System Report:
Agroforestry in the Spreewald Floodplain, Germany

Project name	AGFORWARD (613520)
Work-package	2: High Nature and Cultural Value Agroforestry
Specific group	Agroforestry in the Spreewald Floodplain, Germany
Deliverable	Contribution to Deliverable 2.4: Detailed system description of a case study system
Date of report	10 November 2015
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Contents

AGFORWARD (Grant Agreement N° 613520) is co-funded by the European Commission, Directorate General for Research & Innovation, within the 7th Framework Programme of RTD. The views and opinions expressed in this report are purely those of the writers and may not in any circumstances be regarded as stating an official position of the European Commission.

1 Context

The AGFORWARD research project (January 2014-December 2017), funded by the European Commission, is promoting agroforestry practices in Europe that will advance sustainable rural development. The project has four objectives:

1. to understand the context and extent of agroforestry in Europe,
2. to identify, develop and field-test innovations (through participatory research) to improve the benefits and viability of agroforestry systems in Europe,
3. to evaluate innovative agroforestry designs and practices at a field-, farm- and landscape scale, and
4. to promote the wider adoption of appropriate agroforestry systems in Europe through policy development and dissemination.

This report contributes to Objective 2, Deliverable 2.4: "Detailed system description of case study agroforestry systems". The detailed system description includes the key inputs, flows, and outputs of the key ecosystem services of the studied system. It covers the agroecology of the site (climate, soil), the components (tree species, crop system, management system) and key ecosystem services (provisioning, regulating and cultural) and the associated economic values.

2 Background

Hedgerows can be landscape structures of high cultural value. In the past in Germany, trees in hedgerows were periodically harvested every 5-15 years for fuelwood, and these interventions helped to maintain the hedgerow structure (DVL 2006). In recent decades, hedgerow trees have not been harvested due to a reduced need for firewood and the high labour requirements of these harvests (Reif and Richert 1995; DVL 2006). Planting and maintaining hedgerows requires substantial financial investment and it can be complicated in nature protected areas due to strict regulations.

The Spreewald reserve in Germany is protected by Natura 2000, all of the reserve is considered a Special Protected Area, and 27% is considered an important flora-fauna-habitat (FFH). The Filower Area, which will be used for this research is part of the FFH area. Due to nature protection regulations, the farmers are not allowed to harvest the old trees for their biomass without special permission. As a result, the hedges are not maintained and their rejuvenation is hindered by trampling and grazing by cattle and tree aging (Tsonkova and Mirck, 2015). Degradation of hedgerow structures has also increased because the dominant tree species, black alder (*Alnus glutinosa*) has become more susceptible to *Phytophthora alni* due to high water events during the past five years (Riek and Strohbach, 2004). Further, the European ash (*Fraxinus excelsior*) has also become a victim of *Hymenoscyphus fraxineus* in the Spreewald since 2006 (Alsop 2014). A rejuvenation strategy is necessary in order to maintain this historical agroforestry system and protect the provision of important ecosystem services. Rejuvenating these hedgerows demands a new approach to facilitate establishment and maintenance, and to investigate funding opportunities to reduce high financial burden to farmers.

3 Update on field measurements

Field measurements described in the research and development protocol (Tsonkova and Mirck 2015) began on October 7 2015 with a baseline assessment and will continue until the end of 2016. All measurements have been and will be conducted by researchers from the BTU Cottbus-Senftenberg.

4 Description of the system

The experiments are taking place in the Spreewald Biosphere Reserve. The research site is characterized by a mosaic of landscape features including hedgerows, a structure typical to the Spreewald. Table 1 provides a general description of the system. A description of the specific case study system is provided in Table 2.

Table 1. General description of hedgerows in nature protected area

General description of system	
Name of group	Agroforestry in the Spreewald Floodplain, Germany
Contact	Jaconette Mirck and Penka Tsonkova
Work-package	2: High Nature and Cultural Value Agroforestry
Associated WP	WP5
Geographical extent	Hedgerows in nature protected areas which need rejuvenation are found throughout Germany.
Estimated area	Spreewald reserve occupies 475 km^2.
Typical soil types	Gleysol
Description	In the past the tree hedgerows were maintained through regular harvests. It is prohibited to use products from hedgerows growing in nature protected areas in Germany. Hence, the farmers are not allowed to harvest the old trees for their biomass without special permission. As a consequence, the hedges are not maintained and their rejuvenation is further hindered by the presence of cattle. In addition to grazing pressure, trampling, tree aging and diseases significantly reduced natural rejuvenation.
Tree species	Trees include black alder (*Alnus glutinosa* (L.) Gaertn.), bird cherry or hackberry (*Prunus padus* L.), black poplar (*Populus nigra* L.), durmast oak (*Quercus petraea* Liebl.), English oak (*Quercus robur* L), willow (*Salix* spp.), European Ash (*Fraxinus excelsior* L), and Wych elm (*Ulmus glabra* Huds.) Shrubs include glossy buckthorn (*Frangula alnus* Mill.), common buckthorn (*Rhamnus cathartica* L), buckthorn (*Rhamnus alaternus* L.), wild rose (*Rosa canina* L.), blackberry (*Rubus sectio rubus*), European cranberrybush (*Viburnum opulus* L) and hops (*Humulus lupulus*)
Tree products	Biomass for heating and cooling
Crop species	None
Crop products	None
Animal species	Cattle
Animal products	Meat, milk. The average daily milk production in Spreewald is between 10 and 30 litres. The average milk production per year is 7500 l.
Other provisioning services	Possibility of using trees and shrubs as a source of biomass. In the forest area of the nature conservation zone in the Spreewald reserve the average timber use for the period 2000-2010 was 2.9 and 3.3 m^3 ha^{-1} yr^{-1} for the regions of Oberspreewald and Unterspreewald, respectively (MLUL 2012). The average yield of the grassland in Spreewald was estimated between 2 and 6 Mg DM ha^{-1} yr^{-1} which is in accordance with extensively managed grasslands (LUGV 2011).
Regulating services	The trees increase carbon storage, regulate the water balance and water quality. In the forest area of the nature conservation zone in Spreewald

