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Cooperation between scientific institutions and local administration – the way for implementation landscape ecology knowledge into practice

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Abstract: Intensive agricultural activity in the last two centuries has brought about serious threats to sustainable development of rural areas. Achieve the higher and higher yield without consideration the negative effect caused by such activity was a paradigm of agriculture. Worsening of agricultural landscape properties (water deficit, depletion of soil organic matter content, impoverishment of biodiversity, pollution of environment) leading to retardation of ecosystem services made the ecologist end environment engineers to look for toolkit allowing to counteract such negative trends. Increasing production farmers subsidize energy in order to simplify plant cover structure both within cultivated fields (selection of genetically uniform cultivars and weeds elimination) and within agricultural landscape (elimination of hedges, stretches of meadows and wetlands, small mid-field ponds). There is growing body of ecological knowledge that management of agricultural landscape for its structural diversity is becoming the important pillar of the sustainability of rural areas. Programs of environmental protection in rural areas should aim not only at introduction environmental friendly technologies of cultivation within farm. They should also be concerned with challenge of how to increase the resistance or resilience of the whole landscape against threats. Close cooperation between local administration and scientific institutions is prerequisite to achieve positive effect of implementation of ecological knowledge into practices. Since the end of last century Institute for Agricultural and Forest Environment cooperate with local administration (district, commune and local society) in the frame of enhancement shelterbelt net, restoration degraded postglacial ponds and other mid-field or village ponds as well as restoration and reconstruction old by palace parks.

Key words: rural areas, small water bodies, landscape management, knowledge implementation, cooperation of scientist and local administration

Introduction

The environmental problems appearing in rural areas all over the world have become one of the serious threats undermining prospects for implementation of sustainable development not only in agriculture but also distort a global economy. Agronomic research have traditionally focused on the farm level, leading to more productive and economically efficient methods of plants cultivation and animal husbandry, which simultaneously resulted often in environmental threats. More recently, however, the recognition of landscape properties having important bearing for control of threats opened new frontiers for sustainable management of rural areas (Ryszkowski et al. 1999).

Intensive agricultural activity in the last two centuries has brought about serious threats to sustainable development of rural areas. Many errors in agricultural activity made in the last centuries brought about deterioration of landscape functions and worsening or even lost of ecosystem services. Farmer desiring to get higher and higher yields caused simplification of the landscape structure by elimination unproductive element like mid-field ponds, shelterbelts, ditches and so on. According to Gołaski (1988) and Kaniecki (1991) in Wielkopolska region near all mill ponds and majority of small water bodies disappeared during last two centuries (Fig. 1).

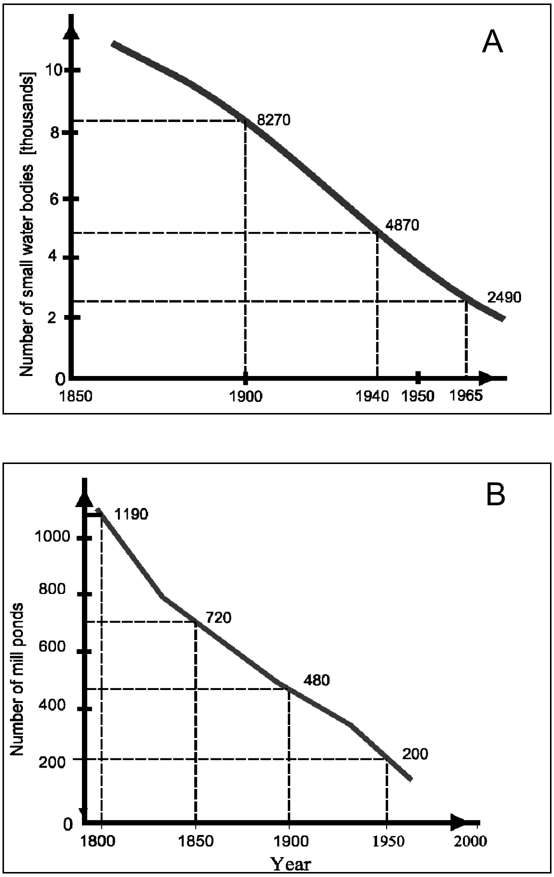
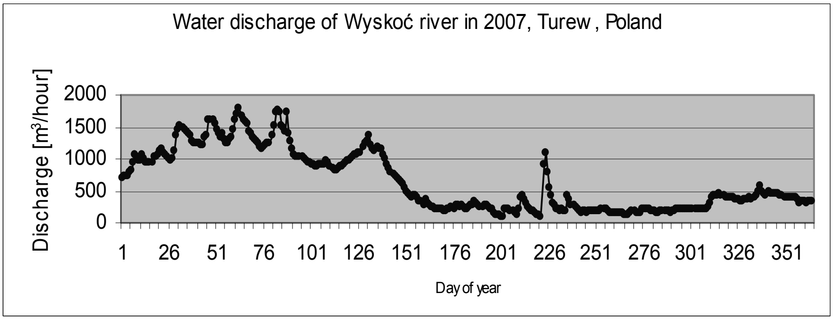


