	*.294*	*.114*	*.364*	*.203*

*Significant at the 10% level, **significant at the 5% level, ***significant at the 1% level. [1]dichotomic variable; [2]measures per holding; [3]measures per 1,000 inhabitants

8.2.2 Model D (Expenditures) – OLS Regression (aspatial)

Table 13. OLS Regression model for RDP expenditures.

		Expenditures per ha UAA in €, M121[1]	Share of UAA under organic farming schemes 2010, in %	Expenditures per ha UAA in €, M311	Expenditures per ha UAA in €, M313	Expenditure Measure 322 per 1,000 inhabitants, in €
Socio-Economics	Factor Urban / Economic Development	n.s.	n.s.	n.s.	**1792.072*****	n.s.
	Factor Tourism	n.s.	n.s.	n.s.	n.s.	**13.924***
	Factor Working Place	n.s.	**-12.949*****	**50.976*****	n.s.	n.s.
	Factor Retirement	n.s.	**12.661****	**-47.565****	**892.689***	n.s.
	Factor Peri-urbanisation	n.s.	n.s.	n.s.	n.s.	n.s.
Landscape	Factor Forest/LFA	n.s.	n.s.	n.s.	n.s.	n.s.
	Factor Water/FFH	n.s.	n.s.	n.s.	n.s.	**18.171*****
	Factor HNV Area	n.s.	n.s.	**-15.399****	**-315.335***	n.s.
Farming Structure	Factor Large-scale Agriculture	n.s.	**-15.129****	n.s.	n.s.	n.s.
	Factor Grassland Management	n.s.	n.s.	n.s.	**-890.298****	n.s.
	Factor Horticulture	n.s.	n.s.	**51.910***	n.s.	n.s.
	Factor Co-operatives	**-634.662***	n.s.	n.s.	n.s.	n.s.
	Factor Arable Production	n.s.	n.s.	n.s.	**1729.060*****	n.s.
Intercept		**718.379****	**19.231*****	**37.029****	**1132.056*****	**30.405*****
R²		*.121*	*.524*	*.731*	*.438*	*.220*
Corrected R²		*.016*	*.353*	*.565*	*.351*	*.108*
Std. Error of Estimate		*2742.046*	*16.924*	*70.195*	*2827.353*	*62.296*

*Significant at the 10% level, **significant at the 5% level, ***significant at the 1% level.

8.3 Discussion of Results

– Due to the generally **high amount of municipalities without any participating** farm holding in the particular RDP measures, a **binary logistic regression model has been applied to explain the participation**. These models aim to explain the variation between municipalities with or without participating farm holdings, NOT the share of participating holdings. Against this background the results need to be interpreted. Generally the Nagelkerke Pseudo R² indicate a rather **low model quality**, which differ for the various measures (from 0.364 for measure 313 to 0.114 for measure 311).

– For modelling the **RDP expenditures OLS regression models have been applied**. To avoid too many zero figures, only those cases (municipalities) have been taken into consideration for the model, where at least one farm holding has participated in the measure. Regarding the interpretation, the models explain the intensity of RDP measures, NOT to simple occurrence. Further, the overall number of cases considered in the model was additionally reduced and need to be taken into consideration for interpretation (M121: N=108; M311: N=21).

– Occasionally, **participation and expenditure models for same measure show varying and even contrary behaviours of influencing factors** (e.g the role of factor "co-operatives" for measure 121 – positive for participation, negative for expenditure). Here, it needs to keep in mind that the participation model refers to all cases and the expenditure model only to those cases where the RDP measure has been adopted. So the data base for the regression model is not the same.

8.3.1 Measure 121

– The factors representing **co-operative farms** (0.873) and **large-scale agriculture** (0.456) account for the highest influence on the distribution of **participation and expenditures** in measure 121. This means that especially the large holdings participate in farm modernisation measures. This is an indication for the professionalisation of large-scale farms, including investment plans with public co-financing (others might invest without making use of 121). At least for expenditures, the factor horticulture is negatively related, which is interesting as the modernisation of irrigation systems is major priority of the programme.

– Little more surprising also the socio-economic factors for **tourism** and the **working places** outside agriculture have a **positive influence on the participation rate**. An argumentation could be the "insurance" factor, that general economic power and viability (counts also for tourism) and off farm work opportunities provide a positive climate for investments. Landscape and bio-physical parameters are without any significant influence.

8.3.2 Measure 214 (Organic Farming)

– The **participation** in organic farming schemes is **positively related to the forest/LFA factor** (0.575) confirming the observation of concentrations of organic farming in the surrounding of forested nature protection area (Schorfheide-Chorin, Spreewald).

– Concerning the agricultural structure, **large-scale farming** and **horticulture** account for **significant negative**, the availability of **co-operative ownership** for a **positive influence**. An interpretation of these results is difficult. Usually horticultural holdings relatively more often participate in organic farming schemes (MIL, 2010), whereas participation in traditional fruit and vegetable growing areas, e.g. county Teltow-Fläming[4] (5.6%), Märkisch-Oderland[5] (4.7%) is rather low.

– Regarding the model explaining the **distribution of the area share under organic farming** schemes (R²=0.353), especially the **large-scale agriculture shows significant negative**

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[4] South-west of Berlin

[5] East of Berlin

influence, confirming, that small-scaled structured communities tend to have a larger share of the agricultural land under organic farming schemes.

8.3.3 Measure 311

- The **participation model** for measure 311 (Diversification) has a **very low explanatory value** ($R^2=0.114$) with **grassland management** (0.595) as the only significant influencing factor. Certainly, the high number of "0" values and the skewness of the value distribution can be brought in as reasons for the weak model quality.
- When looking at the **expenditure model** for all municipalities under participation in M311, the model quality is improved ($R^2=0.565$). Socio-economic framework conditions such as **working place (positive) and aging (negative)** show significant relationship. It confirms some previous results, that the local (non-farming) community influence on diversification (Lange et al. 2013).

8.3.4 Measure 313

- For the **participation model** for measure 313 (Tourism infrastructure) the explanatory extent is 36.4%. Significant contributions come from the **factors tourism** (1.348), working place (0.362) and **arable production** (-0.549). Especially the positive influence of the presence of existing touristic accommodation facilities and overnight stays was to be expected. Also the absence of arable production as representative for more regular (partly intensive) agriculture is hardly surprising.
- In terms of the **expenditure intensity** ($R^2=0.351$), other factors, such as **urbanisation and retirement location account for a positive influence**. Here the consumer demands need to be taken into consideration as incentive to implement touristic infrastructure. Little counter-intuitive is the **strong positive relationship of arable production** and **negative relationship to grassland management**.

8.3.5 Measure 322

- The factors for **urbanisation/economic development** and **peri-urbanisation** account for **negative significant influence** for measure 322 (Village renewal). The programme follows a political distribution strategy (top-down in contrast to voluntary distribution patterns that only work on an individual basis.) to support specific target area. The measure is only applicable in villages.
- In terms of **expenditures per 1,000 inhabitants**, the model shows a **positive dependence from the factor water / FFH area**, which more or less also point to more peripheral areas.

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