	Reserve the average growth increment for the period 2000 to 2010 was 6.3 and 6.7 m^3 ha^{-1} yr^{-1} for the regions of Oberspreewald and Unterspreewald, respectively (MLUL 2012). Compared with the average timber use of 2.9 and 3.3 m^3 $ha^{-1}yr^{-1}$ in these regions, the trees are storing a significant amount of carbon in their biomass (MLUL 2012). High Nature and Cultural Value (HNCV) grasslands are related with improving water quality as leaching of nitrate is reduced under the extensive management. The average reduction for extensively managed grassland in Germany is between 0 and 20 kg N ha^{-1} when compared to intensively managed grassland and between 30 and 70 kg N ha^{-1} when compared to agricultural land (Osterburg et al. 2007). The average costs of preventing N leaching for the former were estimated at 100€ ha^{-1} and for the latter at 400€ ha^{-1} (Matzdorf et al. 2010).
Habitat services and biodiversity	The system provides habitats for rare species and assessing the development of biodiversity can be used to optimize the management of the system. Within the Environmental Monitoring Program established in 1998 data regarding relevant parameters is collected to assess soil, water, flora and fauna for different ecosystem types in the Spreewald reserve, e.g. forests, moor, grassland and agricultural land (Luthardt et al. 2007). The development of earthworm fauna in the forest ecosystem between 2000 and 2003 was related to the development of vegetation and weather fluctuations (Jenssen and Hofmann 2004). During an extreme drought period in 2003, a strong reduction in the abundance and biomass of earthworms was measured in the monitoring areas affected by drought. The earthworm abundance was reduced from 3.9 million ha^{-1} to 0.4 million ha^{-1} in a plot with bird cherry-European ash and from 2.8 million ha^{-1} to 0.6 million ha^{-1} in a plot with nettle and black alder. The vegetation patterns of black alder stands were related to the hydrological conditions of the groundwater table, with flooding during winter and the drying of the top soil in summer. Tree vitality, recently investigated at selected locations in Spreewald, was also found to follow the pattern of flooding events (Birnstengel 2015). Black alder stand damage on an area basis was observed in a location flooded for 5 to 12 weeks, whereas in locations flooded for 3 to 6 weeks trees were partly damaged. The damage could be mostly related to the variation in relief and the occurrence of diseases, such as *Phytophthora alni*. A clear link between structural diversity or tree species and tree damage could not be established. The Spreewald grasslands are rich in biodiversity including Red List species, for example *Caltha palustris*, *Ranunculus auricomus* agg., *Stellaria palustris*, *Carex vesicaria*, *Lychnis flos-cuculi* (LUGV 2011). The different species found within a monitoring plot varied between 3 and 9, while the total number of species varied between 6 and 32. The development of species was related to the intensity of use as different species have different requirements, but no clear trend regarding the influence of intensity, hydrology and soil conditions was found. Considering implementation of measures from the national biodiversity strategy, the willingness to pay to preserve biodiversity of HNCV grasslands in

	Germany amounted to approximately 10€ per month (Matzdorf et al. 2010).
Cultural services	The system has a high aesthetic and cultural value and is of importance for tourism. The region of Spreewald is important tourist area with about 2 to 2.2 million visitors between May and September each year (Grossmann 2011). With the decline in mining activities in the Lusatian region, water has become a contested resource and concerns were raised that the reduced water quantity could negatively affect the boat tourism which is important for the Spreewald region. The recreational value of the Spreewald wetland for boating trip tourism was quantified by Grossmann (2011) by using a travel cost method. For a one day trip the consumer surplus was estimated at 19€ and for a 3 day trip at 33€. A reduced water quantity would significantly affect the economic value of the area as recreational point considering the high number of tourists. The value of the hedgerow system remains to be assessed.
New initiatives to boost the HNCV agroforestry system/practice	In 2015 the community foundation "Spreewald Cultural Landscape" launched a program called "Spreewald Grassland Shares" to stimulate public involvement in maintaining the traditional landscape of Spreewald, more specifically the maintenance of grassland. Buying a share for the amount of 50€ guaranties the maintenance of 0.1 ha of grassland for 1 year.

Table 2. Description of the specific case study system

Specific description of site	
Area	109 ha
Co-ordinates	51°52'N;14°4'E (51.87186654N, 14.07097541E)
Site contact	BTU contact: Jaconette Mirck and Penka Tsonkova
Site contact email	jmirck@gmail.com; penka.tsonkova@b-tu.de
Example photograph	

Map of system

Map of Germany with location Spreewald (inlay; Source: http://www.spreewald-info.de). Aerial photo Filower area, where red line delineates the trial field (Source: Google Maps).

Possible modelling scenarios	
Comparison	Technical and economic analysis of hedgerow protection vs. status quo
Climate characteristics	
Mean temperature	9.4°C
Mean annual precipitation	570 mm
Details of weather station (and data)	Data from 01/01/1981-31/01/2010 (available here) for the Luebben-Blumenfelde weather station (id: 3083, 51°56'N, 13°53'E)
Soil type	
Soil type	Gleysol
Soil depth	>3 m
Soil texture	Loamy sand
Groundwater	Groundwater depth between 10 and 80 cm
Tree characteristics	
Species and variety	Trees include black alder (*Alnus glutinosa* (L.) Gaertn.), black poplar (*Populus nigra* L.), bird cherry or hackberry (*Prunus padus* L.), English oak (*Quercus robur* L), and willow (*Salix* spp)