Fig. 1. Disappearing small water bodies in Wielkopolska, Poland (Kaniecki 1991) – A and mill ponds within watersheds of Warta, Brda and part of Barycz (Gołaski 1988) – B

One of the most serious threats is increasing water shortage and water pollution, mainly ground water pollution. The water balance of studied areas, located in Wielkopolska region, is very unfavorable for development of sustainable agriculture, especially in the front of expected climate conditions. In long-term scale relatively low precipitation and high evapotranspiration born the problem with restoration of soil water reserve. In the case of increasing air temperature and wind speed causing increase of atmospheric water vapor demands the depletion of ground water reserve will be occur. Increasing worsening environmental water condition in Poland, particularly in Polish Lowland during last century as well as today is observed. It manifests mainly by increasing soil water deficit, longing series of drought, and drying up small water courses and midfield ponds (Fig. 2).



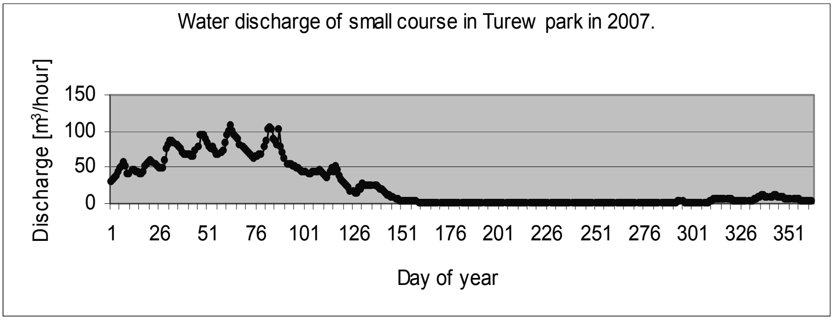


Fig. 2. Discharges of small water courses in the Turew vicinity, Poland.

In very dry and extremely dry years magnitude of water deficits (differences between evapotranspiration an sum of precipitation and readily available water in the soil) varied from 29 mm (in dry years on heavier soils) to 169 mm (in extremely dry years on lightest soils), (Tab. 1).

Achieve the higher and higher yield without consideration the negative effect caused by such activity was a paradigm of agriculture. Worsening of agricultural landscape properties (water deficit, depletion of soil organic matter content, impoverishment of biodiversity, pollution of environment) leading to retardation of ecosystem services made the ecologist end environment engineers to look for toolkit allowing to counteract such negative trends. Increasing production farmers subsidize energy in order to simplify plant cover structure both within cultivated fields (selection of genetically uniform cultivars and weeds elimination) and within agricultural landscape (elimination of hedges, stretches of meadows and wetlands, small mid-field ponds). There is growing body of ecological knowledge that management of agricultural landscape for its structural diversity is becoming the important pillar of the sustainability of rural areas. Programs of environmental protection in rural areas should aim not only at introduction environmental friendly technologies of cultivation within farm. They should also be concerned with challenge of how to increase the resistance or resilience of the whole landscape against threats.

The activity for increase water retention and its use efficiency and reducing unproductive water outflow from the landscape should be undertaken in the both, microscale (farm) and macroscale (region and country).

Tablel. 1. Water deficits on arable lands in Wyskoć catchment during IV–IX, Turew, Wielkopolska

Land classe	Soils	Rn	ETR	P In year:				Retention	
				normal	dry 82% of norme	v. dry 62% of norme	ekstr. dry 50% of norme	TAW	RAW
1	Pl, pl.ps, pl:ps, ps.pl,	88	415	365	299	226	186	60	35
2	ps, ps:pl, ps:gl	90	415	365	299	226	186	80	45
3	ps.gl, pgl.gl, pgl:gl	93	415	365	299	226	186	120	65
4	pgm.gl, pgm:gl	95	415	365	299	226	186	160	80
		P+TAW in year:				P+TAW-ETR in year:			
		normal	dry	v. dry	ekstr. dry	normal	dry	v. dry	ekstr. dry
1	Pl, pl.ps, pl:ps, ps.pl	425	359	286	246	10	–56	–129	–169
2	ps, ps:pl, ps:gl	445	379	306	266	30	–36	–109	–149
3	ps.gl, pgl.gl, pgl:gl	485	419	346	306	70	4	–69	–109
4	pgm.gl, pgm:gl	525	459	386	346	110	44	–29	–69