	Shrubs include glossy buckthorn (*Frangula alnus* Mill.), common buckthorn (*Rhamnus cathartica* L), buckthorn (*Rhamnus alaternus* L.), wild rose (*Rosa canina* L.), blackberry (*Rubus sectio Rubus*), European cranberrybush (*Viburnum opulus* L), and hops (*Humulus lupulus*)
Date of planting	
Intra-row spacing	To be confirmed
Inter-row spacing	~50 m
Tree protection	None
Crop/understorey characteristics	
Species	Sedge (*Carex* spp), such as lesser pond-sedge (*Carex acutiformis*), meadow soft grass (*Holcus lanatus*), creeping buttercup (*Ranunculus repens*), rabbitfoot clover (*Trifolium arvense*), bitter dog *(Rumex obtusifolius*), and reed sweet-grass (*Glyceria maxima*)
Management	Extensively managed through grazing with cattle and mowing
Crop products	Fodder. The yield of the grassland in the Filow area was estimated at 6.9 t DM ha^{-1} yr^{-1} (LUGV 2011).
Regulating services	The grass cover protects soil from erosion
Habitat services and biodiversity	Grazing and intensity of use affected the biodiversity of grassland and moor areas. In the monitoring plot of the Filow grassland area a reduction in the plant diversity between 1999 to 2009 from 128 to 96 total number of species (LUGV 2011). Considering only the buffer area between the hedgerow and the field the number of species was reduced from 30 to 6. This reduction was associated with the grazing activities in the neighbouring tree row. Regarding the average species per recording plot which varied between 9 and 19, Filow was among the species richest areas with 19 species which could be associated with the common use which prevented the development of dominant species and allowed the growth of rare plant communities and non-competitive species.
Fertiliser, pesticide, machinery and labour management	
Fertiliser	None
Pesticides	None
Machinery	Mowing
Manure handling	To be confirmed
Labour	
Livestock management	
Species and breed	Cattle
Date of entry to site	May
Date of departure from site	October
Stocking density	Summer: 3 ha^{-1} Winter: None
Animal health and welfare issues	
Financial and economic characteristics	
Costs	The area is a part of the nature conservation zone of the biosphere reserve and the activities are organised with priority to nature conservation. According to Beesk (2013) the potential amount of black alder found in the hedgerows in 1/10 of the Filow area (11 ha), would yield 889 solid cubic meter timber which could amount to the potential value of 17780 €.

5 Tree component

The tree hedgerows consists of native flood plain species and have three layers (tree, shrub and herbaceous). Tree species that can be found are black alder (*Alnus glutinosa* (L.) Gaertn.), black poplar (*Populus nigra* L.), bird cherry or hackberry (*Prunus padus* L.), English oak (*Quercus robur* L), willow (*Salix* spp). Commonly found shrub species are glossy buckthorn (*Frangula alnus* Mill.), common buckthorn (*Rhamnus cathartica* L), buckthorn (*Rhamnus alaternus* L.*),* wild rose (*Rosa canina* L.), blackberry (*Rubus Sectio Rubus*), European cranberrybush (*Viburnum opulus* L), Hops (*Humulus lupulus*). The Spreewald is a semi-natural system. This research will focus on the Filower site, which is characterized by its mosaic structure of tree hedgerows intertwined with small meadows. The tree rows are between 10 and 15 m wide and the distance between them is about 50m.

6 Grass component

The grass consists of native grasses such as meadow soft grass (*Holcus lanatus*), lesser pond-sedge (*Carex acutiformis*), creeping buttercup (*Ranunculus repens*), rabbitfoot clover (*Trifolium arvense*), *bitter dog* (*Rumex obtusifolius*), and reed sweet-grass (*Glyceria maxima*) (LUA 2004; LUGV 2011). The grass is mowed twice each year and used as an animal feed. In addition, cattle graze the grassland from May to October.

7 Baseline assessment

7.1 Conceptual design

The primary concern in developing the rejuvenation strategy is to establish both harvest and planting designs while taking into account current conditions, funding possibilities, maintaining ecological functions and services and ensuring protection for the newly planted trees (Tsonkova and Mirck, 2015). Five treatments were identified (Table 3) according to Tsonkova and Mirck (2015).

Table 3. Description of the five treatments

Treatment	Harvesting/rejuvenation method	Regeneration method
I	Whole row harvesting when rows are close together	One third to one fifth of the rows can be harvested and subsequently left for natural regeneration
II	Whole row harvesting when rows are close together	One third to one fifth of the rows can be harvested and subsequently left for natural regeneration and **protected with fences**
III	Gap filling combined with single tree harvesting	Gaps and/or harvested trees will be filled/replaced with long lived trees and subsequently left for natural regeneration
IV	Gap filling combined with single tree harvesting	Gaps and/or harvested trees will be filled/replaced with long lived trees and **protected with fences**
V	Business as usual	No protection

7.2 Description of design

The research field is located on the northern part of the Filow area and consists of 15 hedgerows (Figure 1 and Figure 2). The plots were selected in autumn 2015.

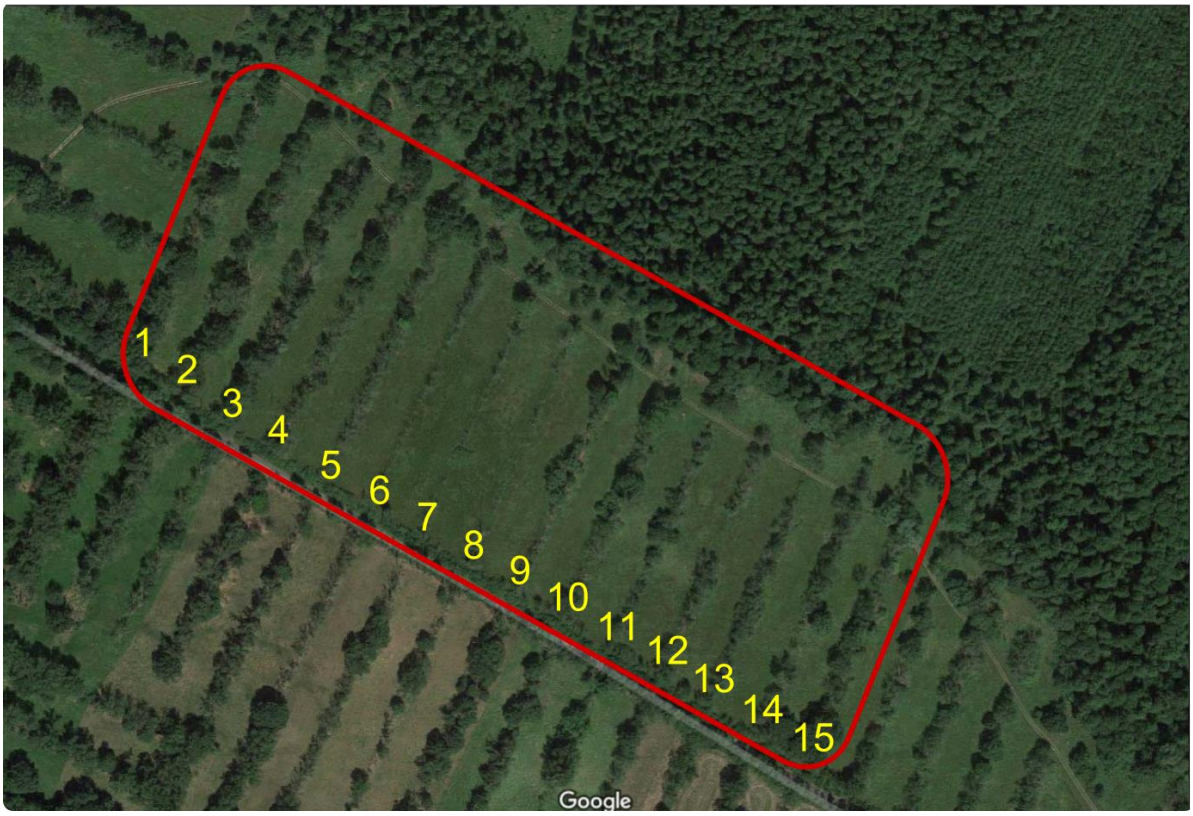

Figure 1. Aerial view of the research area

Treatment I and II will be applied in hedgerows 7 and 8 (see Table 3). Hedgerow 7 which consists almost exclusively of deadwood is shown in Figure 2.

Figure 2. Hedgerow 7

Treatments III, IV, and V can be applied in hedgerows 13 and 15 which are better preserved, (see Table 3). Hedgerow 13 is shown in Figure 3.

Figure 3. Hedgerow 13

Hedgerows 13 and 15 were divided into 6 plots (A to F), each plot had a length of 20 m. The width of the plots varied. Within these plots vegetation assessment was conducted representing the initial condition.

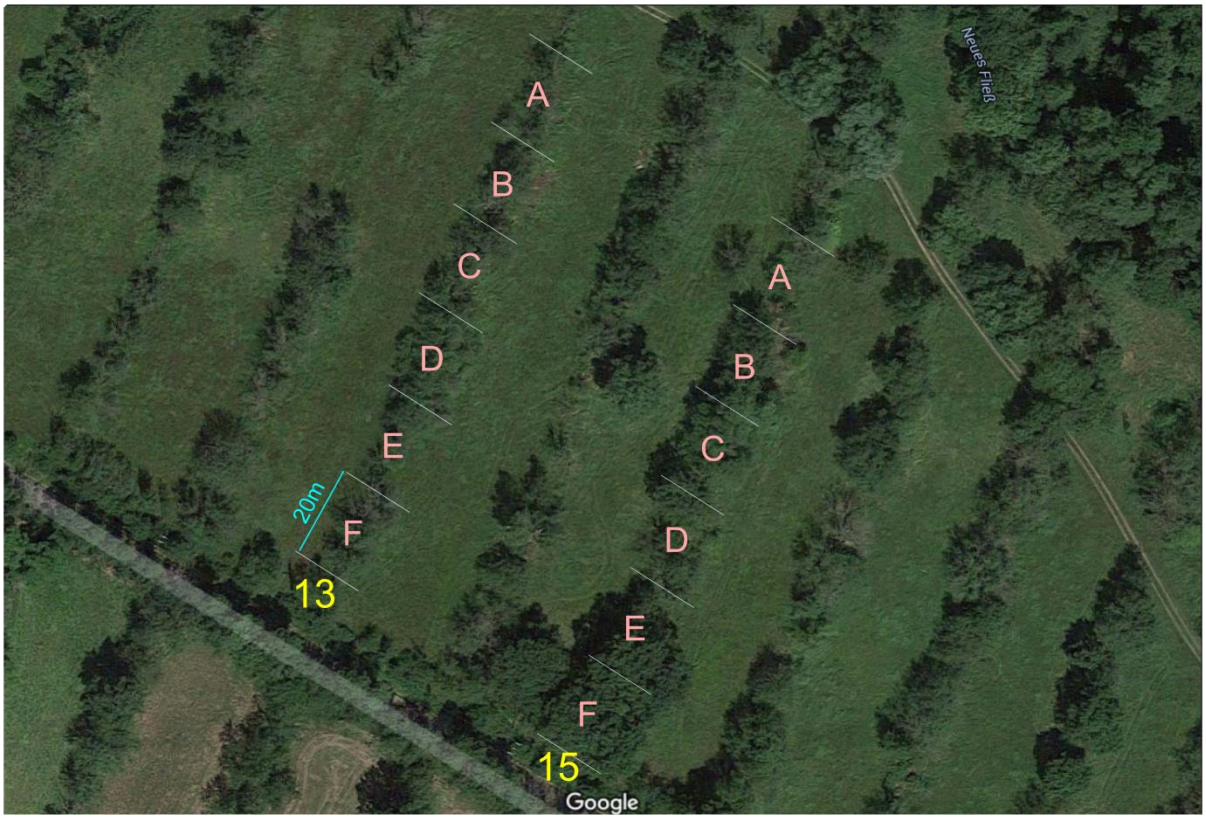

Figure 4. Hedgerows 13 and 15 and research plots

7.3 Measurements

The measurements and actions are described in Table 4 based on Tsonkova and Mirck (2015).