Rn – net radiation [W m^{-2}], ETR – real evapotranspiration, [mm], P – precipitation [mm],
TAW – total available water [mm], RAW – readily available water [mm].
Soil: pl, pl.ps, pl:ps, ps.pl – sandy soil; ps, ps:pl, ps:pg – loamy sandy soil; ps.gl, pgl.gl, pgl:gl – sandy loamy soil; pgm.gl, pgm:gl – loamy soil. One dot between symbols (pl.ps) means that thickness of upper layer equals 30 cm, and bottom layer 70 cm, two dots means inversely – upper layer thickness equals 70 cm but bottom layer 30 cm.

The following activity should be needed to achieve these goals:

1. Increase of small water retention by:

– the use of existing midfield water bodies (postglacial and country ponds),
– restoration of damaged postglacial ponds,
– the use the local depressions for storage of spring water,
– the introduction of sluice gate on the drainage ditches.

2. Increase of soil water retention by:

– increasing of organic matter content in the soil,
– improving soil structure.

3. Creation of the proper plant cover structure in the landscape for controlling of erosion processes, water balance structure, intensity of matter cycling and impact of heat advection on water balance of the landscape by:

– introduction of shelterbelt net into monotonic agricultural landscape,
– increasing complexity of landscape structure,
– increasing non-productive elements in the landscape,
– increasing proportion of non-arable lands to arable lands.
– Increase of water retention in the area neighboring on small pond can be even higher than in the pond itself (Juszczak and Kędziora 2004, Ryszkowski and Kędziora 2003 Juszczak et al. 2007) (Fig. 3).

In the case of reservoirs having long shore, the amount of water stored in the basins of this reservoir can be the dominant effect of human activity for increasing water retention (Ryszkowski and Kędziora 2003). In the Wyskoć river catchment (center of Wielkopolska), it was found that on the area of one square kilometer exist 3.5 small water bodies (Kędziora and Juszczak 2005). The additional water reserve calculated as a depth of water layer on whole catchment reaches 10.4 mm. But if we take under consideration the fact that arable lands in Wyskoć catchment amounts to 30% of total catchment area, this reserve is enough to cover one dose of irrigation amounting 30 mm. Within the analyzed catchment, the local depressions which could be used for retention of spring and drainage water are much numerous than existing small midfield ponds. So, the amount of potential stored water can be higher than it follows presented above analysis. Similar situation can be found in many region of the country.

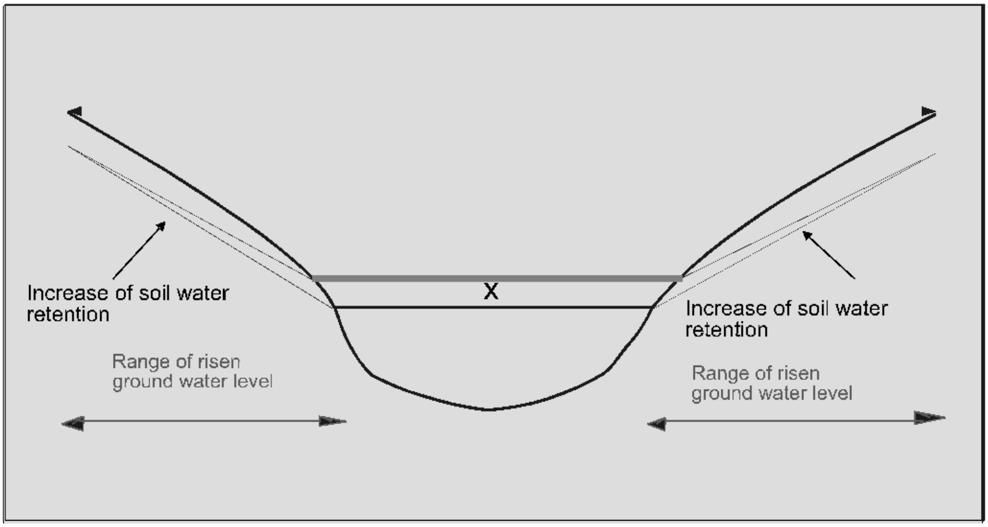


Fig. 3. Increase of water retention in the pond and in adjoining area as a result of rising water level by value X

Ecosystem services and its improvement

The concept of ecosystem services was developed capitalizing on ecological knowledge that ecosystems perform various functions like increasing or retarding water fluxes, cleansing or polluting water, and modifying microclimatic conditions, sustaining or impoverishing biological diversity and so on. The ecosystem services are those goods or non-commodities which benefit people (Millennium Ecosystem Assessment 2005).