Table 4. List of measurements

Component	Description of measurements	Parameter/action	Time
Site characteristics	Investigate site conditions in terms of soil characteristics, weather (local weather station), and water availability.	Map of soil types	Summer 2015/2016
		Map of biotope types	Summer 2015/2016
		Map of water availability	Winter 2015/2016
Soil	Soil samples will be collected in three depths (0-10, 10-30, 30-60 cm) to determine whether the hedgerow degradation has adversely impacted soil quality	Soil active Carbon	2016
Tree biomass live matter	Diameter and height measurements for tree measurement plots will be carried out for both harvested and non-harvested plots to measure regrowth and survival.	Diameter	Winter 2016
		Height	
Design of renewal strategy and selection of new tree species	Carry out vegetation surveys using designated measurement plots.	Designate Plots Vegetation survey	Autumn 2016
	Select appropriate species for rejuvenation.	Select tree and shrub species	Autumn 2016
	Arrange selected species according to the conditions, e.g., trees vs. shrubs, fast growing vs. long lived.	Arrange species according to site conditions	2016
Costs and benefits	Revenues from harvested biomass	Estimate biomass	2016/2017
	Costs of biomass harvesting	Record costs	2016/2017
	Cost of fence and fencing	Record costs	2016/2017
	Assess agroforestry product markets for dead wood and harvested wood		2016
	Cost of installing and using a bio-burner		2016/2017

8 Provisional results

8.1 Description of soil and biotope types

Soil and biotope characteristics are shown in Figure 5 and Figure 6. These are important for species selection, because the research site is in a nature conservation area and therefore new plantings should use autochthonous material (Reif and Richert 1995). The soil in the research area is characterised as Gleysol [in German "Anmoorgley"] in close proximity to a marsh (in German "Moor"). The biotope type is characterized as floodplain pasture [in German "wechselfeuchtes Auengrünland"], which is found at the edge of upland swamps, where the alder swamp forests can be found [in German "Moor und Bruchwälder"].

Furthermore, hydrological conditions such as include flooding events during winter and drying of topsoil during summer influence tree growth (Jenssen and Hofmann, 2004). Therefore, a map of water availability is under preparation.

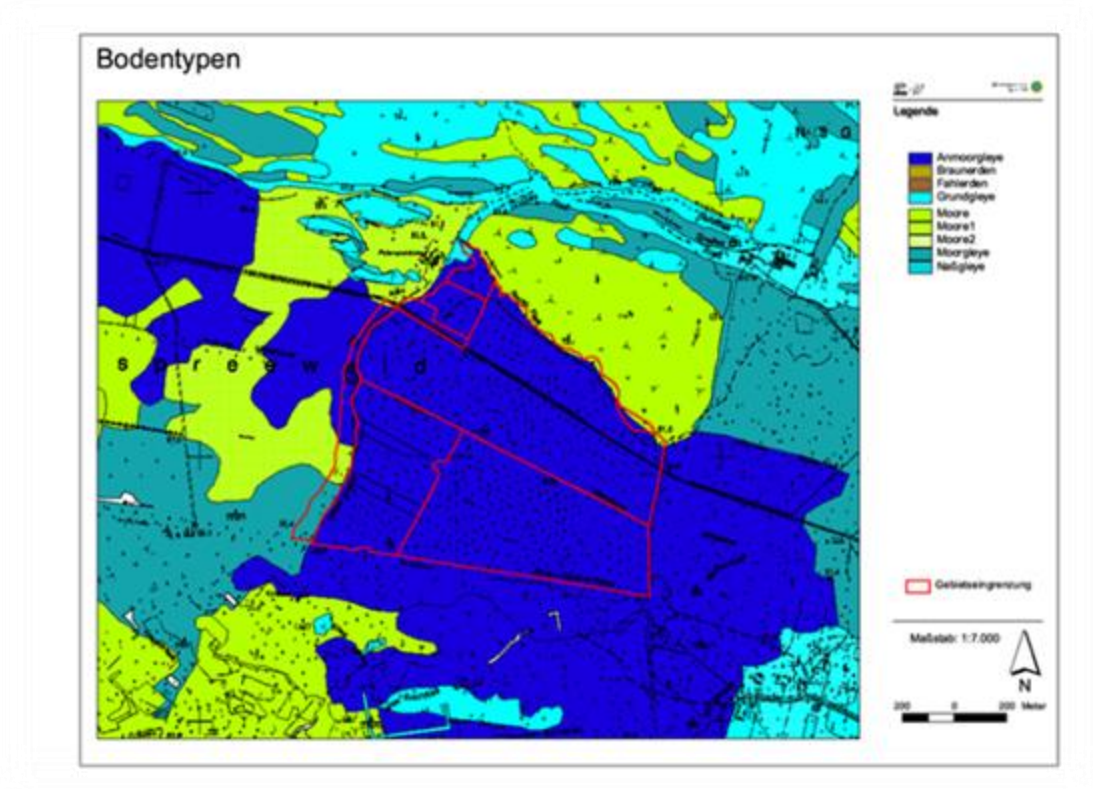

Figure 5. Soil types in the Filow area

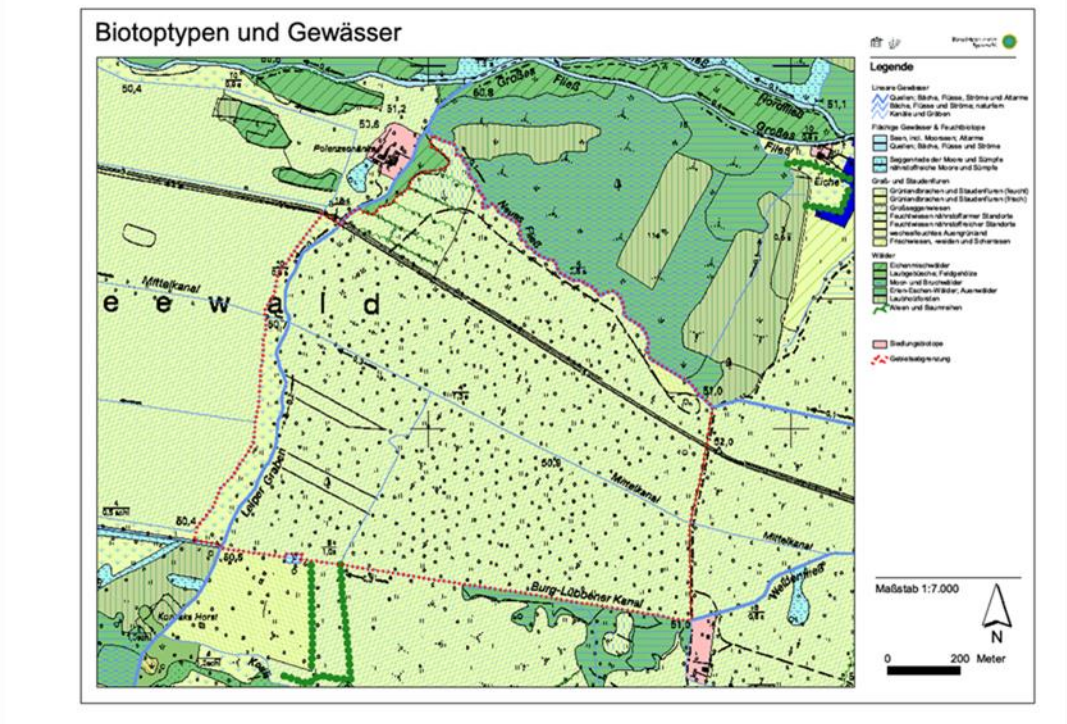

Figure 6. Biotope types and water bodies in the Filow area

8.2 Description of tree and shrub components

The 15 hedgerows in the research area were characterized in terms of their vegetation cover (Table 5). All of the hedgerows had a high coverage in the herb layer (between 66 and 100%). The coverage of shrub layer was lower between 0 and 33%, except for hedgerows 9 and 13, where the shrub layer had a medium coverage of 33-66%. The tree layer demonstrated higher variation with lowest coverage in hedgerows 5 to 9, medium coverage in hedgerows 4, 11, 12, 14, 15, and high coverage in hedgerows 1 to 3, 10 and 13.

Table 5. Vegetation cover according to height (m) and relative cover (%)

Row	Herbal layer (<0.5m)			Shrub layer (0.5-5m)			Tree layer (>5m)		
	0-33%	33-66%	66-100%	0-33%	33-66%	66-100%	0-33%	33-66%	66-100%
1			x	x					x
2			x	x					x
3			x	x					x
4			x	x				x	
5			x	x			x		
6			x	x			x		
7			x	x			x		
8			x	x			x		
9			x		x		x		
10			x	x					x
11			x	x				x	
12			x	x				x	
13			x		x				x
14			x	x				x	
15			x	x				x	

In addition, hedgerow density was recorded according to following three categories; 1) closed for fully dense crown coverage; 2) small gaps when 1 to 33% of the hedgerow was open, and 3) with big gaps when at least one third of the hedgerow was open (Table 6). No hedgerows with closed crowns were found in the area. Hedgerows with small gaps were dominant. Hedgerows 6 to 9 had the lowest tree layer coverage and as can be expected also the greatest number of big gaps. Noteworthy is that these hedgerows also showed lowest vitality (Figure 1). The reason for this is that the area is lower and as a consequence the trees suffered during two recent flooding events.

Table 6. Hedgerow density (%)

Row	Closed <1%	Small gaps 1-33%	Big gaps >33%
1		x	
2		x	
3		x	
4		x	
5		x	
6			x
7			x
8			x
9			x
10		x	
11		x	
12			x
13		x	
14		x	
15		x	

Based on these characteristics, hedgerows 13 and 15 were selected for a detailed vegetation assessment. Tree and shrub species were identified and quantified according to their relative proportion for all plots in both hedgerows. The species found are listed in Table 7.

Table 7. Tree and shrub species found in the research area

	Botanical name	English
Tree	*Alnus glutinosa*	Black alder
	Prunus padus	Bird cherry
	Quercus robur	English oak
Shrub	*Alnus glutinosa*	Black alder
	Humulus lupulus	Hop
	Prunus padus	Bird cherry
	Rhamnus frangula	Alder buckthorn
	Rosa canina	Dog rose
	Rubus sectio Rubus	Blackberry

The relative proportions of tree and shrub species according to the plots in hedgerows 13 and 15 are given in Figure 7 and Figure 8. The main tree species is black alder (*Alnus glutinosa*) which comprised 70% of the trees present and the main shrub species is blackberry (*Rubus sectio Rubus*) which accounted for 40% of shrub species. These results agree with findings from other studies (e.g. Beesk 2013; Rubo and Hilgendorf 2009). *Quercus robur* was found in the area as a long-lived tree comprising 8% of hedgerow 15. This tree will not be harvested.