The ecosystem services can be divided into:

– supporting which underpin other categories of services (solar energy fluxes, matter cycling including water, photosynthesis),
– provisioning providing goods like food, fiber, timber etc.,
– regulating that is cleansing water, modifying microclimatic conditions, controlling rates of matter cycling, regulating diseases etc.,
– cultural providing non-material benefits from ecosystem.

Understanding landscape functions people can stimulate nature services which can limit or modify intensity of negative effects brought about by an intensification of agricultural production needed for feeding human population.

Co-adaptation of human activities with landscape services relies on policy that economic processes should be conformed with ecological processes operating in the region which are enhancing landscape capacities for naturalization of pollution, regeneration of wastes, recycling of water recourses as well as increasing resistance or resilience of the whole system to stresses caused by production of goals required by society. Recognition of system multifunctionality helps to achieve that goal.

The small water bodies in rural areas play a multiple role in environment: improving of microclimatic conditions, storing of water for small scale irrigation, intensifying of water cycling, controlling of chemicals migration, serves people for recreation, can be used as water reservoir for fighting with fire and is habitat of mezofauna, especially amphibia. Water bodies by intensive evaporation use nearly all solar energy, so the heating of the air is much weaker than over the land. In the night, the heat stored in water prevents the deep cooling of the area in the vicinity. Because small ponds use for evaporation not only absorbed solar energy but also additional sensible heat of advection, they evaporate more intensively than big lakes.

Cooperation between scientific institutions and local administration

World-wide changes of ecosystems and landscapes induced by humans are presently well recognized not only by scientific circles but also by administrators and the general public. Close cooperation between local administration and scientific institutions is prerequisite to achieve positive effect of implementation of ecological knowledge into practices. Since the end of last century Institute for Agricultural and Forest Environment cooperate with local administration (district, commune, and local society) in the frame of enhancement shelterbelt net, restoration degraded postglacial ponds and other mid-field or village ponds as well as restoration and reconstruction old by palace parks (Fig. 4).

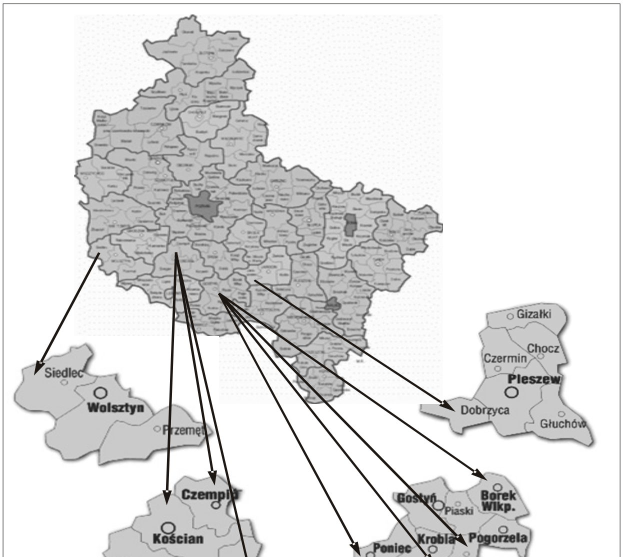


Fig. 4. Communes from Wielkopolska cooperating with Institute for Agricultural and Forest Environment

The first step of this cooperation was inventory and valorizations of small water bodies from their multi-functionality point of view. The following functions were taken into consideration: increasing water retention, improvement of micrometeorological conditions, habitat of small animals, fire-fighting and recreation of village society.

Firstly the map in scale 1 : 10 000 was studied and all potential object was marked. Then group of experts verified everything in the field and all objects were inventoried on the map and described according to the following type of the objects, and the following symbols were distinguished: postglacial pond – P; village pond – S; post peat bog pond – T; local hollow – O; river – R, melioration ditch – M. Size, (length, width) of object, height of slope and special characteristics of each object were noted in the table (Tab. 2).

Next, the following set of criterions determining usefulness of the object for restoration was established (Tab. 3) in such way that the pond having in index most numbers 1. For example: The object has index: 1111w. It means that it is pond having water, have connection with ditch, overgrowing is low and has high slop and is located in the village. Such pond has very high potential for renovation.