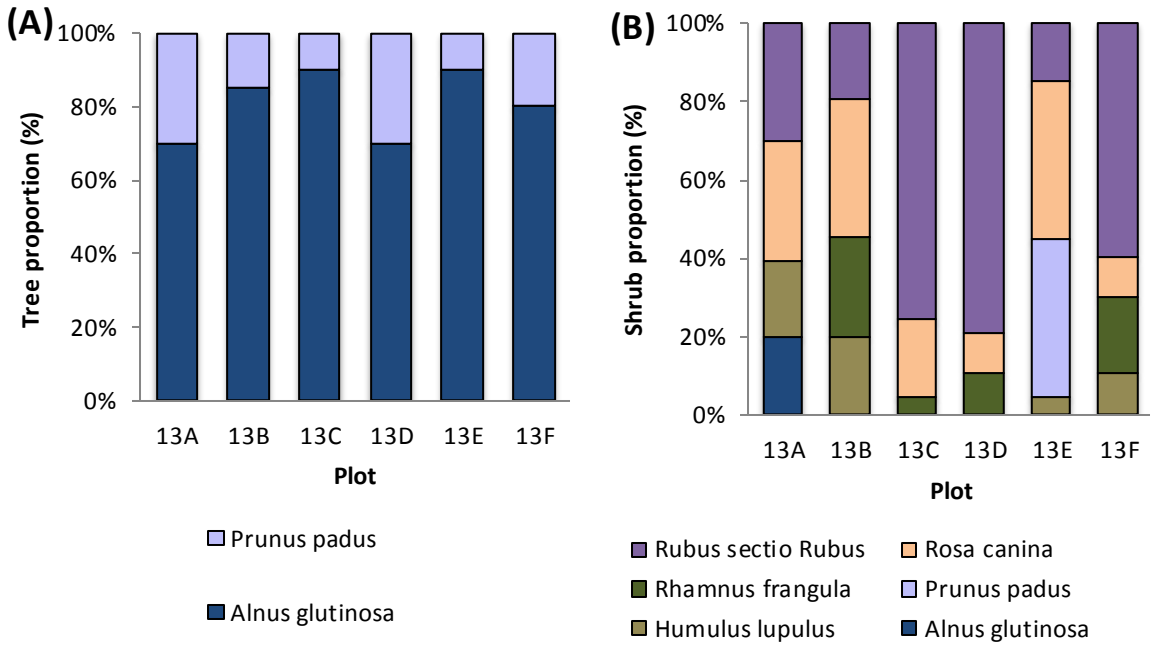

Figure 7. Relative proportion of trees (A) and shrubs (B) in hedgerow 13

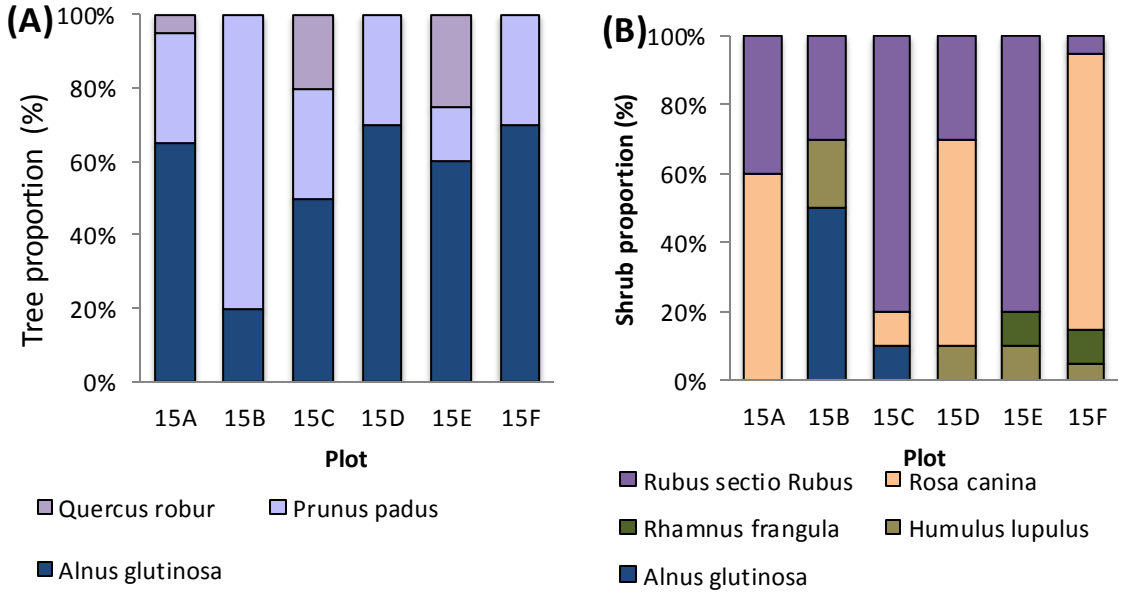

Figure 8. Relative proportion of trees (A) and shrubs (B) in hedgerow 15

The proportion of deadwood in the plots of hedgerows 13 and 15 is given in Figure 9 and Figure 10, respectively.