Table 2. Documentation of the field investigation

Number of object	Type of object	Size		High of slope m	Characteristic
		Length m	Width m		
Commune: PONIEC					
Sheet: 443.111					
1	P	250	150	1–2	Mid-field pond near Zawady (village), very broad, very unshaven. Large ditch is running near object. Number of photo: S500-1805, IMG-1486
2	S	200	150	1–2	Large pond near landfill after rehabilitation, poorly overgrown by reeds. Can be used for irrigation. Number of photo: S500-1850, 1851

Table 3. Set of criterions of usefulness of inventoried objects

Criterion		Cod or symbol
Existence of water:	yes	1
	no	0
Connection with ditch:	yes	1
	no	0
Area covered by plant	0–25%	1
	25–50%	2
	> 50%	3
Height of slope	0–1 meter	3
	1–2,5 meter	2
	> 2,5 meter	1
Localization in landscape:	village	w
	forest	l
	meadow	m
	field	p

All objects were selected according to the criterions into four groups:

1. Object with water and with connection to the ditch,
2. Object without water but with connection to the ditch,
3. Object with water but without connection to the ditch,
4. Object without water and without connection to the ditch.

The results of the classification for two communes – Poniec and Pępowo are presented in the map (Fig. 5) and in table 4.

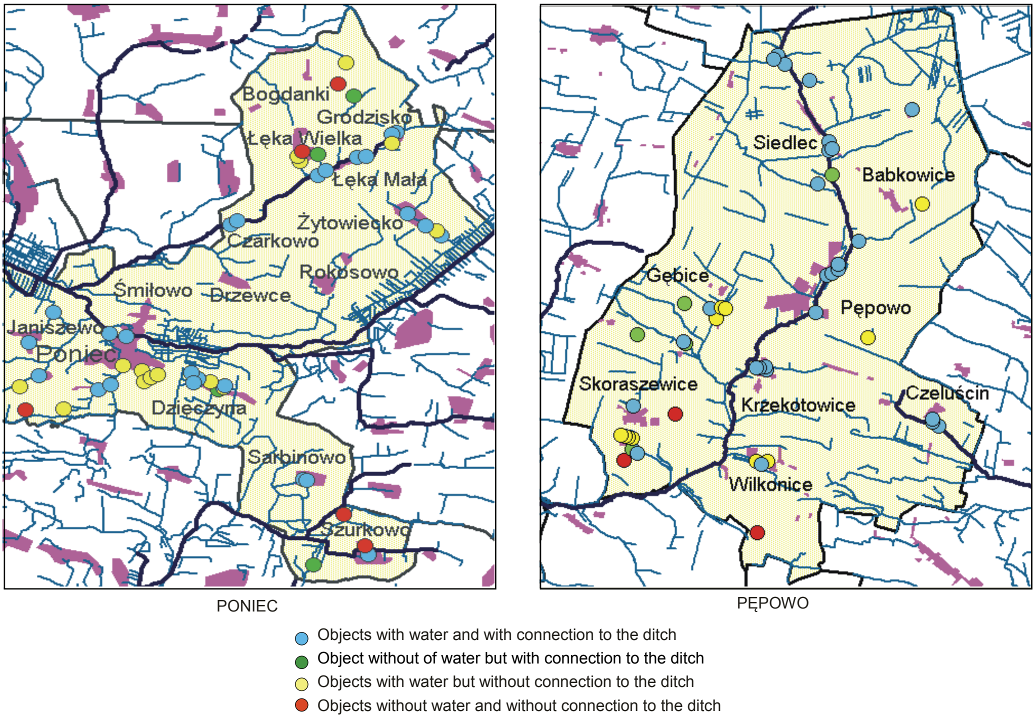


Fig. 5. Localization of different class of water bodies in Pępowo and Poniec communes

Table 4. Classification of water bodies in Pępowo and Poniec communes.

Class of the object	Commune	
	Poniec	Pępowo
Object with water and with connection to the ditch	25	27
Object without of water but with connection to the ditch	4	5
Object with water but without connection to the ditch	14	11
Object without water and without connection to the ditch	5	3
Total	48	46

There are more than 50% of water bodies having high restoration potential.

The next step was meeting of District Council to prepare the schedule of the future work.

Conclusion

To improve the water conditions in an agricultural landscape the following principles must be keep on mind:

1. Developing landscape complexity by introduction of shelterbelts, meadow strips and restoration of midfield ponds;
2. Increasing organic matter content in the soil;
3. Keeping as much water as possible in the landscape for as long as possible, taking care that it is properly allocated;
4. Ensuring that as much water as possible moves from the soil into the atmosphere via plant transpiration, but not as evaporation from the soil.
5. Supplementary to drainage retention, agromelioration measures for improving the physical-water properties of soils and increasing their retention capacities and, consequently, decreasing water deficits for plants during the summer should be widely applied.

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