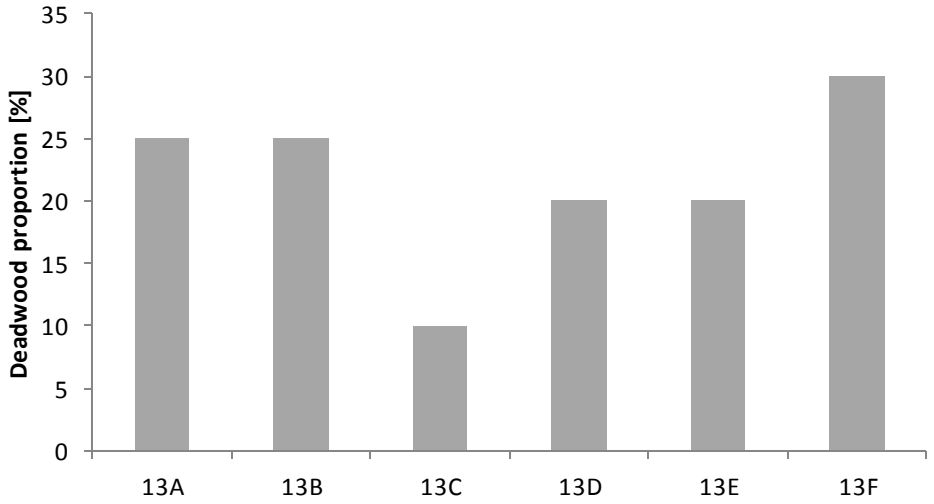

Figure 9. Proportion of deadwood in hedgerow 13

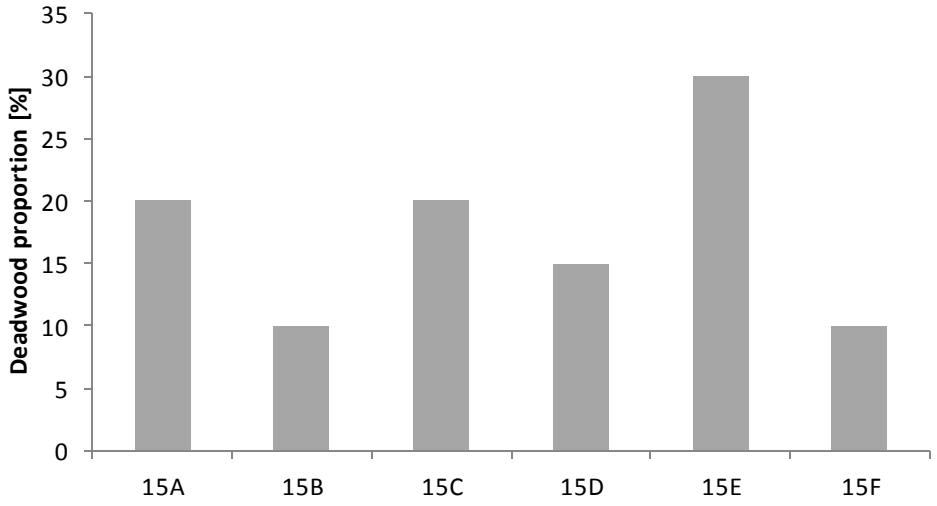

Figure 10. Proportion of deadwood in hedgerow 15

Deadwood represents approximately 20% of the hedgerow. Deadwood provides important habitat for species such as bats, but the amount can be reduced. In addition, deadwood may lead to an increase in nutrients which promotes the growth of undesirable species, like nettles, which may inhibit the growth of new seedlings and hinder hedgerow regeneration (Reif and Richert, 1995).

8.3 Design of strategy and selection of tree and shrub species

The multi-species hedgerow design is given in Tsonkova and Mirck (2015). The tree and shrub species preliminary selected for planting and their site characteristics are shown in Table 8.

Table 8. Selected tree and shrub species for hedgerow planting

Type	Botanical name	Height (m)	Light require-ments	Soil					
				Low nutritional value soil		Medium nutritional value		High nutritional value	
				Wet	Dry	Dry	Wet	Dry	Wet
Long-lived trees	*Acer platanoides*	25	○◑●			■	■	■	■
	Acer pseudoplatanus	25	○◑●			■		■	■
	Carpinus betulus	15	○◑●			■	■	■	■
	Quercus robur	25	○◑	■		■		■	■
	Tilia cordata[1]	25	○◑●			■	■	■	■
	Tilia platyphyllos[2]	25	○◑●			■		■	
	Ulmus glabra[3]	25	○◑			■		■	
	Ulmus laevis	25	○◑			■		■	
Fast-growing trees	*Alnus glutinosa*	20	○◑			■		■	
	Populus nigra	25	○			■		■	
	Populus tremula	15	○◑	■	■	■	■	■	■
	Salix	25	○			■		■	
Shrubs	*Rosa canina*	3	○◑	■		■	■	■	■
	Rhamnus cathartica	6	○◑●	■	■	■	■		
	Viburnum opulus	4	○◑●			■		■	
	Salix spp	3	○◑	■		■		■	
	Frangula alnus	4	○◑●			■	■	■	■

Source: DVL (2000)

○ Full sun ◑ Partial shade ● Shade

[1] Trockenheitsresistent aber auch ein Baumart der frischen Standorte

[2] http://www.wald.de/sommerlinde-tilia-platyphyllos-scopoli/

[3] http://www.wald.de/die-bergulme-ulmus-glabra-hudson/

In addition to selecting the species their relative proportion is also important for hedgerow planting. The proportion of long-lived trees does not need to be more than 10%. The selected main tree species is black alder which will account for about 70% of tree species. The species arrangement will be conducted after harvesting in 2016.

8.4 Costs and benefits

A cost estimation for planting and fencing materials according to DVL (2006) is given in Table 9. The costs for material and working hours for planting one hedgerow that is 100 m long and 6 m wide with 3 rows and 8% long lived trees are given in Table 10 according to DVL (2006).

Table 9. Example costs of materials (€) for planting and fencing a hedgerow

	Type	Unit	Cost
Planting material	Broad leaved tree between 100 and 125 cm	€/piece	1.50
	Broad leaved tree between 150 and 200 cm	€/piece	3.50
	Shrub between 40 and 60 cm	€/piece	0.90
	Shrub between 60 and 100 cm	€/piece	1.50
Fence	Mesh wire	€/m	0.90
	Wooden fence posts	€/piece	4.00
	Total	€/m	1.80

Table 10. Costs of material (€) and labour (h) required to plant and fence 100 m of hedgerow

Material	Broad leaved tree between 150-200 cm x 108 pieces	380 €
	Shrub between 60 and 100 cm x 325 pieces	490 €
	Shrub between 40 and 60 cm x 867 pieces	780 €
	Fence	360 €
	Total costs of materials	**1830 €**
Labour	Planting	33.5 h
	Fencing	16h
	Total working hours	**49.5h**

The cost of labour varies depending on whether the workers are permanent or temporary as well as on their qualification. For a better cost estimation for planting material and labour cost in the research area quotes of local forestry companies are required. For the first trial the total length of hedgerow regeneration amounts to 600 m (4 hedgerows, each ~150 m long). In addition, the costs for soil preparation, plant watering, and machinery used has to be taken into account. No estimation of benefits can be given at this moment.

9 Acknowledgements

The AGFORWARD project (Grant Agreement N° 613520) is co-funded by the European Commission, Directorate General for Research & Innovation, within the 7th Framework Programme of RTD, Theme 2 - Biotechnologies, Agriculture & Food. The views and opinions expressed in this report are purely those of the writers and may not in any circumstances be regarded as stating an official position of the European Commission. We acknowledge the support of Biosphere Reserve Spreewald.

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